OECD Science, Technology and Industry
Outlook 2010

Chapter 2

Main Trends in Science, Technology and Innovation Policy

This chapter presents the main trends in national science, technology and innovation policies, with a particular focus on policies and programmes introduced between 2008 and 2010. It discusses developments relating to public-sector research, government support for business R&D and innovation, collaboration and networking among innovating organisations, globalisation of R&D and open innovation, human resources for S&T, and the evaluation of research and innovation policies.

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.

Introduction

Since the 2008 edition of the *OECD Science, Technology and Industry Outlook,* science, technology and innovation policies have continued to evolve in terms of strategic orientation and related governance structures and with respect to the "policy mix" of instruments.[1] A key message is that despite the recent economic crisis, OECD governments so far have maintained – and in some cases expanded – support for research and development (R&D) and innovation as a means to foster longer-term economic growth, especially in the face of growing competition from emerging economies. In particular, strengthening the science base and the business sector's capacity to innovate and generate new sources of economic growth, especially in "green" areas, remains a key focus of public policy. At the same time, policies for supporting science, technology and innovation are becoming more broad-based and interdependent. On the one hand, there is awareness in policy circles that non-technological innovation and the diffusion and application of new and existing knowledge in both the private and public sectors can help foster productivity and generate growth. On the other hand, there is growing recognition that horizontal policies to support business innovation – from R&D tax credits to innovation voucher schemes for small and medium-sized enterprises (SMEs) – must consider the broader local and global technological and economic context. This is illustrated by a growing effort in some OECD countries to better align supply and demand-side public support for innovation. Indeed, and despite the counter-cyclical boost to public and private R&D in response to the recent economic crisis, policy reform remains on the agenda as OECD countries seek to improve the outcomes and impacts of public support to research and innovation.

A broad set of policy trends has thus emerged or been reinforced since the last edition of the *STI Outlook*:

- *Across many OECD countries,* recent policy trends point to a "greening" of national research and innovation strategies as most countries continue to place environmental issues, climate change and energy high on the agenda of their national science, technology and innovation (STI) strategies. Health and quality of life also remain important priorities in the strategies of OECD countries. In addition, national STI strategies are being complemented by national educational initiatives or strategies as well as regional innovation plans.
- *As global growth shifts to areas outside the OECD, emerging economies – from China, Brazil, Russia and South Africa – increasingly focus on innovation as a means to move up the value chain.* The policy focus is not just on developing technological innovations for export competitiveness, but also on using existing technologies and non-technological innovations to address infrastructure and social needs such as water, health, education, transport and energy.
- *The "governance" of STI remains a key issue on national agendas but also with regard to international collaboration to address global challenges.* Some countries have reorganised

ministerial or departmental functions to strengthen the links between R&D and higher education or between industry and research. Others have enhanced structures to involve societal stakeholders. Germany and the Nordic countries have also launched internationalisation strategies for their public research sector in order to facilitate, and to build capacity for, multilateral collaboration in STI.

- *Re-investing in the science base.* Another development in national strategies concerns the re-emergence of the science base as essential to future innovation, especially as concerns the technologies that will be needed to achieve environmental sustainability. Hungary, Japan, Norway and Sweden give the highest priority to strengthening the science base in order to drive future innovation.
- *Countries are focusing support on key research areas and enabling technologies* such as biotechnology, nanotechnology, information and communication technology (ICT), new materials and advanced manufacturing. While most countries support research in such technologies, there is a growing effort to better target policy support at different stages of the innovation value chain (*i.e.* providing incentives for R&D via grants or tax credits, or fostering specific technology clusters or venture funds) in order to enhance the ability of firms to capitalise on public and private investments and specialise in emerging technologies and industries.
- *Reform of funding mechanisms for research institutions continues* to link budget allocations to performance in order to enhance excellence.
- *Full-cost economic recovery for public research funding is gaining ground in OECD countries.* This allows research institutions to amortise assets and overheads and invest in infrastructure at an adequate rate to maintain future capability.
- *Direct and indirect support to business R&D and innovation continues to increase*, but as in previous years it is characterised by streamlining programmes and improving ease of access and use, especially for SMEs. There is also growing interest in assessing the interaction of various policy instruments used in the "policy mix".
- *Countries continue to adjust R&D tax credits* either by reviewing eligible R&D expenditures or reformulating levels of support in order to increase impact and effectiveness in light of their specific industrial structure and context.
- *Demand-side innovation policies such as innovation-friendly procurement and standards,* are receiving growing attention both in OECD and emerging economies although evaluating impacts and aligning demand with supply-side policies remain a challenge.
- *The recent focus on innovation in the public sector*, for example in the United Kingdom and the United States, has received an impetus as fiscal consolidation in OECD countries creates pressure to generate efficiency gains in the delivery of public goods and services, but also presents new opportunities for innovation.
- *Fostering industry-science relations is an area of continuing reform and policy experimentation.* Countries continue to reform their universities to allow for greater collaboration and public-private partnerships. New initiatives include programmes to speed up commercialisation and promote academic entrepreneurship and spin-offs.
- *Policies to support knowledge networks and markets are emerging.* Key instruments include measures to upgrade ICT infrastructure, improved access to public research data and IPR training on and support for intellectual property rights (IPR) in academia.

- *Support for non-technological and user-driven innovation, including in services, is increasing in some countries*. Recognising that non-technological and other forms of innovation (*e.g.* design, branding) are important for competitiveness, especially in services firms, member countries such as Chile, Denmark, Finland and the United Kingdom, as well as non-members such as Brazil, are trying to raise awareness and encourage non-technological innovation alongside technological innovation.
- *Human resource development and capacity building remain important for innovation*. Policies to improve the development of human resources in science and technology (HRST) range from initiatives to raise interest in and awareness of science among youth, reduce gender gaps in science and technology education, and improve funding opportunities for PhD study and postdoctoral training.
- *The international mobility of students and young researchers and other highly skilled expatriates also remains a high priority in OECD countries that compete for foreign talent*. However, as patterns of world trade, foreign direct investment (FDI) and R&D evolve to include more south-south flows and north-south flows, the international mobility of the highly skilled may also evolve, making it more challenging for some OECD countries to attract foreign talent.
- *A broad-based approach to evaluation is developing that takes into account the qualitative impacts on the economy* as well as the impacts on the missions and development of research institutions themselves. There is also increasing interest in using evaluation findings for policy design.

National strategies for science, technology and innovation

At first glance, the national innovation strategies of OECD countries appear broadly similar. Indeed, strengthening business innovation to improve industrial competitiveness remains a common goal of national plans or strategies for science, technology and innovation in OECD countries especially in terms of raising productivity growth, jobs and living standards. Non-member and emerging economies also view innovation as a means to modernise economic structures and achieve sustainable growth. However, even among OECD countries there are differences in emphasis. For countries that already rank high in terms of business R&D and innovation, such as Korea, Japan and the United States, there is renewed focus on investing in the science base, both public research and human resources, to strengthen the base for future innovation. These countries are also prioritising their research and innovation support to gain competitive advantage for future growth areas such as green technologies and health and at the same time helping to address global challenges. In Germany, for example, successive governments decided to continue the High-Tech Strategy beyond its first phase (2006-09) until 2013, and then 2020, but with a focus on priorities: health, nutrition, climate protection, energy, mobility, security and communication. These are areas in which Germany has the potential to develop lead markets and which contribute to addressing social and global challenges. In addition, in 2009, the federal government and the *Länder* decided to continue three major German policy initiatives that complement the High-Tech Strategy: the Higher Education Pact, the Initiative for Excellence and the Joint Initiative for Research and Innovation. The total funding volume amounts to EUR 18 billion.

For OECD countries in which innovation performance lags, there is a focus on building the institutional capacity to steer or "govern" STI policies, to strengthen the links between public research and industry and to improve the quality of higher education and research. For their part, catching-up and emerging economies are seeking to integrate STI strategies as part of their national economic development strategies. A summary of major developments is presented in Table 2.1.

Table 2.1. **Revised or new national plans for science, technology and innovation policy in OECD countries and selected non-member economies, 2010**

Country	National plan	Period covered	Main objectives
Australia	Powering Ideas: An Innovation Agenda for the 21st Century	2009-20	Integration of innovation across the economy, supported by a substantial boost in funding to: improve high-quality research; reinforce the base of skilled researchers; foster industries of the future and secure value from R&D commercialisation; improve dissemination of new technologies, processes, and ideas; encourage a culture of research; increase sectoral and international collaborations on R&D; and improve policy development and service delivery.
Austria	National STI Strategy 2020	2010-20	Improve networking and co-operation between science and industry; strengthen framework conditions; public infrastructure; financing innovation and foster human resources for innovation.
Belgium	Federal Government Agreement	Since 2008	Federal Belgian policy focuses on reducing costs of researcher employment, stimulating the creation and development of SMEs and supporting R&D efforts towards the 3% of GDP Lisbon target.
	Flanders in Action and Pact 2020	2009-20	Flemish policy focuses on the 3% targets boosting investments in higher education institutions (up to 2% of GDP), boosting creativity and innovative capacity, giving more attention to research outputs, encouraging students to study sciences and giving researchers better prospects. Flanders also foresees a simplification of the set of innovation policy instruments.
	Marshall Plan 2.0 Vert	Since 2009	Wallonia's strategy focuses on boosting business R&D and linking universities to industry, consolidating clusters, especially in environmental technologies, strengthening human capital and vocational training, and putting a stronger focus on sustainable development.
	2006 Regional Innovation Plan	2007-13	Brussels Capital Region focuses on regional clusters and plans to increase regional R&D capacities up to the 3% target by focusing on three areas (ICT, health, environment).
Brazil	Action Plan in Science, Technology and Innovation for National Development	2007-10	Leverage STI for Brazil's sustainable development: boost innovation in the business sector, *inter alia*, by increasing the share of researchers in firms to 33.5% and the share of innovative firms receiving government support to 24% by 2010 and consolidate the national innovation system (the Brazilian Technological system, SIBRATEC).
	Productive Development Programme	Since 2008	Raise private R&D expenditures to 0.65% of GDP. Increase innovation resources; strengthen IPR system (double patent deposits by national firms in Brazil and triple patent deposits abroad).
Canada	Mobilizing Science and Technology to Canada's Advantage	2007 onwards	The strategy is based on four guiding principles: promoting world-class excellence; focusing on priorities; fostering partnerships; and enhancing accountability. In June 2009, the government released a progress report on the implementation of the strategy, and expressed its commitment to bring forward investments to make Canada a world leader in science and technology.
Chile	National Innovation Strategy for Competitiveness	From 2006	Build the institutional framework for the national innovation strategy in order to improve medium-term competitiveness and, in the longer term, double GDP per capita; improve technology absorption; increase critical mass in scientific capacity; build human resources in S&T.

Table 2.1. **Revised or new national plans for science, technology and innovation policy in OECD countries and selected non-member economies, 2010** *(cont.)*

Country	National plan	Period covered	Main objectives
China	Medium- and Long-term Programme for Science and Technology Development	2006-20	Enhance China's S&T and innovation capabilities; use innovation as a tool for restructuring Chinese industry; shift growth modes from investment-driven to innovation-driven; build a conservation-minded and environmentally friendly society; and enhance independent innovation capabilities as a national priority. Raise R&D investment to 2.5% of GDP by 2020; rank in the world top five in patenting and international citations.
Czech Republic	National Policy for Research Development and Innovation	2009-15	Improve efficiency of and simplify R&D support, support excellence in R&D and facilitate application of R&D results in innovation, strengthen co-operation with users of R&D results, improve organisational flexibility of public research institutes, ensure HRST supply, increase involvement in international co-operation. Four thematic areas have been prioritised: sustainable energy and competitive industry, molecular biology for health and prosperity, information society, society and environment.
Denmark	Denmark 2020 – Knowledge > growth > prosperity > welfare	2010-20	Increase public investment in research and innovation, strengthen fundamental research and develop world-class universities (at least one Danish university to be in Europe's top ten by 2020), improve co-ordination in the national innovation system, focus on green research and innovation, increase internationalisation of universities (all Danish universities should maintain or improve their international rankings).
Estonia	Knowledge-Based Estonia. Estonian Research and Development and Innovation Strategy	2007-13	Increase value added in manufacturing and services and enhance export capability: increase intensity and quality of R&D (increase R&D expenditures, HRST supply, patenting, publications, develop a digital research system and new research, development and innovation infrastructures); foster innovative entrepreneurship (increase business investment in R&D and innovation, employment, productivity and commercialisation); create an innovation-friendly society aimed at long-term development (attract foreign investments and foreign talents, increase international co-operation, develop national brands and trademarks internationally).
Finland	National Innovation Strategy	2007-11	Make Finland's innovation environment one of the best in the world by 2015. Raise R&D to 4% of GDP by 2010, develop demand- and user-driven innovation policy.
	Internationalisation of education, research and innovation (ERI)	2010-15	Secure financing and human resources, create and maintain infrastructures, speed up the internationalisation of enterprises, promote networking and risk-taking.
France	National Strategy for Research and Innovation	From 2009	Strengthen incentives for the private sector to invest in R&D (increase in the Research Tax Credit, CIR), develop synergies between key innovation actors and improve transfer from public research to innovation (competitiveness cluster policy), support SME competitiveness and growth through better funding. Three priorities over the next four years: health, well being, food and biotechnologies; environment, emergency and eco-technologies; and information, communication and nanotechnologies.
Germany	High-Tech Strategy 2020	2020	Following a review, the strategy now focuses on priorities which have been defined in accordance with lead-market-oriented topic areas in which the state has special responsibilities and which are of special societal and global relevance: health, nutrition, climate protection, energy, mobility, security and communication.

Table 2.1. **Revised or new national plans for science, technology and innovation policy in OECD countries and selected non-member economies, 2010** *(cont.)*

Country	National plan	Period covered	Main objectives
Greece	Strategic Plan for the Development of Research, Technology and Innovation	2007-13	The priority areas of the "Strategic Plan" are: • Increase and improve investments in knowledge and excellence with a view to sustainable development. • Promote innovation, the dissemination of new technologies and entrepreneurship to generate economic and social "value". A New Action Plan for Research and Technology is under preparation aimed at linking R&D policy with the country's growth model, promoting "green" activities, enhancing human S&T resources, promoting excellence and quality in research, and making Greek innovation more outward-oriented. Finally the recent transfer of the General Secretariat for Research and Technology to the Ministry of Education, Lifelong Learning and Religious Affairs underlines efforts to build a unified area for Education and Research.
Hungary	S&T Innovation Policy Strategy	2007–13	Increase total R&D expenditure to 1.8% of GDP by 2013 with half the R&D performed by the business sector. Strong focus on "key technology areas" (incl. ICT, biotech, nanotech, renewable energy resources tech., environmental technologies), commercialisation (translation into knowledge-based industries) and regional innovation systems.
Iceland	Policy Statement of the Science and Technology Policy Council	2009-12	Revise support system for R&D and innovation (including competitive funding, real cost model for R&D, quality assessment and performance-based funding, tax incentives), greater focus on design and creative industry, consolidate R&D infrastructure, improve access to and utilisation of research results.
India	Science and Technology for the XIth Five Year Plan and other policy documents	2007-12	Increase R&D spending to 2% of GDP with the business sector doubling its contribution; give top priority to primary education and higher education (increase spending by 6% of GDP by 2015) as well as vocational training; better link public research to business needs; strengthen IPR; promote international co-operation; foster research and innovation in agricultural sector (*i.e.* the Second Green Revolution) to address climate change.
Ireland	Strategy for Science, Technology and Innovation	2006-13	Promote R&D to become an innovation-driven economy; improve competitiveness; remain attractive for FDI; and maximise social cohesion. Increase R&D expenditures to 2.5% of GNP by 2013.
Israel	Series of national reports and STI related policy documents		Increased investments and greater policy focus on biotechnology, nanotechnology and low-tech industries. Growing interest in cleantech sectors (renewable energies, water and oil substitutes). Establish and develop an information system on innovation (*i.e.* innovation survey and database).

Table 2.1. **Revised or new national plans for science, technology and innovation policy in OECD countries and selected non-member economies, 2010** *(cont.)*

Country	National plan	Period covered	Main objectives
Italy	National Research Plan	2010-12	Promote knowledge-driven research, strengthen the involvement of business sector and co-operation with the public sector, support the internationalisation of research. Promote centres of excellence in the national/international context, concentrate efforts on large projects and research infrastructure (*www.istruzione.it/web/ricerca/pnr_2010-2012*).
	Industry 2015	2006-15	Enhance competitiveness of the productive system through the implementation of industrial innovation projects; promote public-private partnerships.
	Strategy for the Internationalisation of the Italian Research	2010-15	Renew the vision of Italian research in the European/ international context for implementing the EU2020 strategy, adapting the national context to the present global situation, in a prospective of a sustainable society. (Ministerial act of address 2010)
	Research Infrastructures of Excellence for Italy – The Italian Roadmap 2010	2010-12	Identify research infrastructures of excellence in all areas demanded by Italian scientific communities and recognised by all stakeholders, taking into account the international and European context and expressed priorities for the next 5-10 years.
Japan	New Growth Strategy	2009-20	Lead the world in green innovation and life innovation; increase the number of world-leading universities and research institutions and reform public research institutes; ensure full employment of S&T doctorate holders and provide young researchers with career prospects; foster innovation; encourage utilisation of intellectual property by SMEs; improve ICT use; increase public and private investment in R&D (4% of GDP); improve government services delivery.
Korea	2nd S&T Basic Plan – "577 Initiative"	2008-12	Become one of top five countries in terms of S&T competitiveness by 2012 with highly advanced S&T; increase total R&D investments up to 5% of GDP in 2012; set 7 strategic areas and systems; become the 7th S&T power in the world. Increase the ratio of basic research up to 50% of public R&D investments (focusing especially on basic sciences and big science).
	National Strategy and Five Year Plan for Green Growth	2009-13	The National Strategy fixes a long-term agenda and objectives to mitigate climate change, enhance energy independence and create new economic growth engines (green technologies, green industries, advancing industrial structure, and engineering a structural basis for the green economy) and to improve quality of life and enhance international standing (greening the land, water, building, transport infrastructure, daily life, and becoming a role-model for the international community). The first Five-Year Plan for Green Growth, as a mid-term plan, sets specific budget earmarks and detailed tasks (*e.g.* invest about 2% of annual GDP on green growth programmes and projects).
	International Science-Business Belt Plan		Strengthen basic science and links to business opportunities.
Luxembourg	National Plan for Innovation and Full Employment	2009-14	Increase and improve R&D investments notably by firms, increase R&D activities and increase supply of human resources through better employment conditions. Support innovation in all its forms in encouraging new business creation, promoting intellectual property and norms, accelerate the transition towards an information society by generalising ICT use, developing ICT infrastructures and ensuring quality and security.

Table 2.1. **Revised or new national plans for science, technology and innovation policy in OECD countries and selected non-member economies, 2010** *(cont.)*

Country	National plan	Period covered	Main objectives
Mexico	Programa Especial en Ciencia, Tecnología e Innovación (PECiTI)	2007-12	Apply short-, medium- and long-term state policy to strengthen education, basic and applied science, technology and innovation; decentralise scientific, technological and innovation activities; promote greater funding of basic and applied science, technology and innovation; increase investment in infrastructure for science, technology and innovation; evaluate public investment in development of human resources in S&T and scientific research, innovation and technology.
Netherlands	Innovative, Competitive and Enterprising	2007-11	Strengthen the innovativeness of the Dutch business sector: stimulate innovation in SMEs and promote environmental innovation in industry; foster the development of strong internationally prominent clusters; pursue social innovation (health, safety and security, water, energy); support eco-efficient innovation; strengthen workforce through education and research and strengthen higher education system.
New Zealand	Picking up the Pace – Economic Transformation Agenda	From 2006	Plan for the Ministry of Research, Science and Technology to set clearer directions for research, create a more stable funding environment, accelerate commercialisation of research; support long-term sustainable investment in research, science and technology; support high performers; support engagement of New Zealanders in research, science and technology; and skills for the future. New statement in 2010 to commit to high-quality innovation in traditional resource sectors and to boost support to innovation in new knowledge-intensive activities.
Norway	White Paper on Climate for Research	2009-onwards	The major shift in research policy introduced with the White Paper in 2009 consists of a stronger focus on impacts and results. The White Paper on research defines the nine goals and output areas. These output goals are meant to complement the long-term ambition that total R&D expenditure will reach 3% of GDP. The new goals imply a new direction in research policy with a stronger emphasis on global challenges, welfare issues in research, and on impacts and results. One goal is to introduce a systematic approach to indicators, evaluations and other types of assessments of research.
	White Paper on "An Innovative and Sustainable Norway"		Increase innovation by advancing: a creative society with a sound framework and a favourable climate for innovation.; creative human beings who develop their resources and competences, while grasping the possibility to apply them; and creative undertakings that develop profitable innovations. Improve the knowledge base and establish strategy councils in specific areas (for SMEs and environmental technology further to those for tourism and the maritime industry).
Poland	Strategy for increasing the innovativeness of the Polish Economy	2007–13	Develop human resources to build the knowledge-based economy; link public R&D activities to the needs of the enterprise sector; improve IPRs; mobilise private capital to create and develop innovative companies; build the infrastructure for innovation.
	National Foresight Programme – Poland 2020	2020	Four development scenarios for Poland to 2020. Based on a special report, *Poland 2030. Development Challenges*, that outlines potential routes for Poland's development during the next 20 years and will serve as the basis for the Long-term Strategy of Developing Poland.
Portugal	Technological Plan of the New Government Programme	2006-10	Raise the number of researchers and new PhDs; increase investment in R&D in the public (x 2) and private (x 3) sectors, increase patenting and citations; promote industry-science co-operation, develop partnerships for innovation and employment and activate clusters.

Table 2.1. **Revised or new national plans for science, technology and innovation policy in OECD countries and selected non-member economies, 2010** *(cont.)*

Country	National plan	Period covered	Main objectives
Russian Federation	Strategy for Developing Science and Innovation	To 2015	Raise domestic R&D spending to 2% of GDP by 2010 and to 2.5% by 2015; enhance the prestige of Russian science; increase level of patent activity and capitalisation of R&D; raise the number of small innovative enterprises; and increase innovation activity.
Slovak Republic	Long term Objective of the State S&T Policy of the Slovak Republic to 2015	2008–15	Higher involvement of science and technology (S&T) in development and more intensive use of S&T in solving economic and social problems. Better conditions for developing S&T in the Slovak Republic and through participation in the European Research Area. Setting targets for S&T development in ten focus areas.
	Innovation Strategy	2007-13	Building high-quality infrastructure and an efficient system for the development of innovation; developing high-quality human resources; developing efficient innovation policy tools including support to entrepreneurs, technology transfers and business innovation.
Slovenia	Slovenian Development Strategy	2006-13	Better link science to business needs and capabilities; increase R&D expenditures and promote business R&D investment; raise business absorption capacity and encourage commercialisation of research results; reform the organisational structure of public R&D; increase the number of researchers and sectoral mobility; shift public research towards applied and targeted research; encourage international co-operation; stimulate patenting and high-tech exports.
	National Research and Development Programme	2006-10	The programme has six main goals: *i)* increase the impact of R&D and technology transfer to the business sector, *ii)* increase investment in R&D to 3% of GDP by 2010 and double private sector investments in R&D, *iii)* increase the quality of R&D by redefining the mission of higher education institutions and public research institutes, introduce overall supervision of public R&D activities, reform the evaluation system and strengthen international co-operation in R&D, *iv)* strengthen human resources in R&D, *v)* develop a supportive environment for R&D, *vi)* increase the number of high-tech and innovative companies.
South Africa	Ten Year Innovation Plan (TYIP)	2008-18	The TYIP is aimed at underpinning the country's transformation to a knowledge economy and will be driven by four elements: human capital development (HCD); knowledge generation and exploitation (R&D); knowledge infrastructure development; and policy and institutional enablers to address the "innovation chasm" between research results and socioeconomic outcomes.
Spain	State Innovation Strategy E2I:	2010 onwards	The aim of the strategy is to increase the number of innovative businesses. It is based on five core areas of action: *i)* the modernisation, adaptation and creation of a financial environment conducive to entrepreneurial innovation; *ii)* backing innovative and socially oriented markets through regulation and public procurement; *iii)* internationalisation of innovation activities; *iv)* co-ordination of public policies by means of territorial integration with particular emphasis on the production sector and SMEs; and *v)* human capital.
	The National R&D&I Plan 2008-11		Includes specific public funding instruments to support strategic research in health, biotechnology, energy and climate change, telecommunication and information societies, nanotechnology, new materials and new industrial processes.

Table 2.1. **Revised or new national plans for science, technology and innovation policy in OECD countries and selected non-member economies, 2010** *(cont.)*

Country	National plan	Period covered	Main objectives
Sweden	Sweden Research and Innovation Bill	2009-12	Successive increases in central government support during 2009-12, to reach a permanent increase of SEK 5 billion in 2012 (EUR 500 million) – total addition of SEK 15 billion. The bill implements the largest reform of the funding system for basic research in over 60 years (introduction of appropriations by strategic areas). Strengthen quality relevance and competitiveness with a view to maintaining Sweden's place in the international research arena.
Switzerland	Education, Research and Innovation (ERI) Dispatch	2008–11	The goal of all planned measures is to enable the players and institutions of the ERI sector to extend Switzerland's capacities as a location for thought and work. Education is guided by the principle of securing and improving quality, and the goal in research and innovation is increased competitiveness and growth.
Turkey	National Science and Technology Policies Implementation Plan (BTP-UP) for 2005-2010	2005-10	Seven core strategic objectives: *i)* increase S&T awareness in society and improve STI culture; *ii)* advance the quality and quantity of human resources for S&T; *iii)* support high-quality, results-oriented research; *iv*) enhance the effectiveness of STI governance; *v)* boost S&T performance of the private sector; *vi)* improve the research climate and research infrastructure; *vii)* further the effectiveness of national and international networks.
	International STI Strategy	2008-10	Encourage entrepreneurship, innovation and productivity; use S&T capacity; support the development of sustainable strong competitive markets; develop appropriate infrastructure and environment; international co-operation and co-ordination of the innovation system.
United Kingdom	Science and Innovation Investment Framework	2004-14	Retain and build world-class centres of excellence; improve the responsiveness of publicly funded research; increase business investment in R&D; strengthen supplies of scientists, engineers and technologists; ensure sustainable and financially robust universities and public laboratories; boost public confidence in and awareness of scientific research.
	Innovation Nation White Paper	2008	Promote innovation in business and make the public sector and public services more innovative; strengthen use of procurement and regulation.
United States	A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality	From 2009	The US Innovation Strategy is organised around three pillars: invest in the building blocks of American innovation, including R&D and human, physical and technological capital; promote competitive markets that spur productive entrepreneurship; and catalyse breakthroughs for national priorities such as developing alternative energy sources and improving health outcomes.
	American Recovery and Reinvestment Act (ARR)	2009-2013	Out of the USD 787 billion allocated under the AAR, USD 100 billion will be used to support investment in innovative and transformative programmes. In this context, four areas are targeted: modernisation of transport, including advanced vehicle technology and high-speed rail; renewable energies (wind and solar); broadband, Smart Grid, and health IT; and groundbreaking medical research.

Source: Responses to the STI Outlook 2010 Policy Questionnaire; OECD (2008), *OECD Science, Technology and Industry Outlook*, OECD, Paris; European Commission, ProInno Europe country reports and national sources.

Selecting and focusing S&T policies on priority areas

National plans serve to articulate priorities for research and innovation and to set out policies and instruments. Table 2.2 highlights the continued shift towards environmental sustainability in the strategic orientation of national priorities across OECD countries. In addition to environment and energy, new and emerging technologies as well as food security issues remain high on the STI policy agenda. Social issues such as health-related sciences, transport, ageing and urbanisation also rank high in national STI strategies.

Table 2.2. **Main national priorities in research and innovation policy, 2010**

	Strategic STI policy priority areas											
	National security	Environment, climate change and oceans	Natural resources and energy	Food security	Health and related life sciences (incl. biotech.)	Social challenges (incl. pension, transport, urbanisation, housing)	Engineering and advanced manufacturing	New materials/ technologies (incl. nanotech.)	ICT	Children, education and creativity	Regional influence, tourism and culture	Others[1]
Austria	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Belgium (Flanders)		✓			✓	✓		✓	✓			✓
Belgium (Wallonia)				✓	✓	✓	✓					✓
Canada		✓	✓		✓			✓	✓			
Czech Republic		✓	✓		✓	✓			✓		✓	
Denmark		✓	✓	✓	✓	✓		✓	✓	✓		
Finland	✓	✓	✓			✓						
France		✓	✓		✓	✓		✓	✓			
Germany	✓	✓	✓		✓	✓	✓	✓	✓			✓
Hungary		✓	✓		✓			✓	✓			
Israel		✓	✓		✓			✓	✓			✓
Italy	✓	✓	✓	✓	✓		✓	✓	✓		✓	
Japan		✓	✓	✓	✓	✓			✓	✓	✓	
Korea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Netherlands	✓	✓	✓	✓	✓	✓		✓		✓		✓
New Zealand		✓	✓	✓	✓	✓						
Norway		✓	✓	✓	✓			✓	✓	✓	✓	
Slovenia		✓	✓	✓	✓	✓		✓	✓			
Spain		✓	✓		✓			✓	✓			
South Africa		✓	✓		✓	✓						✓
Sweden	✓	✓	✓		✓	✓	✓	✓			✓	
Turkey	✓	✓	✓	✓	✓		✓	✓	✓			
United Kingdom		✓			✓			✓	✓			
United States	✓	✓	✓		✓							

1. Others policy priority areas include: space in Belgium, Korea and South Africa; mobility in Germany and the Netherlands; and low-technology industries in Israel.

Source: Responses to the STI Outlook 2010 Policy Questionnaire.

High-quality S&T governance and reform

A key element of national STI strategies is the governance structure for STI policy making. In most OECD countries, but also in non-members, the governance of STI is organised as a multi-layered matrix in which ministerial bodies, advisory bodies and a range of different actors are involved in the making and steering of policy and its implementation. This matrix has bottom-up and top-down flows in the advisory and decision-making processes. As in previous years, some countries have created new interministerial committees or co-ordinating councils which often operate at the top levels of government. Some countries are also making changes at the operational level, such as merging the functions of various agencies, in order to improve co-ordination and implementation.

Advisory councils, co-ordination and implementation

The creation of interministerial councils at the highest levels of government to develop national strategies for science, technology and innovation has become more widespread in the past decade. Many of these councils are assisted by high-level expert or advisory councils with links to research funding agencies and non-governmental stakeholders. Overall, many countries have seen increased participation by various actors in the STI system and governments have responded by developing or strengthening co-ordinating structures.

New institutions and institutional structures

Changes in institutional structures for STI policy have sometimes resulted from efforts to consolidate responsibility for related policy areas under a single institutional umbrella in order to improve co-ordination or to reflect the higher priority of these fields. In other cases, they reflect changes in government and a reshuffling of responsibilities. Some countries have reorganised ministerial or departmental functions to strengthen the links between R&D and higher education. The following are some of the recent changes:

- In Austria, following a recent review of research and innovation policy, the government is reassessing the role and organisation of its two advisory councils (the Research, Technology and Innovation Council and the Science Council) in order to improve STI governance.
- In Belgium, the roles of the advisory bodies of Flanders and Wallonia have been broadened. The Flemish advisory board now advises on innovation policies in general, while the Walloon body takes care of specific policies for the French speaking community (*e.g.* education policies).
- The Canadian federal government took steps to enhance accountability and value for money from the Granting Councils. The Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC) have separated the roles of President and Chair of the Granting Councils and increased membership in the councils from the research user community. Other initiatives are under way to better co-ordinate programmes, facilitate interdisciplinary and international collaboration, and improve client service. Efforts are being made to collect and report standardised data on the results and impacts of investments made by the three Granting Councils and the Canada Foundation for Innovation (CFI). The Government of Canada has also taken significant steps to realise gains in S&T management – moving forward with activities aimed at strengthening Canada's domestic and international science and technology (S&T) partnerships and seeking a fresh approach to accessing external S&T advice.
- In the Czech Republic, the government has reduced the number of funding bodies from 22 to less than ten, simplified administrative procedures and introduced a Technology Agency for applied R&D.

- The Danish advisory and funding system for research was evaluated in 2009. Based on this evaluation, the legislation was revised in 2010, with changed requirements for peer reviews of applications, a stronger international orientation, closing down of the co-ordinating body of the system, and strengthening of the independent policy advisory body.
- The Finnish Advisory Board for Sectoral Research, whose goal is to improve the commissioning of sectoral research by government ministries and enhance the targeting of sectoral research across administrative boundaries, has been strengthened and instructed to co-ordinate the overall steering of sectoral research funded by the government.
- In 2010, in line with government decree [198/2005(IX.22)], Hungary launched an evaluation of the Operation of the Research and Technology Innovation Fund over 2004-09 to consider the system and context requirements for the evaluation of publicly financed STI programmes.
- Since 2009, the Israeli government has shifted from an annual to a biennial budget which allows for better planning and execution of STI policies and budgets.
- Since it reorganised its Ministry for Education, University and Research in 2009, Italy promotes a new approach to STI policies at national and international level, with the establishment of a General Directorate for Internationalisation of Research. During 2009 and 2010 several interministerial groups involving different national STI stakeholders were established to broaden the national debate and improve decision processes in key sectors (*www.istruzione.it/web/ministero/organizzazione/dg_uni_internazionalizzazione*).
- In 2008, the new Korean administration merged a number of STI agencies into two ministries: the Ministry of Education, Science and Technology (MEST), which mainly focuses on basic R&D, and the Ministry of Knowledge Economy (MKE), which mainly focuses on industrial applied R&D.
- In New Zealand, the government has made changes to institutional arrangements for the publicly owned Crown Research Institutes and in March 2010 merged the Ministry for Research, Science and Technology with the main funding agency, the Foundation for Research, Science and Technology. This merger led to strategic priorities and operational decisions about funding allocations made by the same department.
- South Africa is introducing a new Technology Innovation Agency (TIA) to stimulate and intensify technological innovation. The TIA will be fully operational in 2013 with the establishment of national and provincial TIA offices, the implementation of a framework for Centres of Competences and the creation of a National Intellectual Property Management Office (NIPMO). The TIA will head and consolidate existing funding programmes including the Innovation Fund (IF), the Support Programme for Industrial Innovation (SPII), and the Technology for Human Resources in Industry Programme (THRIP). In parallel the government has enacted the establishment of a National Space Agency.
- The Spanish government is working on a new Science and Technology Act that will create a new framework for research funding. The State Research Agency will be the funding body for basic research in Spain. The act will 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 STI governance.
- Switzerland's innovation promotion agency (CTI) has become an independent authoritative government commission. Beginning in 2011, CTI is taking up business activities in its new form. The promotion activities of CTI are not affected by this organisational change.

- The United Kingdom's White Paper, *Innovation Nation*, mentions that regional development agencies (RDAs) and devolved administrations will work with the Technology Strategy Board (TSB) in developing strategies and programmes for translational research, infrastructure and demonstration together with the Research Councils. RDAs and the TSB have also put in place new arrangements to align their funding and activities to implement the recommendation in the Sainsbury Review to enable a collective RDA network investment of at least GBP 180 million over three years (2008-11) in activities to support the Technology Strategy. Further, the Science and Innovation Investment Framework (SIIF) aims to develop closer working relationships between regions and central government departments in order to ensure the best use of resources at national and regional level. Consequently, certain elements of government funding are now being managed at the regional level.

Box 2.1. **Russian initiatives in green technologies**

Among the latest Russian initiatives in the area of green technologies are the following:

- The Water Strategy of the Russian Federation for 2020 (adopted in 2009), envisages the development of mechanisms to implement technologies for improving the use of water resources. A special section is devoted to S&T issues, including the introduction of the best available technologies for supplying water to industrial enterprises, agriculture and households, purification and the efficient use of water, monitoring and forecasting water resources, etc.
- The Russian Priority Areas for S&T Development approved by the President in 2006 include the area of "Rational Use of Natural Resources" which includes five critical technologies for environmental protection. The priorities are implemented via funding relevant projects in the framework of the Federal Targeted R&D Programme managed by the Russian Ministry of Education and Science.
- President Medvedev initiated a technology modernisation programme for Russian industry with a focus on the energy sector and the introduction of green technologies.
- The Russian Ministry of Natural Resources and Environment recently declared it would introduce stronger penalties for harmful impacts on the environment by industry and that it would decrease those penalties (up to 70%) for the enterprises that introduced green technologies.
- The development of the Environmental Strategy of the Russian Federation for 2030 is currently one of the key tasks for the Ministry of Natural Resources and Environment. The introduction of the best available technologies is the key instrument to achieve the goals of the Strategy.
- The Center of Ecological Certification – "Green Standards", operating under support of the Russian Ministry of Natural Resources and Environment, is involved in developing regulations to ensure the functioning of the systems of ecological certification. The non-profit partnership Center of Ecological Certification – "Green Standards" has developed two systems of voluntary certification for the building sector: "Green standards" and "Ecological passport".
- The Federal Targeted "National Technological Base" Programme (2007-11), co-ordinated the Russian Ministry of Industry and Trade, aims to, *inter alia*, improve the ecological situation of the country.
- The Russian Ministry of Natural Resources and Environment has presented to the conclusion of the Ministry of Justice of the Russian Federation legislative amendments aimed at enhancing environmental protection. The amendments envisage the possibility of an unequivocal definition of environmental harm and increasing penal sanctions for ecological infringements.
- The "RosNano" State Corporation is elaborating a system of standards for nano-products that would allow the identification of, *inter alia*, materials and technologies potentially harmful for the environment.

Source: OECD, based on national sources.

Evaluation

The demand for effective evaluation tools to inform decisions on research funding and impacts has increased in line with public investments in R&D and innovation as countries try to enhance competitiveness and improve innovation capacity. The increased interest in evaluation also reflects societal demands for greater accountability. While much of the policy discussion on evaluation has focused on applying quantitative methods and tools to assess impacts, increasing attention is being paid to developing a broad-based approach that takes into account the qualitative development of research institutions with regard to their changing missions and ability to adapt. Of course, evaluation concerns not only discrete policy interventions or instruments but also entire research portfolios or the overall research and innovation system. International peer review of institutions or entire systems are increasingly used for this purpose. Finally, there is increasing public demand for extending evaluation processes to enhance the understanding of possible scientific and technological developments and their impacts on the wider economy and society.

Among the recent initiatives reported to the STI Outlook Policy Questionnaire are the following:

- In Belgium the Federal Science Policy Office has launched an international network financed by the European Commission on "impact assessment". The Walloon Council for Science Policy has carried out several broad evaluations, benchmarking Wallonia and comparing its recovery with European regions presenting similar industrial traditions. Following these evaluations, many recommendations were made to the Walloon government. Flemish research institutes have been evaluated by looking at their broader socioeconomic impact and efforts have been made to use an evaluation toolbox to determine a balance between research funding instruments.
- In 2008 The Danish Ministry of Science, Technology and Innovation drew up a framework for its research evaluation practices which deals with a number of questions concerning research evaluations such as their organisation and the principles on which they rely. The purpose of the evaluations is to document the quality of Danish research, create a basis for qualifying future prioritisations, and assess the results of research investments. The framework covers four areas: funding instruments, areas of research, research programmes and research systems. To create the highest possible degree of transparency, guidelines have also been drawn up. They contain a detailed description of the evaluation process, including when different stakeholders are involved.
- Finland's Science and Technology Policy Council has initiated an effort, spearheaded by Tekes and the Academy of Finland, to develop a commonly accepted Impact Framework and Indicators for Science, Technology and Innovation (VINDI). Within the framework, the impacts of science, technology and innovation are examined in relation to four key societal and economic areas: *i)* The economy and renewal. This impact area addresses the economic impacts of science, technology and innovation; *ii)* Learning and skills. The impact area of learning and skills includes the impacts of R&D and innovation activities on the accumulation of knowledge, a skilled labour force and networks of experts; *iii)* Well-being of Finns: This impact area consists of impacts of science, technology and innovation on the objective and subjective factors of well-being, such as health and social relations; *iv)* Environment. The impact area of environment addresses the impacts expected from science, technology and innovative activities in the face of environmental challenges such as climate change.

- From 2008, responsibility for the evaluation of Germany's technological performance and innovation system was transferred to the Expert Commission for Research and Innovation (EFI), established in 2007, which now publishes an annual expert opinion on federal policies for research, innovation and technological productivity.
- In Italy, a new Agency for Assessment of the University and Research Institutions (ANVUR) was established in February 2010 under the supervision of the Ministry for Education, University and Research and based on the positive evaluation experience previously developed in CIVR (*www.civr.miur.it*). It represents a completely new approach for the evaluation of national research quality (*http://anvur.miur.it/index.php/*). Part of the central institutional budget for ordinary financing is assigned to universities based upon the results of the evaluation. At local level, universities and research institutions have already adopted the ANVUR criteria and excellence indicators to distribute human and limited financial resources to research groups. The national large-scale facilities, which grant open access to research groups on the basis of excellence, have developed evaluation procedures close to those typically applied at international research infrastructures.
- In New Zealand, the government increased its emphasis on evaluation at the programme level to measure the benefits of investment in R&D and assess the value for money from such investments. In the specific case of research targeted to industry needs, the government has used several methods in parallel to identify economic impacts. These include microeconomic case studies showing qualitative and quantitative impacts, general equilibrium modelling of diffuse economy-wide impacts and counterfactual microdata analysis. Agencies have sought to collaborate to achieve better vertical integration of evaluation outcomes so as to link evaluations of strategic policy and operational policy agencies. At the institution level, the government is developing new arrangements for the Crown Research Institutes to address the recommendations of the independent CRI Taskforce to set new performance indicators for financial and non-financial performance of institutional behaviour and financial and non-financial outcomes from investment of public funds.
- The Norwegian Ministry of Education and Research has begun the process of developing a set of indicators for each of Norway's national goals. As a part of this process an independent expert committee – *Fagerbergutvalget* – was set up. The committee has been given the task of assessing goal achievement for publicly funded research, and as part of this, the indicators to be employed in evaluating progress. The committee is one of several efforts announced in a new White Paper on research in order to facilitate more efficient use of resources and results in the Norwegian system. The committee´s final report is expected in May 2011.
- The Swiss government published in 2009 its overall strategic assessment of education, research and innovation during the funding period 2004-07, concentrating on the impact of measures. Currently, the assessment framework is being redesigned in light of the findings.
- NESTA in the United Kingdom is developing an Innovation Index to improve the way the UK government measures investment in innovation and its impacts. The pilot index was launched in November 2009 and is expected to be ready in final form in autumn 2010. The Pilot Index has three components: *i)* a measure of the amount of investment in intangible assets in the United Kingdom and its contribution to economic growth and

productivity; *ii)* a tool to understand innovation at firm level that captures "hidden innovation" and reflects the different ways in which innovation occurs in different sectors; and *iii)* a set of metrics that can be tracked to assess how favourable is the UK climate for innovation. A parallel work stream to measure innovation in the public sector is also under way. This is an area in which metrics are not as well developed, but where innovation is nonetheless essential.

- The US National Science Foundation created a new research programme on the "science of science policy" that aims to set a scientifically rigorous and quantitative basis for science policy. In 2009 a joint Office of Management and Budget (OMB) and Office of Science and Technology Policy (OSTP) memo outlined federal priorities for FY 2011 and emphasised that agencies should develop science of science policy tools that can improve management of their research and development portfolios and better assess the impact of their science and technology investments (*www.scienceofsciencepolicy.net/*).

Improving actors' competences and enhancing incentives for innovation

Business, public research institutes and the higher education sector are key actors in the innovation process. However they are not the only ones; the public sector itself, users-consumers and non-government institutional actors, such as private non-profit foundations, play a role in translating knowledge into innovation. While policy has long supported strengthening capacity and incentives for innovation among the former set of actors (business, public research institutes and higher education), there is now a trend for policy to encourage capacity building in the latter group.

Increasing public support to R&D

Despite the slowdown in economic growth and the resulting fall in tax revenue, government investments in R&D have outpaced outlays in other areas. Government investments or spending and tax cuts, taken together, have represented on average more than 3% of GDP in the OECD area and up to 5% of GDP in the United States and Korea. Recognising that innovation is a source of long-term growth, many governments have policies to improve infrastructure, support basic science, R&D and innovation, strengthen human capital, promote green technology and innovation, and foster entrepreneurship. Recent stimulus packages have also provided additional support to science, R&D and innovation ranging from 0.01% (Finland and Norway) to 0.29% of GDP (Sweden) in 2009 (OECD, 2009a).

One of the drivers for the increase in R&D outlays has been the setting of R&D spending targets in most OECD countries (Table 2.3). In line with the Lisbon Agenda, many EU countries had set R&D targets of 3% of GDP by 2010. However, most have fallen short of that target, although countries such as Austria and Portugal have made significant progress in closing the gap. Austria expects to reach its target of 2.8% of GDP by 2010. It is noteworthy that countries with significant R&D and technological capacity have set targets beyond the 3% target: Korea (5% by 2012); Finland (4% by 2010); Sweden (4% by 2010); and Japan (4% by 2020).

A number of specific measures have been taken to stimulate the recovery from the recent economic crisis. The European Union has urged member states to increase planned investments in R&D and consider ways to increase private-sector R&D investments (Box 2.2). Luxembourg increased its R&D support by EUR 30 million in 2009. Norway has

Table 2.3. **R&D spending: targets and achievements, 2010**

	R&D spending targets		R&D expenditures GERD (% of GDP)	
	Target	Target date	2006	2008 or latest
Austria	3.0% of GDP	2010	2.47	2.73
Belgium	3.0% of GDP	2010	1.86	1.92
Brazil[1]	0.65% of GDP (business sector)	2010	1.02	1.09
China	2.5% of GDP	2020	1.42	1.54
Czech Republic	2.06% of GDP	2010	1.55	1.47
Denmark	3.0% of GDP	2010	2.48	2.72
Estonia[2]	3.0% of GDP	2014	1.14	1.29
Finland	4.0% of GDP	2011	3.48	4.01
France	3.0% of GDP	2012	2.10	2.02
Germany	3.0% of GDP	2010	2.53	2.64
Greece	2.0% of GDP	2020	0.58	0.58
Hungary	1.8% of GDP	2013	1.00	1.00
India[1, 3]	2.0% of GDP		0.71	
Ireland	2.5% of GNP	2013	1.25	1.43
Italy	2.4% of GDP	2010	1.13	1.19
Japan	4.0% of GDP	2020	3.40	3.42
Korea	5.0% of GDP	2012	3.01	3.37
Netherlands	3.0% of GDP	2010	1.78	1.75
Norway	3.0% of GDP	Indefinite	1.52	1.62
Poland	2.2-3.0% of GDP	2010	0.56	0.61
Portugal	1.8% of GDP	2010	1.02	1.51
Russian Federation	2.5% of GDP	2015	1.07	1.03
Slovenia[2]	3.0% of GDP	2013	1.56	1.66
Spain	2.2% of GDP	2011	1.20	1.35
Sweden	4.0% of GDP	2010	3.74	3.75
Turkey	2.0% of GDP	2013	0.58	0.73
United Kingdom	2.5% of GDP	2014	1.75	1.77
United States	3.0% of GDP	Indefinite	2.61	2.77
European Union	3.0% of GDP	2010	1.76	1.81

Note: The last year available for GERD data is 2007 for Greece, 2009 for Austria and Finland.
1. Data for R&D expenditures come from national sources and may not be fully comparable with others countries.
2. Data from Eurostat.
3. Data for R&D expenditures are for 2004.

Source: OECD (2008), *OECD Science, Technology and Industry Outlook 2008*, OECD, Paris; and OECD (2010a), *Main Science and Technology Indicators 2010/1*.

allocated more than NOK 1.8 billion in direct grants for R&D and innovation and radically expanded its fiscal support to R&D through tax relief. Despite fiscal pressures, Spain is aiming to strengthen public investment in R&D through tax credits and public procurement. Estonia has pledged to maintain its focus on increasing R&D spending and plans to increase levels by 44% in 2009 and by 25% in 2010 (OECD, 2009a). As part of the American Reinvestment and Recovery Act of 2009, the United States government has increased its spending on R&D related to climate change by USD 26.1 billion, and to energy by USD 6.36 billion. An additional USD 10 billion was allocated for biomedical research funded by the US National Institutes of Health and an additional USD 2.3 billion was allocated to research funded by the National Science Foundation. The response to the crisis has also given a boost to efforts.

Box 2.2. **European Union "Innovation Union" initiative**

In June 2010 the European Union agreed on a new "Europe 2020" strategy, which succeeded the previous Lisbon Strategy, with the priorities of smart, sustainable and inclusive growth. The strategy includes a number of headline targets, including the aim to invest 3% of GDP in R&D by 2020 and proposed the development of a new indicator on innovation. To implement the strategy, seven flagship initiatives were announced.

One of the flagship initiatives is entitled "Innovation Union" and proposals were presented by the European Commission in October 2010. The "Innovation Union" is intended to provide an integrated strategy across research and innovation with over 30 measures to be implemented across the EU and by EU member states. These cover:

- Improvements to the knowledge base, in particular to complete the "European Research Area" which is now an explicit commitment in the EU Lisbon Treaty, including the removal of barriers to the movement of researchers and funding between EU countries. The Innovation Union also points the direction for future EU research and innovation funding programmes, towards a reduction in complexity, simpler access, a broadening to non-technological areas such as design and creativity, and more emphasis on the take up of results through open access and innovation.
- Enabling entrepreneurs to get good ideas to market more quickly. Specific measures include further support to venture capital, loans and guarantees; a rapid agreement on the EU patent; and a strengthening of demand side policies for innovation, notably public procurement and standard setting.
- Social and regional impacts of innovation, including using the EU Structural Funds to support smart specialisation strategies in the eligible regions of the EU member states, and launching pilot activities in social innovation and public sector innovation.
- A new approach, labelled "European Innovation Partnerships" with the aim of bringing together both supply and demand side policies to focus on specific societal challenges. A first pilot Partnerships is proposed to address the challenge of active and healthy ageing with a specific target to increase by 2 years the average number of healthy life years of EU citizens.
- Concerning international co-operation, the Innovaton Union proposal suggests a closer collaboration between EU member states in their co-operations with non-EU countries around some commonly agreed priorities.
- Building on the policy principles set out in the OECD innovation strategy, the European Commission proposes a policy diagnostic tool to support EU member states to conduct self assessments of the research and innovation policies.
- Finally, the European Commission proposes the development of a new indicator to measure the share of fast growing, innovative companies in national economies. This was the outcome of discussions by a High Level Panel that was established to consider a headline innovation indicator for the Europe 2020 strategy. As pointed out by the Panel, such an indicator requires development work to access the necessary data sources and define the indicator in a way that allows international comparisons.

Source: Response to the STI Outlook 2010 Policy Questionnaire.

Building critical mass in public research

Reinforcing the science base remains an important element of national STI strategies and is among the highest priorities for Hungary, Japan, Norway and Sweden (Table 2.4). In addition, Canada, Germany, Norway, Spain and Sweden have reported additional increases to public funding for R&D. The German federal government and the *Länder*, for example, have expanded

Table 2.4. **Strengthening public research: performance, priority level and measures taken between 2008 and 2010**

	Performance 2008 or nearest			Priority level	Increase financing of public R&D				Reforms of public research institutions							
	GOVERD + HERD intensity[1] 2008	Basic research performed by the public sector[1, 2] 2008	Scientific publications[3] 2008	Strengthen the science base	Additional funding	New targets	Quality assessment	Full economic cost recovery	Autonomy of universities	Accountability of universities	New structures	Research priorities setting	Ownership and licensing	Improve rankings of HEIs	Internatio-nalisation	Quality of infrastrucures
	Index 100 = Highest OECD value			Self-reported (1-8)[4]	Measures/initatives taken between 2008 and 2010			Principle applied	Measures/ initatives taken between 2008 and 2010							
Austria	69	62	50	7					✓	✓				✓	✓	✓
Canada	73		61	7	✓			✓	✓			✓				✓
Czech Republic	49	64	33	7		✓		✓		✓	✓		✓	✓	✓	✓
Denmark	70	46	71	6			✓	✓	✓	✓		✓			✓	✓
Finland	83		72	7				✓	✓	✓	✓	✓	✓	✓	✓	✓
France	64	79	39	7		✓			✓	✓		✓			✓	✓
Germany	70		38	6	✓				✓	✓	✓	✓	✓		✓	✓
Hungary	40	35	22	8							✓				✓	✓
Israel	70	83		7							✓				✓	✓
Italy	48	51	32	7			✓		✓	✓	✓	✓			✓	✓
Japan	60	41	25	8					✓						✓	✓
Korea	69	45	29	7		✓		✓	✓	✓	✓		✓	✓	✓	
Netherlands	76		64	6					✓							
New Zealand	61	61	62	7												
Norway	66	46	68	8	✓	✓	✓				✓					✓
Poland	37	30	18	7					✓				✓	✓		✓
Slovenia	52	25		7												✓
South Africa	33	24		7							✓		✓			
Spain	53	35	35	7	✓						✓		✓		✓	✓
Sweden	85		76	8	✓	✓	✓	✓	✓	✓						✓
Switzerland	66	100	100	n.a.	✓							✓			✓	✓
Turkey	36		10	n.a.												
United Kingdom	55		57	n.a.						✓	✓	✓	✓			
United States	57	63	39	6				✓								

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore, the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.

n.a.: Response not available.

1. As a percentage of GDP.
2. The public sector includes the government and higher-education sectors.
3. Per capita.
4. Self-reported ranking of national STI priorities based on scale whereby 1 = least important and 8 = most important.

Source: OECD (2010a), *Main Science and Technology Indicators*, 2010/1; OECD, *Research and Development Statistics*, 2010; OECD (2010b), *Measuring Innovation: A New Perspective*, OECD, Paris; responses to the STI Outlook 2010 Policy Questionnaire.

public R&D funding to major public research institutes by 3% annually between 2005 and 2010 and plan to further increase their contribution by 5% annually between 2011 and 2015. Sweden has assigned an additional SEK 5 billion to the initial SEK 25.6 billion allocated by the central government in 2008. This increase represents about 20% additional resources over 2009-12 and accompanies the largest reform of the funding system for basic research in over 60 years.

In Portugal, a national contract for the development of higher education has been collectively signed between the government and all public universities and polytechnics. This contract entails an increase of public investment in higher education to show the commitment of the Portuguese government and higher education institutions to increase the qualifications of the Portuguese population by setting a goal of graduating a further 100 000 adults annually to current graduation levels by 2013.

Strengthening public research entails more than increases in expenditures on public R&D however. Policy reforms of funding mechanisms, university governance and autonomy as well as evaluation all aim to enhance efficiency, research quality and impact.

Box 2.3. **Recent developments in China's STI policies**

In January 2006, the Chinese government adopted the Medium- and Long-term National Strategic Plan for Science and Technology Development (2006-20) (MLSTSP). The aim is to make China an innovation-oriented society by 2020 and eventually a leading science and technology power and innovation economy. One of the main targets is to increase R&D intensity from 1.23% of GDP in 2004 to 2% in 2010 and to 2.5% by 2020. The plan has been implemented through the 11th Five-year National S&T Plan (2006-10), to be followed by the 12th Five-year S&T Plan (2011-15). The State Council document, Implementing Policies for the Medium- and Long-term National Plans for S&T Development, aims to raise the innovative capacity of firms in China via a combination of supply and demand-side policies (*e.g.* R&D tax incentives) and demand-side policies (*e.g.* innovation-friendly public procurement policy, IPRs).

Key priorities. The 11th five-year plan consists of two main parts: major national S&T projects (the so-called megaprojects) and the basic R&D programmes. It identifies 11 priority research fields: energy, water and mineral resources, environment, agriculture, manufacturing technologies, transport, information technology, population and health, urbanisation, public security and national defence. In addition, eight frontier technologies are priorities for funding; biotechnology, information technology, new materials and nanotechnology, advanced manufacturing technologies, advanced energy technologies, ocean technology, laser technology and aeronautics and astronautics. The 16 "megaprojects" address specific objectives defined in the Medium and Long-term National Strategic Plan in the engineering and science fields. They have been conceived, directed and funded by the government with a view to achieving R&D breakthroughs in key platform, general purpose, technologies needed for national strategic products, important S&T projects and large-scale S&T infrastructure projects.

Support to business R&D and innovation. Many measures encourage innovative activities on the supply side; they include technology and R&D tax incentives (Table 2.7), the national high and new technology zones, and national science and technology incubators. Furthermore, in response to the global financial crisis, the State Council on 19 September 2009 issued "several opinions on further development of SMEs" and the central government released RMB 10.9 billion in 2009 (roughly EUR 1.1 billion) to support technological innovation by SMEs, upgrading of the industry structure, and development of international markets.

Box 2.3. **Recent developments in STI policies in China** *(cont.)*

Public procurement and innovation. On the demand side, the Chinese government has tried to use government procurement policy to encourage Chinese enterprises to develop their own core technologies, products and brands, hence the term "indigenous innovation", in order to increase their longer-term competitiveness. According to China's Ministry of Finance (MOF), government procurement reached RMB 599.1 billion in 2008, a 28.5% increase from 2007. This represented 2% of GDP and 9.6% of total fiscal expenditure. In 2009, government procurement represented RMB 741.3 billion, a further 23.7% increase from the previous year. The initial implementing policies proposed that indigenous innovative products should have priority in public procurement and that accredited companies competing in public tenders with innovative products will benefit from a discrete price advantage. Furthermore, no less than 60% of the cost of purchasing technology and equipment should go to domestic firms. In response to foreign concerns about market access, the Ministry of Science and Technology (MOST), MOF, and National Development and Reform Commission (NDRC) jointly issued a draft notice in April 2010 that made some changes to the criteria for defining such products. Under Circular 618 of 2009, they had to have a trademark owned by a Chinese company and registered in China; the company also had to have full ownership of the product's intellectual property (IP) in China. Under the 2010 draft notice, a product is eligible if the applying party has exclusive rights to the product's trademark in China and is licensed to use the IP in China. These policies to promote innovation through public procurement in China continue to be high on the agenda in discussions with foreign governments and business representatives.

Support for IPRs and innovation. On 5 June 2008, the State Council of the People's Republic of China issued the "Outline of the National Intellectual Property Strategy", which reiterated China's determination to "create, utilise, protect and manage IPRs at a relatively high level by 2020". The strategy gives particular attention to the role of firms in the creation and use of IPRs. On 15 September 2009, the Ministry of Finance released the Interim Measures for the Administration of Special Funds for Subsidising Foreign (or International) Patent Applications, which encourage Chinese applicants to participate in the international patent system and to protect their innovations. On 26 May 2010, the Ministry of Finance and the SIPO (State Intellectual Property Office) jointly formulated the Circular on Organising Funding for Patenting Overseas. The MOF has laid aside RMB 100 million to subsidise Chinese international patent applications. SMEs, public institutions and research institutions are eligible for the subsidy, which can partly cover the fees incurred during the patent application phase, the annuity fees for the first three years after grant, and fees paid to related agencies. Each Patent Cooperation Treaty (PCT) filing should be granted a minimum of RMB 100 000 per country for a maximum of five countries, with the exception of big innovation projects. In 2009, the central government granted RMB 52.85 million to 1 146 PCT applicants. These subsidies have helped SMEs to meet the high cost of filing abroad, which is often a barrier for small companies seeking to expand in international markets.

Human resources in S&T. On 6 June 2010, the Communist Party of China and the State Council issued the first Medium and Long-term Talent Development Plan 2010-20. Under the plan, by 2020, the number of researchers should increase to 3.8 million, with 40 000 top scientists in leading innovation fields. Researchers should reach 43 per 10 000 population in 2020, up from 25 in 2008. The share of the labour force with higher education should reach 20% by 2020, up from 9.2% in 2008. Furthermore, 300 innovation "talent bases" have been set up, along with "elite scientific studios", in order to foster joint research

Box 2.3. **Recent developments in STI policies in China** *(cont.)*

projects and scientific co-operation. College graduates are encouraged to work in rural areas and contribute to local scientific development. In order to promote mobility of researchers to firms, a number of schemes have been launched to link academic S&T personnel with industry and to promote the return of overseas Chinese scholars and graduates.

Source: OECD Secretariat based on national sources and "Policy Updates on Selected Key Issues in China's S&T and Innovation Policies", OECD, 2010, forthcoming.

Revising funding mechanisms for public research institutes and universities

Public research organisations have always been important actors in country innovation systems and they contribute to major technological breakthroughs and innovations. However, since the early 1980s, the share of R&D performed in the government sector has declined and recent years have seen a number of challenges facing public research institutes, including their relationships with other actors, the renewal of their infrastructure, and the commercialisation of public research results. In response, governments have introduced a number of changes to priority-setting processes, governance structures and mechanisms for allocating funding for public research (Basri and Box, 2009).

One of the key issues with regard to funding is to balance competitive funding mechanisms with longer-term non-competitive funding. Competitively awarded funding, either for projects or block grants, allows research systems to encourage competition among researchers and research institutions and encourages institutions to attract external funding, in particular from industry. Non-competitive, institutional block funding ensures financial stability and long-term outlooks which may be more favourable to fundamental research or projects that require more time to reach maturity. Such institutional funding also helps prevent the fragmentation of research and allows more time for research as opposed to fund-raising activities.

Although institutional funding remains important, a shift towards project funding has been observed for some years. Many countries have introduced or strengthened mechanisms for competitively awarded project funding:

- Belgium. Flanders research programmes receive funds according to the ratio of research funds per university based on output criteria (bibliometric and other) and responses from individual researchers to open calls and the evaluation of proposals by independent experts.
- Czech Republic. In the context of the reform of its R&D and innovation system, the Czech Republic has increased the use of project-based funding.
- Germany. Procedures for funding higher education institutions have been increasingly oriented towards a performance-based approach based on indicators. Today, the majority of German federal states have such procedures in place. In many cases current models have been adapted and modified in accordance with new demands, *e.g.* by modifying the set of indicators or expanding the share of budget allocated according to performance.

- France has increased significantly its support to public research through project funding with the creation of the National Research Agency (ANR) while institutional grants have remained stable. In addition, the pooling of education and research grants and university autonomy in allocating funds represent significant changes in national funding mechanisms.
- Netherlands. Recently the Netherlands has increased the share of public funding allocated through competitive grants (from 27% to 33% of total public funding between 2008 and 2010), but a large part of this increase is due to temporary measures taken in response to the financial crisis.
- Norway. Effective 1 January 2009, there is a new core funding system for the research institute sector.[2] It has two parts: performance-based basic funding and strategic institute programmes. Basic funding is comprised of a permanent allocation and a fluctuating allocation of about 10% which is distributed on the basis of institutes' performance on the following indicators: 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 institutes' scores are adjusted using a relevance component, calculated according to the percentage of the institute's R&D income that is subject to competition. The institutes are divided into four groups to ensure that relatively similar research institutes compete for core funding on similar terms. The four groups are environment and development research institutes, primary industry research institutes, social science research institutes, and technical and industrial research institutes. The government has also stipulated how much of the core funding framework may be allocated to strategic institute programmes for each of the institute groups. The Research Council of Norway is responsible for administering the new funding scheme which will be evaluated after an initial three-year period.

Countries are also incorporating elements of competition or performance-based allocation into their institutional or block funding. Denmark has introduced a new competitive block funding instrument for world-class research. The Investment Capital for University Research (UNIK) is granted to universities that compete for large grants which can be used as block funding. Sweden has put more emphasis on long-term support based on institutions' research profiles to develop new research areas. The funders of national research will be provided with an additional SEK 670 million a year for strategic investments.

In line with increased use of competitive funding, block funding is also increasingly linked to *ex post* performance evaluation in many countries:

- Belgium (Flanders). One important feature of university research in Belgium is a gradual shift towards output-based financing based on criteria such as PhDs awarded, citations, publications, etc.
- Denmark has implemented a bibliometric model based on scientific publications to introduce a performance-based measure into the distribution of general university funds (GUF). The model was introduced in 2009 and covers all fields of science but currently only concerns a limited proportion of the total funds allocated to the universities.
- Finland. The Ministry of Education and the Higher Education Institutions set specific quantitative goals and new indicators.
- France. The development of international partnerships and co-publications are systematically used as performance indicators for public research institutes.

- Norway funds part of its total public general university fund on the basis of several performance indicators, including bibliometric results and third-party research funds.
- Slovenia. The Slovenian Research Agency has set up a system for monitoring the transfer of knowledge from public research institutes to potential users which is used to increase budgetary funds for R&D.
- Sweden. Quality is measured in terms of institutions' capacity to attract external funding and number of publications, combined with a citations analysis.

There is increasing evidence of countries seeking to recover the full economic cost of research activities so as to allow research institutions to amortise assets and overhead and invest in infrastructure at an adequate rate to maintain future capability. Full economic costing means that capital, infrastructure, maintenance and functioning costs associated with each piece of research are included in the final price. This requires sponsor departments or bodies to contribute to the building and sustaining of the necessary infrastructure within the science base. Recovering the full economic costs of research activities helps guarantee universities' and public research institutes' financial sustainability. This approach represents a step towards establishing internal and external market pricing.

- Canada has implemented the federal Indirect Cost of Research Programme. Grants are awarded annually (for a total budget of CAD 325 million in 2009-10) and institutions must re-apply every year to continue receiving funds. Indirect costs grants are inversely based on the amount of money received so as to help in priority smaller universities and institutions to strengthen their research capacity.
- From 2008/09 Finnish universities have been developing full costing models. Along with the 2010 reform of universities, the government is raising awareness of cost accounting and is stressing the importance of applying a full cost model in all university operations, not just for research funding. Full costing has become a strategic institutional management tool. Similarly, as of 2009, the Finnish Funding Agency for Technology and Innovation (Tekes) has implemented a full economic cost recovery model in its funding decisions and the Academy of Finland has already adopted a partial economic cost recovery model (80%).
- In Sweden the common rule to withdraw 35% for university overhead from public grants has been reformed and Swedish universities receive compensation for the full costs of their projects based on their own evaluation.
- In the United States, the Office of Management and Budget has established guidelines that are periodically updated for direct and indirect cost recovery by higher education institutions.

Although Germany and Norway do not apply the full economic cost recovery principle at central level, the new German Higher Education Pact 2020 foresees funding of programme overhead of higher education institutions by the German Research Foundation, and the Research Council of Norway provides specific funding instruments that take into account cost elements such as maintenance costs and the day–to-day running of scientific equipment.

Strengthening research infrastructure for universities and public research institutes

Maintaining high-quality research infrastructure is crucial to the improvement of the quality of public research and to the provision of the best research conditions to attract national and world-class researchers. Many governments have increased the resources allocated to universities and public research institutes to modernise old infrastructure or to build new capabilities (Table 2.5).

Belgium (Flanders) has set up several new public research institutes in recent years, in the field of medical (pharmaceutical) research and materials. Improvements in public research funding has led to more investment in infrastructure and new investments in research laboratories.

Table 2.5. **Country initiatives to improve research infrastructure, 2008-2010**

Country	Programme/ Funding agency	Budget	Timeline	Objective
Austria	Federal Government	EUR 34 M	2009-10	Competitive funding for the modernisation of university infrastructure.
Belgium (Flanders)	“Herculus” fund	EUR 15 M (2010)	Since 2007	Created in 2007 to allow HEIs to acquire heavy infrastructure (cost above EUR 1.5 million) or mid-heavy research lab infrastructure (between EUR 150 000 and EUR 1.5 million).
Canada	Canada Foundation for Innovation	CAD 750 M	2009-17	Renew the infrastructure that support world-class research and training (accelerate repairs, maintenance and construction of universities, funding leverage to advance frontiers of knowledge and ensure skills training).
Denmark	Programme for Research Infrastructures	DKK 6 billion	2010-11	Support investments of strategic and scientific importance and improve quality of university research labs.
France	"Plan Campus"	EUR 5 billion	2008-2015	Renovation of universities’ buildings and support to excellence in teaching and research. Reinforce the international attractiveness and influence of French universities.
Germany	Intiative for Excellence	EUR 1.9 billion + EUR 2.7 billion	2007-12 and 2013-17	Promote cutting-edge research at universities.
Hungary		EUR 209.4 M		Develop educational, research and IT infrastructure of national HEIs.
Italy	Research Infrastructures of Excellence for Italy – The Italian Roadmap 2010	EUR 100 M annually	2010-15 and 2015-20	Promote, coordinate and support the Italian participation to the European Programme for Research Infrastructures (ESFRI Roadmap). Improve the facilities at the National excellence centers to strengthen their role as sites of European size infrastructures.
Norway	National Research Fund	NOK 208 M	Each year	Research infrastructure.
	Centres for Excellence		2009	
Slovenia	Centres of Excellence	EUR 77.4 M	2009-13	Creation of 8 new Centres of Excellence
				Acquisition of new research equipment by universities and institutes.
Spain	International Excellence Campus Programme	EUR 203 M		Improve the research infrastructure of national universities.
	Map of Singular Scientific and Technological Infrastructures			Increase the availability of S&T infrastructures; improve the existing S&T capacity; foster the internationalisation of the Spanish facilities.

Source: OECD (2009a), *Policy Responses to the Economic Crisis: Investing in Innovation for Long-Term Growth*, OECD, Paris, and responses to the 2010 STI Outlook Policy Questionnaire.

In 2009 Canada invested CAD 50 million to support the construction and cost of a new research facility at the Institute for Quantum Computing at the University of Waterloo. This investment followed a previous CAD 50 million outlay provided in 2007 to the Perimeter Institute for Theoretical Physics and aims to position Canadian researchers at the forefront of quantum computing. In parallel, the federal government provided additional new funding for the Canadian High Arctic Research Station and TRIUMF (Canada's premier national laboratory for nuclear and particle physics). The government has also established the Canada Excellence Research Chairs (CERC) programme under which universities receive up to CAD 10 million over seven years to support each of the 20 CERC holders and their research teams in establishing ambitious research programmes at Canadian universities.

In 2010 Denmark launched a forward-looking digital work programme. Universities as digital spearheads are particularly targeted. An international conference in 2010 focused on how universities can use ICT to create innovative learning environments. In addition an increased focus will be put on ICT research at Danish universities.

Israel has set up a programme for the promotion of converging technologies, which includes investment in equipment and research infrastructure. The TELEM Forum decided in 2006 to finance the creation of R&D infrastructures in the field of nanotechnology over the years 2006-2011 for a total budget of ISL 220.5 million. Six new nanotech laboratories have been spread across national academic institutions. Israel has also supported the establishment of a Biotechnology Institute in the Ben Gurion University and the establishment of two technological centres dedicated to renewable energies and water that will conduct market-oriented public R&D. In addition the Planning and Budgeting Committee (PBC) and a philanthropic association, Yad HaNadiv, created in 2009 a joint ISL 30 million fund to encourage research in the humanities.

In Italy, the "Research Infrastructures of Excellence for Italy – The Italian Roadmap 2010" sets up a national plan for research infrastructures, including participation in European and global facilities, as well as upgrading national centres of excellence.

The establishment of the European Spallation Source (ESS) in Lund and Copenhagen will lead to the first large-scale research facility north of Hamburg. The facility will boost European leading-edge research in scientific fields such as material science and life sciences. When the facility is completed, up to 5 000 researchers may work there annually.

South Africa has implemented the South African Research Chairs Initiative (SARChI) designed to significantly expand the scientific research base and support the making of an internationally competitive global knowledge economy. In 2009, 15 new research chairs were created.

The United States has established the ARPA-E (Advanced Research Projects Agency-Energy) with initial funding of USD 400 million to develop innovative and transformational clean energy technologies. An additional USD 1.3 billion was provided to the US National Institutes of Health in 2009 to fund the construction, renovation and repair of existing non-federal biomedical research facilities and to pay for shared instrumentation and other capital research equipment.

Fostering the autonomy of universities and public research institutes

In addition to changes in the level and mechanisms of funding, many countries have reformed the governance of universities and public research institutes to increase their efficiency and responsiveness to societal needs.

Finland has introduced reforms in state universities with the adoption of a new Universities Act that bestowed economic and administrative autonomy on the universities. The universities will be given the status of independent legal person under public law. Their assigned tasks of research, teaching and societal interaction remain unchanged. The state ensures the institutions' core funding but the criteria used for funding and university steering have been modified to take into account the diversity of the institutions and are applied to the same extent to all institutions. In particular quality criteria have been markedly enforced to account for a third of funding.

In Sweden, higher education institutions can now propose representatives when appointing board members. Furthermore, the Commission on University Autonomy has investigated the future organisation of the higher education sector in Sweden and submitted proposals to the government to promote greater autonomy.

Since the 2007 Law on freedom and responsibilities of the universities (LRU), two-thirds of French universities have benefited from greater autonomy in terms of funds and human resource management. In particular, the functions of the universities' scientific and technological councils have been broadened to include taking responsibility for the distribution of funds among research labs. Since 2009, the "*crédits écoles doctorales*" that were allocated to institutions for organising seminars for PhD students and preparing them for postdoctoral life have been integrated with the funding of the universities.

Japan plans to speed up reforms of universities and public research institutes and provide an environment for autonomous research, and the Russian Federation has authorised educational and research institutions to establish spin-out companies, thus promoting postgraduate training and employment and stimulating R&D investments (OECD, 2009a).

Fostering business R&D and innovation

Business enterprises are the main source of innovation. They play a primary role in funding and performing R&D in most countries and, more than ever, governments seek to increase business investment in R&D and innovation. Global competition and the emergence of new players, such as China and India, have led countries to seek to boost the innovative capacity of the business sector. In the EU, another catalyst has been the EU's 3% R&D spending target, which is to be achieved primarily by increasing business investments in R&D to 2% of GDP.

Table 2.6 provides an overview of country performance in business R&D investment based on four indicators: *i)* the intensity of business expenditures on R&D (BERD) as a percentage of GDP; *ii)* the share of BERD performed by SMEs (as percentage of total BERD); *iii)* the share of BERD performed in the services sector (as percentage of total BERD); and *iv)* triadic patents per million population.

The intensity of BERD indicates the financial effort devoted by the business sector to advance research. Japan and Sweden, for example, have high BERD and patenting intensities. Smaller firms and non-traditional actors play a greater role in R&D in small countries (New Zealand) or catching-up innovation systems (Greece, Portugal and Spain). The shares of the services sector and SMEs in BERD tend to mirror the structure of business R&D systems and the relative contribution of non-manufacturing and SMEs to R&D performance. Triadic patenting is an indicator of the ability of innovation systems to generate new inventions that may be exploited globally.

In addition to framework conditions such as competition policy and access to capital markets, a broad range of direct policy instruments, such as block grants or competition-based schemes, are used to stimulate business R&D and innovation. Increasingly, many direct support R&D schemes are being oriented or targeted to strategic sectors/technologies in order to foster competitiveness but also to help firms in their specialisation strategies. Soft support, such as assistance in firm creation, counselling and entrepreneurship measures, is also being used to complement direct R&D support and to encourage risk-taking attitudes. While the general tax system is used to foster investment in innovation by firms, specific R&D tax incentives remain important in many OECD and emerging economies, even if their design and scope continues to evolve. Finally, OECD governments increasingly look to use public procurement as a way to accelerate the diffusion of innovative products or services in the business sector while meeting public demand for goods and services.

Responses to the STI Outlook Policy Questionnaire 2010 (Table 2.6) make it clear that direct support to business innovation, in the form of competitive grants or subsidised and guaranteed loans, remains important and has increased in some countries, especially for key industrial sectors such as renewable energy, advanced manufacturing, ICTs and health. However, the balance between merit-based and block instruments varies considerably according to factors such as industrial structure, existence of large R&D-intensive firms, R&D intensity and specialisation (Figure 2.1). For example, Canada provides most of its direct support to business R&D through credit loans and guarantees as well as through competitive grants, although most support to business R&D is indirect in the form of tax credits. In the Czech Republic, and despite recent emphasis on indirect funding, direct support (partly through EU structural funds) remains the main policy tool to foster R&D spending; the Czech Technology Agency allocates extra funds to applied research.

Spain offers a combination of subsidies, loans, venture capital and tax relief, depending on the company and the project. In recent years, there has been an increase in the use of government loans to companies, above all in the industrial sector.

Since 2008, Denmark has increased national support to R&D and innovation by 40% via the National Council for Technology and Innovation. This covers the establishment of a new national infrastructure of competence, of innovation networks and of an innovation voucher scheme. Moreover, a new fund for green growth was set up in 2009 to support green transformation and development in SMEs (EUR 100 million from 2010 to 2012).

The United Kingdom has put forward plans for a new fund to financially support low carbon investments (GBP 250 million, USD 364 million), GBP 50 million (USD 72.85 million) for the Technology Strategy Board to support innovation and research in advanced manufacturing, low carbon tech and life sciences; and GBP 10 million (USD 14.6 million) for UK Trade and Investment to help promote UK expertise at home and abroad (OECD, 2009a).The United States is providing USD 26 billion of loan guarantees as part of the American Reinvestment and Recovery Act of 2009 to improve energy efficiency and spur development of clean energy technologies.

Meanwhile, the Netherlands launched in mid-2008 a new innovation credit scheme that aims to meet companies' needs for a credit facility for high-risk innovation projects. The EUR 50 million structural budget starting in 2009 supports 10-20 development projects a year. In addition, local and regional Dutch authorities have created several loan and credit schemes (*e.g.* the Acceleration Agenda for the Innovation Fund in Limburg).

Table 2.6. **Foster business R&D and innovation: performance, priority level and measures taken between 2008 and 2010**

	Performances				Priority level			Stimulate private investments in R&D and innovation							Targeted public support									
								Direct public funding						Indirect support	Support to SMEs and new-technology based firms							Support to services and specific industries		
	BERD intensity[1] 2008	BERD performed by SMEs[2, 3] 2008	BERD performed in the services[3] 2007	Triadic patent families[4] Average 2005-07	Strengthen business R&D and innovation capacity	Improving framework conditions for STI	Demand-side STI policy	Credit loans and guarantees	Repayable advances (sales contingent claims, etc.)	Compe-titive grants	R&D subsidies	Technology consulting services, extension programs	Other	Tax incentives	Angel investor incentives	Venture capital (funds of funds)	SBIR	Innovation vouchers	Public procu-rement	IPR support	Other	Non-techno-logical innovation	Services	Industries/ techno-logies
	Index 100 = Highest OECD value				Country self-reported note (1-8)[5]			Principal instruments used							Measures/initatives taken between 2008 and 2010									
Australia	41	44	68	14	n.a.	n.a.	n.a.							✓										✓
Austria	64	38	47	40	6	4	4	✓		✓	✓	✓		✓				✓					✓	
Belgium	45	50	27	33	n.a.	n.a.	n.a.							✓										
Canada	37	50	60	19	8	6	4	✓		✓						✓					✓			✓
Czech Republic	31	50	61	1	6	5	4			✓				✓				✓		✓		✓	✓	✓
Denmark	65	43	56	48	5	5	2			✓	✓	✓				✓		✓				✓	✓	
Finland	100	27	23	52	5	6	8	✓		✓		✓	✓			✓	✓					✓	✓	
France	43	25	16	33	7	3	1		✓	✓	✓			✓					✓	✓		✓		✓
Germany	63	15	16	63	8	6	4	✓		✓	✓	✓				✓				✓		✓	✓	✓
Greece	5	82	75	1	n.a.	n.a.	n.a.							✓										
Hungary	18	40	36	4	8	7	5			✓	✓						✓	✓		✓				
Ireland	32	63	55	14	n.a.	n.a.	n.a.							✓										
Israel	134		106		8	6	1	✓	✓	✓	✓		✓							✓		✓		✓
Italy	22	23	44	11	7	5	6				✓	✓		✓	✓					✓	✓	✓	✓	✓
Japan	91	9	14	94	8	7	7				✓			✓		✓				✓			✓	✓
Korea	86	31	12	41	6	5	7	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓
Mexico	6		55		n.a.	n.a.	n.a.							✓										
Netherlands	30	30	37	53	7	3	4	✓			✓	✓	✓	✓			✓	✓	✓	✓				
New Zealand	18	100	69	11	7	3	3			✓		✓	✓	✓										
Norway	30	68	67	23	8	7	7			✓	✓			✓			✓		✓	✓		✓		
Poland	6	45	50		7	6	4	✓		✓	✓	✓	✓	✓		✓		✓		✓	✓	✓	✓	✓
Portugal	26	53	74	1	n.a.	n.a.	n.a.							✓										
Russian Federation	22		121		n.a.	n.a.	n.a.							✓										
Slovenia	37	36	22		8	7	5	✓		✓				✓		✓		✓		✓				

Table 2.6. **Foster business R&D and innovation: performance, priority level and measures taken between 2008 and 2010** *(cont.)*

	Performances				Priority level			Stimulate private investments in R&D and innovation							Targeted public support									
								Direct public funding						Indirect support	Support to SMEs and new-technology based firms							Support to services and specific industries		
	BERD intensity[1] 2008	BERD performed by SMEs[2, 3] 2008	BERD performed in the services[3] 2007	Triadic patent families[4] Average 2005-07	Strengthen business R&D and innovation capacity	Improving framework conditions for STI	Demand-side STI policy	Credit loans and guarantees	Repayable advances (sales contingent claims, etc.)	Competitive grants	R&D subsidies	Technology consulting services, extension programs	Other	Tax incentives	Angel investor incentives	Venture capital (funds of funds)	SBIR	Innovation vouchers	Public procurement	IPR support	Other	Non-technological innovation	Services	Industries/ technologies
	Index 100 = Highest OECD value				Country self-reported note (1-8)[5]			Principal instruments used							Measures/initatives taken between 2008 and 2010									
South Africa	18		61	1	7	8	5			✓	✓													✓
Spain	25	74	56	4	6	5	5	✓			✓					✓			✓				✓	
Sweden	95	25	26	73	6	1	5			✓	✓		✓				✓	✓		✓	✓	✓	✓	✓
Turkey	11		52		n.a.	n.a.	n.a.	✓		✓	✓	✓		✓			✓			✓	✓			✓
United Kingdom	37	25	39	23	n.a.	n.a.	n.a.	✓		✓	✓			✓	✓	✓	✓	✓		✓				
United States	68	12	50	45	6	3	3			✓			✓											✓

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010 and countries that provided responses to the NESTI questionnaire on R&D tax incentives. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.

n.a.: Response not available.

1. Value equal to 1 to 100 based on data expressed as a percentage of GDP.
2. Fewer than 250 employees.
3. As a percentage of BERD.
4. Per million population.
5. Self-reported ranking of national STI priorities based on a scale whereby 1 = least important and 8 = most important.

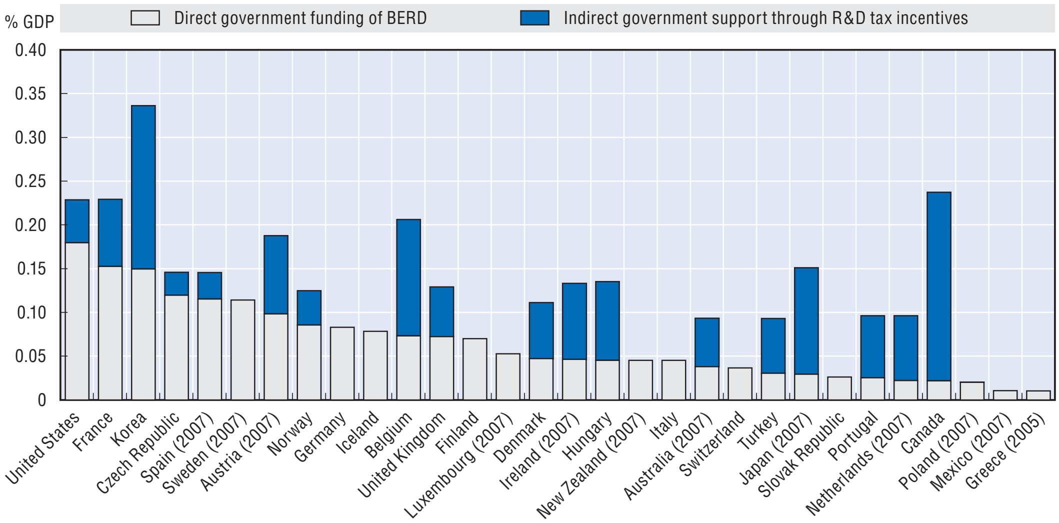
Source: OECD (2010a), *Main Science and Technology Indicators 2010-1*; OECD (2010b), "*Measuring Innovation: A New Perspective*", OECD, Paris; responses to the STI Outlook 2010 Policy Questionnaire.

Stimulate private investments in R&D and innovation

As mentioned above, direct public funding through grants, subsidies and loans remains the most frequent form of support to business R&D, with competitive and merit-based grant programmes having gained ground. However tax relief for R&D continues to complement more direct measures in many countries. Tax credits on social charges for researchers engaged in R&D have recently been introduced as a subsidy for highly skilled human capital, especially in small research intensive firms.

Figure 2.1. **Direct and indirect government funding of business R&D and tax incentives for R&D, 2008**

As a percentage of GDP



Note: The estimates of R&D tax expenditures do not cover sub-national R&D tax incentives. The Austrian estimate covers only the refundable research premium. The estimate for the United States covers the research tax credit but excludes the expensing of R&D. Italy, Greece and Turkey offered R&D tax incentives in 2008, but estimates of the foregone tax revenues are not yet available. Claims under the French R&D tax scheme totalled EUR 4.2 billion in 2008 (or 0.21 per cent of GDP), but France's scheme allows carry-forwards and a 3-year lag before total refunds of unused credits, and because the tax credit was much lower until 2007, only EUR 1.5 billion (or 0.08 per cent of GDP) are registered as government forgone tax revenue in the above figure.

Source: Updated from OECD (2010), *Measuring Innovation: A New Perspective*, based on OECD, R&D tax incentives questionnaire, January 2010; and OECD, *Main Science and Technology Indicators Database*, September 2010.

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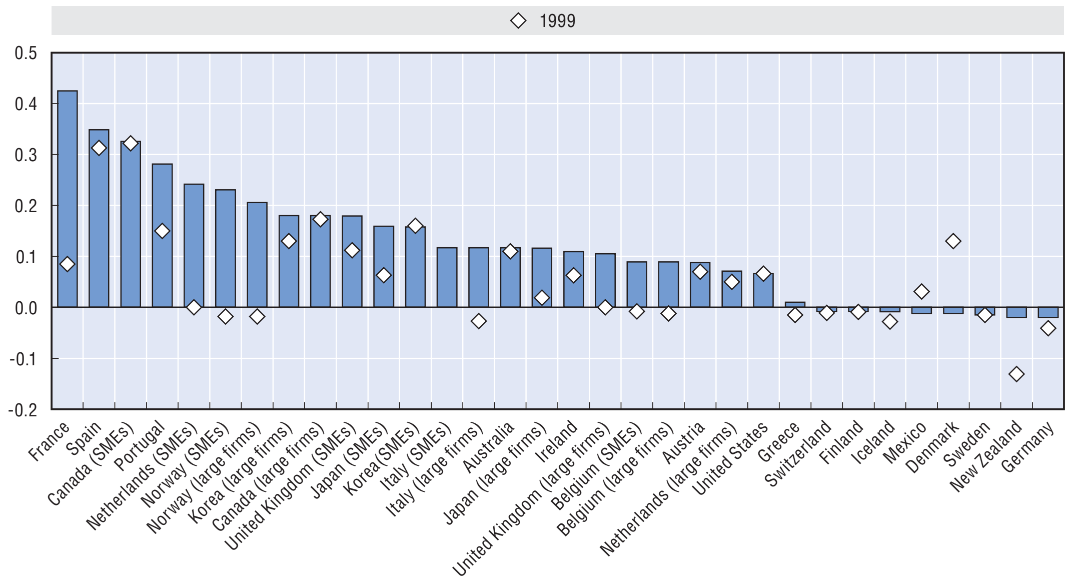
There are broadly speaking three major forms of R&D tax incentives: *i)* R&D tax credits that allow a deduction from the tax payable; *ii)* R&D allowances that represent an additional deduction from taxable income; and *iii)* depreciation allowances. Depending on the country, tax concessions are calculated either on a volume share of R&D expenditure, an incremental share (marginal R&D performed above a certain threshold of qualified expenditures), or a mix of both. Moreover, differences in country practices (*e.g.* eligible R&D activities, expenses base, rolling base *versus* fixed base for incremental credits, carry-forward of unused R&D tax credits, tax credit refund mechanisms) add to the great variety of fiscal schemes (Colecchia, 2007). In addition to the three major types of schemes, the Belgian and Dutch systems represent a fourth category, as tax incentives in those countries aim at lowering the cost of researchers either by diminishing wage tax and social contributions (*i.e.* the Netherlands WSBO scheme) or just the taxes on wages (as in Belgium) (Table 2.7).

To date, 22 OECD governments provide fiscal incentives to sustain business R&D, up from 12 in 1995 and 18 in 2004 (OECD, 2008, 2010b) (Figure 2.2). Tax credits for R&D are particularly widespread in Canada and Japan, where over 80% of public support to business R&D is provided in the form of fiscal incentives. In countries like the United States (through competitive R&D contracts) or Spain (through grants, subsidies or loans), direct support remains the main vehicle for public funding of business R&D. The wider issue of how many firms take part in public support schemes for innovation (as opposed to R&D) is not well documented. It is estimated that between one-tenth and one-third of innovating firms participate in public support programmes for innovation, with large firms receiving support more frequently than SMEs (OECD, 2010b).

Figure 2.2. **Change in tax treatment of R&D, 1999 and 2008**[1]

Tax subsidy to R&D (calculated as 1 minus B-index)[2]



1. 2009 for Mexico.
2. For example, in France, 1 unit of R&D expenditure results in 0.425 unit of tax relief.

Source: Warda, J. (2009), "An Update of R&D Tax Treatment in OECD Countries and Selected Emerging Economies, 2008-2009", mimeo.

StatLink http://dx.doi.org/10.1787/888932333025

Although some countries do not offer any tax incentives for R&D or innovation, R&D tax subsidies have become more generous over the decade to 2008 in all countries that offer them except Italy (for SMEs) and Denmark (Figure 2.2). However, France, Norway and the Netherlands (for SMEs) are the countries which have enlarged their indirect support to R&D most significantly. In 2008, France and Spain provided the most generous schemes with respectively 0.425 and 0.349 units of tax relief per US dollar of R&D expenditure. These instruments are also being developed in non-member countries. Brazil, China, India, Singapore and South Africa provide a generous and competitive tax environment for R&D investments (OECD, 2009b).

Several countries also have adopted special provisions for smaller firms and in 2008 granted larger subsidies for SMEs than for large firms. Korea stands out as an exception since tax credits for large firms have increased faster than for SMEs. Greece, Italy and the

Slovak Republic have recently introduced R&D tax incentives. Germany has plans to do so within the current legislation.

Contrary to the general trend, Mexico and New Zealand have repealed their R&D tax credit since 2008. Mexico converted its R&D tax credit to direct assistance in 2009. New Zealand had introduced a R&D tax credit of 15% in 2008 but has since repealed it with effect from the 2009-10 fiscal year and introduced new schemes (Table 2.7). Finally, it is worth noting that in Belgium, tax relief on social charges allows lowering the wages of the researchers in both the private and public sectors. This extra funding to universities and public research institutes is estimated at EUR 200 million; the government funds directly EUR 844 million of the EUR 1.2 billion higher education R&D expenditures.

Many countries have changed their R&D tax credit schemes in order to expand the number of beneficiaries and increase the amount of business R&D spending. Some have modified the criteria of eligibility, extended the coverage of R&D activities or the coverage of firms eligible for tax relief. Table 2.7 provides an overview of recent trends in R&D tax credits.

Table 2.7. **Recent and proposed changes in R&D tax incentives in OECD and selected non-member countries**

Australia	Australia has announced its intention to replace its R&D tax concession with an R&D tax credit. The new scheme will provide 45% on volume refundable for small firms (aggregate turnover of less than AUD 20 million) and 40% of volume non-refundable for large firms (aggregate turnover of greater than AUD 20 million). Eligibility for the scheme has been expanded in line with OECD non-discrimination articles to include all Australian resident companies and foreign companies, subject to certain requirements. The new R&D tax incentive redirects assistance to activities most likely to generate spillovers. It tilts assistance in favour of smaller innovative firms, as they are more likely to respond to fiscal incentives. The new incentive also removes the requirement that intellectual property (IP) be held in Australia, encouraging investment by the growing number of multinational enterprises in Australia that hold their IP overseas.
Belgium	A partial exemption of payment to the tax administration of withholding tax on earned income has been gradually introduced (since October 2003) with respect to remunerations paid to research workers. The exempted part that is deducted but not paid to the tax administration stays at the disposal of the employer. Research workers are allowed to set off the part not paid to the tax administration against their income tax liability on their tax return. The payment to the tax administration of withholding tax on earned income is exempted to 75% (new percentage since January 2009) and is valid for the following research workers: • European universities and *hautes écoles*, as well as for one of the Belgian research institutes; • scientific institutions approved by royal decree; • private companies employing research workers collaborating with the above-mentioned institutions; • companies employing research workers having either a PhD in applied sciences, exact sciences, medicine, veterinary medicine or pharmaceutical sciences or civil engineering, or a Master or equivalent in fields of sciences. These persons must be working on R&D programmes.
Canada	On the basis of consultations with stakeholders, the Government of Canada introduced several changes in 2008 to enhance the availability and accessibility of financial support for R&D for Canadian SMEs. It also allocated additional funding to improve the administration of the Scientific Research and Experimental Development (SR&ED) investment tax credit programme. In particular: • Budget 2008 improved the availability and accessibility of financial support for small and medium-sized R&D performers by increasing the expenditure limit for the enhanced refundable SR&ED investment tax credit available to small Canadian-controlled private corporations (CCPCs) from CAD 2 million to CAD 3 million and increased the upper limit for the taxable capital phase-out range from CAD 15 million to CAD 50 million. Budget 2008 also extended the SR&ED tax credit to certain activities carried out outside of Canada. • Budget 2008 also announced some improvements to the administration of the SR&ED programme that will facilitate access to the programme, improve its consistency and predictability, and enhance the quality of the claims process. Changes to SR&ED as a result of the 2008 federal budget are explained at *www.cra-arc.gc.ca/txcrdt/sred-rsde/whtsnw/bdgtch-eng.html*.

Table 2.7. **Recent and proposed changes in R&D tax incentives in OECD and selected non-member countries** *(cont.)*

China	The 2008 Corporate Income Tax Law (CIT) allows an enterprise to claim an additional deduction of 50% of R&D expenses incurred for the development of new technologies, new products and new craftsmanship. If the R&D expenses result in an intangible asset, then the enterprise is allowed to amortise the intangible asset based on 150% of the capitalised R&D costs. In addition, since October 2009, qualified foreign-funded research and development centres ("FIE R&D centres") are eligible for the import tax exemption treatment. Moreover, qualified R&D centres regardless of whether they are domestic-funded or foreign-funded can obtain the VAT refund treatment for the purchase of domestic-manufactured equipment ("DME VAT Refund"). The *Caishui* Circular 115 of 2009 stipulates the minimum threshold of R&D expenditure, the number of R&D personnel and accumulated costs of equipment purchased since the establishment of the R&D entity. In order to encourage the establishments of FIE R&D centres as well as effectively implementing the above-mentioned circulars, on 22 March 2010, the Ministry of Finance (MOF), the General Administration of Customs (GAC) and the Ministry of Commerce (MOC) jointly issued circular *Shangzifa* [2010] No. 93 concerning measures for verifying tax exemption/refund eligibility related to the purchase of equipment by FIE R&D centres.
Denmark	Denmark provides tax incentives for experimental research conducted by the private sector. Foreign researchers and key staff are also taxed at a lower income tax rate than the normal income tax. Foreign researchers and key staff can choose between a 25% tax rate in 36 months or a 33% tax rate in 60 months. A number of limitations and conditions apply. The system was introduced in 1991 and was modified in 2008 with the opportunity to choose between the 25% or 33% tax rate (including labour market contribution the tax rates are 31% and 38.4%). From 2010, individuals will get a deduction for gifts to charities, etc., which use their resources for research to the benefit of the public. The purpose is to make an opportunity for more resources to flow research that benefits the public.
France	The reform of the national tax credit, the *Crédit d'impôt recherche* (CIR), in effect since 2008, has seen no major changes. As part of the stimulus package the French government has agreed to temporarily modify the statutes of the CIR in order to provide temporary tax relief to companies that carried out R&D activities between 2005 and 2008 (OECD, 2009b). From 2011 the R&D tax credit for SMEs will systematically be reimbursed immediately.
Germany	The new German federal government has agreed to introduce R&D tax incentives during the current legislative period 2009-12.
Hungary	Since 1 January 2005, a tax credit on wage costs related to R&D activity and software developers has been applicable, and as of 1 January 2006, a specific tax credit on wage costs incurred in connection with software developers was introduced for SMEs. As of 1 January 2008, the limit of the development reserve was increased from 25% to 50% of the pre-tax profit. The VAT regulation for enterprises changed on 1 January 2006 to make purchases under funded projects eligible for refund of VAT.
Ireland	In 2009 (accounting periods commencing on or after 1 January 2009), the tax credit for incremental R&D spending has been increased from 20% to 25% with the base year fixed at 2003-13. Such expenditure can be taken against corporate tax. Companies may claim cash payments over three years in the event of insufficient or no corporation tax. The tax credit on buildings/structures can be fully claimed (25%) in the period when the expenditure is incurred. The requirement that building/structure be used wholly and exclusively for R&D has been removed. Credit is now due if at least 35% of all activities carried on in the initial four-year period are R&D activities. Companies may claim cash payments over three years in the event of insufficient or no corporation tax.
Israel	Israel has adopted a slightly different tax scheme to support R&D. Tax benefits are calculated on annual turnover but eligible firms are intensive R&D performers. Since September 2007 the Law for the Encouragement of Capital Investment allows companies that are considered to have a high rate of R&D expenditures (at least 7% of annual turnover and 20% of employees devoted to R&D activities) to reduce their turnover base annually by 10% and benefit from a tax credit. Additional benefits that a company could receive after capital investment is approved by the authorities will enjoy tax relief and deductions.
Italy	In Italy, the budget law of 2006-07 established a volume-based R&D tax credit of 10% for business R&D expenditures and a rate of 15% for eligible business R&D carried out in collaboration with universities and public research institutions. The budget law of 2007-08 raised the rate of 15% to 40% as well as the limit on eligible expenditures from EUR 15 million to EUR 50 million.
Japan	In FY 2003, the government established a permanent volume-based credit of 8-10% (12% for SMEs) for total R&D expenditures within 20% of corporate income tax. In this system, firms are allowed to carry forward the unused portion of their R&D tax credit only if they increase the amount of R&D expenditures during the next fiscal year. In FY 2006, the government abolished a special depreciation of equipment for "developmental research". In FY 2008, the government modified its tax incentive system to allow firms to claim an additional credit for 5% for the increase in R&D expenditures or an additional credit for 0.2% multiplied by the amount of R&D expenditures exceeding the equivalent of 10% of average sales, both within an additional 10% of corporate income tax. In FY 2009, the government, as a measure of addressing the economic crisis, temporarily increased the limitation of total tax credits up to 30% of corporate income tax for FY 2009 and 2010; and allowed firms to carry forward the exceeded tax credits in those fiscal years to 2012.
Korea	In 2008, the tax credit rate for research and human resource development was raised to 10% (it was previously 7%). In 2009, this tax credit became permanent and the preferential tax credit rate for SMEs was raised to 25% (previously at 15%). In 2010, a 20% preferential tax credit rate is expected for new-growth-engine R&D (30% for SMEs), and a 25% preferential tax credit rate is expected for original-sourcing-technology R&D (35% for SMEs).
Mexico	In 2009, the government converted its R&D tax credit to direct assistance.

Table 2.7. **Recent and proposed changes in R&D tax incentives in OECD and selected non-member countries** *(cont.)*

Netherlands	The budget for the WBSO tax scheme (reduction of wage tax and social security contributions for companies with R&D personnel) was increased to EUR 115 million by 2011. In addition, an extra deduction will be created for existing companies (not start-ups) embarking on R&D for the first time. Finally, consideration is being given to raising the limit up to which companies may profit from the high rate. As of 2009 the definition of R&D has been extended to the development of services based on software.
New Zealand	A R&D tax credit was introduced on 1 April 2008 and was stopped after a year. However, the government has recently launched two new business R&D schemes. A technology development grant is available from 1 July 2010 to firms with a strong R&D record that spend 5% revenue or more on research. A technology transfer voucher is available from 1 November 2010 to firms with limited R&D capability so that they may commission research from accredited research organisations.
Norway	In 2002, the Ministry of Finance launched a tax incentives scheme (*Skattefunn*) as a broad instrument that covers every sector and all companies. The scheme gives enterprises with business activity in Norway a tax credit on their R&D projects. The R&D content must be approved by the Research Council of Norway *ex ante*. The scheme offers a rebate of 20% of expenses for SMEs and 18% for large enterprises. In 2009, the cap on expenses per enterprise for intramural R&D projects increased to NOK 5.5 million (previously it was NOK 4 million), and NOK 11 million (previously it was NOK 8 million) for projects conducted at an R&D institution. If the calculated rebate exceeds the assessed taxes of the enterprise, the difference is refunded as part of the assessment. About three-quarters of the total tax expenditure under the *Skattefunn* scheme has been such cash refunds. The total R&D tax rebate for 2008 is approximately NOK 1.0 billion.
Poland	The act on some forms of support for innovation activity was modified as of 1 January 2006 to enable all enterprises to deduct from their tax base no more than 50% of their expenditures for the purchase of new technologies (including patents and intangible assets). In 2009 the government introduced a deduction from the tax base for development costs in the month during which the expenditure was made. In 2010 the government is working on R&D tax credits for entrepreneurs granted the status of R&D centre.
Portugal	Portugal has an established policy of tax credits granted to companies that perform or contract R&D activities, called SIFIDE. This tax measure was created in 1997, suspended in 2004 and 2005, re-established in 2006 (under severe public budget constraints imposed by the European Union) and reinforced in 2009. Following SIFIDE's reinforcement, companies can now reduce their tax debts by a percentage double the amount invested in R&D activities (*e.g.* the basic rate that corresponds to 32.5% of expenses, and an incremental rate of 50% of the increase of expenses in regard to the average of the two previous years but up to the new limit of EUR 1.5 million). The institution responsible for this measure is the Ministry of Science, Technology and Higher Education and the Innovation Agency (AdI) is responsible for managing it.
Russian Federation	The Russian Federation now allows full deduction of current R&D expenditures for tax purposes. Previously only 50% of such expenditures were taken into account.
Slovenia	In 2010 general tax allowances on business R&D expenditure were increased from 20% to 40%, thus enabling total (general + regional) allowances on business R&D expenditures of a maximum 60%.
South Africa	The enhanced R&D tax incentive introduced in November 2006 offers a 150% tax deduction on current expenditure, and a three-year accelerated depreciation on R&D capital investment of 50:30:20. Before 2006, the tax deduction was 100% and depreciation was 40:20:20:20.
Spain	To compensate for the general decrease in corporate taxes (as of 2007), R&D and innovation corporate tax credits were gradually reduced and were to be phased out completely by 2011. However, the Royal Decree-law 3/2009 suppressed the temporary limit on the deductibility of R&D investments from tax income, and the R&D tax remains in force.
Turkey	Issued in 2008, the Law on Promoting Research and Development Activities (No. 5746) is a policy tool primarily aimed at addressing the need to create R&D centres with critical mass. It aims to increase the scale of R&D carried out even in large firms so that it is at a favourable level with the top global competitors. It is thus an additional incentive to promote large R&D centres in Turkey. In particular, under this law, several incentives are provided, without any sectoral or regional distinction, including: R&D allowances (100% on volume; and for large R&D centres with at least 500 FTE researchers, 50% on incremental R&D from the previous year); incentives on income tax withholding (90% of FTE PhD researchers and 80% of other R&D workers), insurance premiums, stamp duties; and 100% depreciation of the capitalised R&D expenditures for R&D centres with at least 50 FTE researchers. These incentives are provided until the end of 2023.
United Kingdom	The Pre-Budget Report of December 2009 announced the government's commitment to promoting innovation through the R&D tax credit scheme. At the time of publication, over 36 000 claims had been made, with over GBP 3 billion of relief claimed, supporting over GBP 32 billion of R&D activities by companies. To enable companies to access the scheme more easily, the government announced the dropping of the condition that any IP deriving from the R&D must be owned by the company making the claim. This will allow companies to benefit from the scheme without distorting their commercial arrangements in relation to IP. In 2008, the R&D tax credit scheme for SMEs was extended to mid-size companies and the enhanced relief was increased to 175% (for SMEs) and 130% (for large companies) of eligible expenditure.
United States	The Federal Research and Experimentation (R&E) tax credit was established by the *Economic Recovery Tax Act of 1981*. Given its temporary status it is subject to periodic extensions and it was last renewed by the *Emergency Economic Stabilization Act of 2008* through 31 December 2009. The *AmericanRecovery and Reinvestment Tax Actof 2009* (P.L. 111-5; February 2009) increased the research credit for energy research and allowed for claiming a refundable credit for certain unused research credits in lieu of depreciation allowance for eligible qualified property. Legislation to extend the R&D tax credit continues to be considered in both chambers of the US Congress.

Source: OECD responses to the STI Outlook 2010 Policy Questionnaire and OECD, responses to the 2009 NESTI R&D tax incentives questionnaire.

Support for R&D and innovation in SMEs and start-ups

Although large firms tend to introduce more "novel" innovations than SMEs, which tend instead to be adopters (OECD, 2009b), SMEs form the bulk of businesses and play a key role in knowledge diffusion. Their contribution is more significant in marketing or organisational innovation than in technological innovation.

SMEs typically have more limited access to finance than large firms and fewer resources for generating and stocking knowledge. The credit crunch caused by the crisis has raised serious concerns about their capacity to remain innovative. Consequently, many countries have developed specific policy instruments to foster innovation among SMEs.

Direct financial support to small firms is used to subsidise R&D, finance technology investments, and help them develop human capital or access knowledge-intensive services.

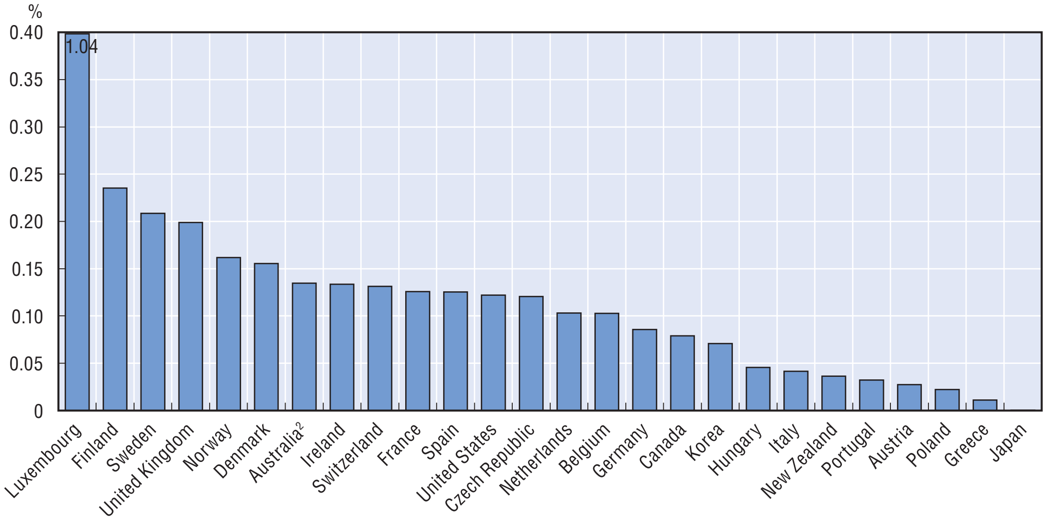
- In the context of their second stimulus package (*Konjunkturpaket II*), Germany pledged EUR 900 million for R&D in SMEs in 2009 and 2010 and the programme is being expanded to include larger companies with up to 1 000 employees. In addition more than EUR 950 million were earmarked in 2009 for technology funding for SMEs.
- In 2009 Canada also temporarily expanded its funding to initiatives for technology-based SMEs (CAD 200 million over two years) during the economic downturn. Canada introduced the Innovation Commercialization Program, a two-year-pilot initiative (CAD 40 million over two years) through which federal departments and agencies will adopt and demonstrate the use of innovation prototype products and technologies developed by SMEs.
- One of the most important tasks of the Danish Competence and Innovation Networks is to ensure that smaller companies participate in network projects and that this target group makes use of innovation policy initiatives.
- Finland provides SMEs funding for the procurement of innovation services. Eligible targets include consultation related to the development of a company's business model and strategy, market and customer needs surveys, and studies on rights to a product or service. The funding for SMEs consists of either a financial grant of 35% or 50%, or of a loan of a maximum of 70% of the total costs, depending on the nature of the project.
- In 2008, France replaced the previous AII scheme by the *Innovation Stratégique Industrielle* (ISI) programme to help SMEs and medium-sized firms (up to 5 000 employees) with high-growth potential to develop breakthrough innovations in the framework of collaborative projects involving firms and centres of competences (annual budget of EUR 150 million). In addition, EUR 1.5 billion have been allocated to the national agency for innovation and SMEs (OSEO) for grants, advances, guarantees and loans to innovative SMEs and medium-sized firms and to allow the OSEO to take higher risks.
- In Sweden, the SME lending facility (*Almi*) was substantially increased. At the same time a new governmental evergreen fund, *Almi Invest*, was introduced, investing at the level of SEK 1-10 million in SMEs.
- Turkey has developed new support systems (KOSGEB) to provide innovative SMEs with R&D facilities and to support their technology development (OECD, 2009a).

Innovation vouchers aim to encourage and help SMEs to access and use knowledge from the higher education and research sectors. At the same time, innovation vouchers help firms to formalise their knowledge needs and allow knowledge institutions to identify business demand and make public research more relevant. Innovation vouchers have already been implemented in many countries and policy makers have tended to simplify their use and to extend their scope.

- Belgium (Wallonia) has introduced technological vouchers (*chèques technologiques*) as a 75% subsidy, granted within three business days and available to all SMEs in Wallonia interested in using the services of a research centre.
- In 2008 Denmark established a new Innovation Voucher Scheme. The scheme is open to projects in all scientific fields and has been designed to reduce bureaucratic measures as much as possible. There are two vouchers: *i)* a "basic" voucher for research-based business development projects to ensure transfer of knowledge from research to SMEs (state co-funding level of 40% with a maximum of DKK 100 000); *ii)* an "extended" voucher with similar characteristics for a larger-scale R&D collaboration project to find new solutions to current problems (state co-funding level of 25% with a maximum of DKK 500 000).
- In 2009, Greece introduced innovation vouchers for SMEs (EUR 8.4 million). The new scheme grants innovative consulting and support services from public research institutes (universities, technical institutes, research centres, industry companies) to SMEs with up to 20 employees (mainly in the manufacturing sector). Each grant or voucher is issued in amounts up to EUR 7 000 and allows SMEs to get specialised services and expertise in order to address a problem, a query or improve a production process.
- In Italy, several regional governments granted vouchers to SMEs for R&D services and the development of human capital in 2009 and 2010 (*e.g.* the region and chamber system of Lombardy has provided around EUR 6 million).
- The Netherlands has renewed its commitment to intensify its innovation voucher scheme. Since it was launched in 2008, over 20 000 innovation vouchers have been provided to entrepreneurs. In addition, in 2009 another 8 000 vouchers were issued to entrepreneurs in the SME sector. The success of the instrument relies on low-threshold access which allows broad coverage among SMEs and a digital format that reduces the administrative burden and makes it easy to apply for (the application process can take as little as eight minutes). To expand the potential of the innovation voucher scheme, a pilot project has been carried out with 1 000 innovation vouchers that can be cashed in with private knowledge suppliers. Syntens, an executive body of the Ministry of Economic Affairs, was involved in helping entrepreneurs find the appropriate knowledge institute.
- Slovenia has implemented innovation vouchers through the Agency for Entrepreneurship and Foreign Investments.
- The Swedish Agency for Innovation Systems (VINNOVA)'s VINNOVA Research & Grow programme was modified in 2008 to allow continuous application handling for small projects (grants up to SEK 100 000). This reshaped the programme to create a more voucher-like instrument and make the process more open and faster, especially for SMEs.
- In 2009, the Swiss innovation promotion agency CTI launched Innovation Voucher for SMEs with a value of CHF 7 500 per voucher. Given the positive reaction, CTI launched in 2010 a further series of innovation vouchers, again with a value of CHF 7 500 per voucher. This second series is open exclusively to projects in the field of "cleantech".

Venture capital (VC) plays a crucial role in promoting innovation and is a key determinant of entrepreneurship (OECD, 2009b). But venture capital is highly sensitive to economic downturns and the appetite in markets for new technology-based firms (Figure 2.3). Most private venture capital funding concerns expansionary capital in

Figure 2.3. **Venture capital, as a percentage of GDP, 2008**[1]



Note: The OECD defines venture capital here as the sum of "seed/start-up stages" and "early development and expansion stages". The coverage of VC stages within these two broad groups differs across countries and the data may therefore not be fully comparable. See notes at the end of Chapter 3 for further details.

1. 2006 instead of 2008 for Japan.
2. Venture capital in Australia includes seed, start-up, early and late expansion, and turnaround investment. Australian data are overestimated.

Source: OECD, *Entrepreneurship Financing Database,* July 2010.

StatLink http://dx.doi.org/10.1787/888932333044

higher-technology industries. Consequently, governments have tended to provide funds for early-stage and seed financing, often along a "fund of funds" model in which government invests along with private actors and the fund is privately managed.

In 2008, Luxembourg led, with venture capital investments of 1.04% of GDP. Venture capital investments were also substantial in Finland, Sweden and the United Kingdom (around or slightly above 0.20% of GDP) but very limited in Japan and Greece (around or below 0.01% of GDP) (Figure 2.3).

In Canada and Germany, where venture capital markets are relatively limited, new measures in favour of risk capital have been introduced. In 2008 Germany approved the Act on the Modernisation of Framework Conditions for Venture Capital and Equity Investments. The federal government's High-Tech Start-ups Fund, with a volume of some EUR 272 million, invests venture capital in young, promising technology companies making entrepreneurial use of promising research findings.

The government of Canada provided CAD 350 million to expand venture capital activities, of which CAD 260 million will be directly invested in Canadian firms and another CAD 90 million in Canadian venture capital funds. In addition CAD 75 million have been earmarked to create a new privately run venture capital fund aimed at later-stage Canadian technology firms. To further improve access to financing for Canadian businesses, the federal government launched the Business Credit Availability Program (BCAP) in 2009 to deliver at least CAD 5 billion in incremental financing to businesses, largely SMEs.

In the framework of *Investissements d'avenir*, France has allocated EUR 400 million to a fund managed by the Strategic Fund of Investment (FSI) to reinforce start-up capacities.

Support for R&D and innovation in specific industries and technological areas

Government has a key role to play in sustaining industrial competitiveness and promoting cutting-edge research in advanced technology areas. Canada has maintained individual programmes, such as the Strategic Aerospace and Defence Initiative (SADI), which offers repayable investments for industrial research and pre-competitive development in aerospace, defence, security and space industries (up to CAD 225 million a year). In 2009, France implemented the *Pacte Automobile*, a national plan for the automobile industry which involves EUR 6.5 billion in participative loans for car manufacturers, an up-to-90% guarantee fund managed by OSEO, a EUR 600 million sectoral fund, higher partial unemployment compensation, and support schemes to innovation.

To address its lag in expanding fields, such as nanotechnology and biotechnology, France has boosted funding for nanotechnology research by EUR 70 million. Japan has allocated funds to research on advanced and innovative technologies such as regenerative biology. More broadly, the Japanese New Growth Strategy aims to address the issues of an ageing society and long life expectancy by promoting innovative pharmaceuticals and medical and nursing care technologies and fostering drug development ventures. Korea announced a Green New Deal and government investment in green technology R&D for a total of USD 4.7 billion over four years (OECD, 2009a).

Box 2.4. **Greening the automotive industry**

As a response to the global crisis that hit the automobile industry, many OECD governments have deployed rescue plans aiming to sustain the vehicle cluster during the economic downturn and ensure the foundations of future international competitiveness.

Governments have implemented financial compensation schemes to renovate the automobile park and prompt businesses and households to replace their old cars for newer and more energy-efficient ones. France, Germany, Italy, Japan, Portugal, Spain and the United States all have such incentives, with differences in the criteria of eligibility (age of the car) and the amount of the allocation (OECD, 2009a).

In addition many governments have developed incentives to better link automobile production to clean technologies (OECD, 2009a). Green R&D and the development of non-polluting energy sources are at the core of national strategies. Australia has invested in a New Car Plan for a Greener Future to improve environmental outcomes of the national automobile sector. In Belgium, both the Walloon and the Flemish governments have launched cluster policies in the automotive sector and the greening of the car industry has been high on the policy agenda. The Flemish research institute VITO in particular has invested in research on green cars. Germany has pledged EUR 500 million to foster the development of hybrid and other clean car technologies. Korea has increased its R&D spending for the development of technology in green cars. The US government awarded USD 2 billion in grants to spur private sector investment in battery and electric drive components; another USD 25 billion in loans was made available to accelerate the production of more fuel efficient vehicles. The European Green Cars Initiative covers a broad range of technologies and research on smart energy infrastructures to achieve a breakthrough in this direction.

Box 2.4. **Greening the automotive industry** *(cont.)*

Canada has launched major initiatives to advance automotive research: *i)* the Automotive Partnership Canada (APC), with CAD 145 million over five years (2009-14) to support collaborative industry-driven R&D; *ii)* the Automotive Innovation Fund (AIF), a CAD 250 million fund created in 2008–09 to support large-scale R&D projects that may help increase competitiveness and environmental performances of the Canadian automobile industry. A CAD 80 million repayable contribution has already been allocated to the Ford Motor Company of Canada's Renaissance Project to establish a flexible engine assembly plant (Ontario), and to create a new North American Centre for Diesel and Advanced Powertrain Research in order to advance research on powertrains (CAD 730 million by 2012).

The Swedish government created in late 2009 a venture capital firm, *Fouriertransform AB*, to finance commercially viable investment and R&D projects in the vehicle cluster. The firm has been allocated capital of EUR 300 million to be invested in operations that aim to strengthen the Swedish automotive industry's international competitiveness especially in terms of safety and respect of environment.

Source: OECD (2009a).

R&D and innovation in services and non-technological innovation

While OECD economies are clearly serviced-based, services still contribute a much smaller share of R&D activity (OECD, 2007). Iceland (60%) and Luxembourg (55%) are the rare OECD countries in which most business R&D is performed in the services sector.[3] In smaller OECD economies such as Chile, Greece, Portugal or the Slovak Republic, the services sector accounts for 43-45% of total business R&D expenditures. It represents less than 10% of total business R&D expenditures in France, Germany, Japan or Korea.

Services firms contribute substantially to non-technological innovation. In Austria, Greece, Portugal and Luxembourg, more than half of the firms in the services sector introduced organisational or marketing innovations between 2004 and 2006. In these countries, as in Finland, New Zealand as well as in the Czech Republic, Hungary and Poland, the services sector appears to be even more innovative than the manufacturing sector; more services than manufacturing firms have introduced non-technological innovation (OECD, 2009b).

Policy makers have paid increasing attention to promoting innovation in the services sector. Health services have particularly benefited from the increased policy focus.

Austria initiated in 2010 a Service Initiative for technological and non-technological services and provided funding with an emphasis on projects for innovative services. The initiative is at the moment limited to 2010.

Finland has launched two support programmes. Innovation in Social and Healthcare Services (2008-15) aims to renew social and health-care production processes, improve the availability of services and their quality and effectiveness, and promote new business opportunities. Serve – Pioneers of Service Business (2009-13) aims to broaden services development of Finnish industry and to promote academic research in service-related areas.

Germany has devoted EUR 17.5 million annually to the programme Innovation with Services (2006-11) to realign services research, create conditions for attractive jobs and improve market position. In addition a Service Task Force has been established to help link services research and technological research. Health and energy efficiency are the first areas in which pilot projects have been launched.

Korea formulated five "growth engines" with support for research in high-value-added services including health care, education and tourism (OECD, 2009a).

Greece launched in 2009 a new scheme to support new innovative companies (spin-offs, spin-outs) to promote both technological and non technological innovation.

In addition to efforts to stimulate health and care services, Japan plans to develop its tourism potential with an objective of 25 million foreign visitors annually by the beginning of 2020 and 30 million in the future. Japan has announced its intention to ease tourist visa requirements for citizens of Asian countries and study "local holiday systems" and other ways of staggering vacation times.

Sweden is working on the formulation of a strategy for promoting innovation in services and non-technological innovation. A debate is also under way concerning the establishment of a national research institute in services, possibly within the existing Research Institutes of Sweden Holding (RISE) infrastructure. Some services have already been identified as strategic research areas and benefited from the additional public funding provided in the framework of the 2008 Research and Innovation Bill. Health and IT services will receive particular support. Finally, Sweden launched in 2009 a VINNOVA research programme to increase knowledge about leadership in and organisation of service-oriented domains. Thematically, the largest number of service-oriented projects financed is in transport, followed by life sciences, and then production and product development.

Other examples of initiatives around services, non-technological and user-driven innovation include:

- Denmark has implemented a programme backed with a yearly budget of DKK 100 million (2007-10) to strengthen the diffusion of methods for user-driven innovation in the private as well as the public sector. Moreover the Danish Council for Technology and Innovation has an Open Pool for new types of collaboration.
- Canada has implemented a network of over 240 industrial technology advisors located in technology communities, local associations, universities and colleges across the country which provide support to SMEs on technological and non-technological matters. They assist firms from concept to product, give technical and business advice, referrals and other innovation services.
- Finland has significantly increased public allocations for non-technological development, which accounted in 2009 for 41% of the total financing of its main Funding Agency for Technology and Innovation (Tekes). Tekes' Workplace Development Programme (2004-09) aims to improve the modes of operation of Finnish companies and other work organisations, and enhance productivity and the quality of working life.
- In 2008 France implemented the *Plan Qualité et Performance 2010* to improve the diffusion and appropriation of best practices by SMEs through the organisation and funding of collective actions (diagnostics, awareness campaigns, and implementation of operational tools). In addition, a policy action was implemented late in 2009 to foster education on these best practices. At local level, higher education institutions of the *Rhône-Alpes* region are developing a pilot *atelier-école* project to implement these best practices and measure their impact on the production line.

- Germany is providing EUR 22.5 million a year to develop innovations in the workplace and an additional EUR 10 million annually to improve the employability of individuals by introducing training and new concepts for personal development. In addition, Germany is funding an international monitoring project to study the development of working skills.
- Sweden is developing its R&D activities to advance current knowledge on how to achieve and maintain organisational and managerial conditions for innovation and to promote learning, creativity and innovation at work.

Several countries have also emphasised fostering creative industries and sectors.

- Denmark has focused public efforts on improving market conditions for the design sector, increasing the visibility of Danish design, and strengthening research as well as education and training in the areas of design.
- France has reinforced general tax incentives for the textile, craft and art industries. The French government has also commissioned a comparative survey of creativity schools in France and abroad, and an international survey of design policy in order to implement new policy actions and increase the influence of French design internationally.
- Israel has adopted two special programmes to support innovation in industrial design and to encourage companies going through the creativity process.
- Spain has implemented the ADÑ programme to help establish a culture that promotes innovation and design through the diffusion of good practices and advanced knowledge.
- Sweden has allocated EUR 7 million over three years to stimulate the creative and cultural sector.

Demand-side innovation policies

Demand-oriented innovation policies have recently attracted much attention from policy makers, partly in response to interest in increasing market demand and uptake of innovation that can address certain societal needs while improving economic performance. The existence of market or system failures which stunt market demand for innovation (*e.g.* information asymmetries, spillovers, externalities or appropriability of public goods) may justify policy action, especially in areas for which the public sector is a provider of goods and services. Targeted demand-oriented innovation policies include public procurement, lead markets, regulations and standards, pricing schemes and consumer policies.

Box 2.5. **Examples of demand-side innovation policies**

Australia: The Australian Industry Participation (AIP) National Framework (2001) aims at supporting Australian industry to innovate, develop and enhance competitive capabilities and take advantage of investment opportunities. In its 2009 Procurement Statement, the Australian government announced a series of measures to extend and strengthen the Australian Industry Participation framework, notably to apply the AIP framework to large Commonwealth tenders (above AUD 20 million) and Commonwealth infrastructure projects; and to emphasise the connection of Australian suppliers to Commonwealth-funded infrastructure (AUD 8.5 million will be provided to the Industry Capability Network).

Austria: Austria will launch an Action Programme on Innovation – Promoting Public Procurement in 2010 to deal with major issues related to public procurement for innovation such as co-ordination of stakeholders, SMEs and acceleration of the process.

Box 2.5. **Examples of demand-side innovation policies** *(cont.)*

Denmark: The Danish programme for user-driven innovation aims to strengthen the development of products, services, concepts and processes in companies as well as public institutions through increased focus on innovation from the perspective of the user. The programme funds projects that develop and test methods of user-driven innovation.

EU: The European Commission's Lead Market Initiative (LMI) identifies e-health, protective textiles, sustainable construction, recycling, bio-based products and renewable energies as areas in which a combination of procurement, regulations and standards can strengthen the competitiveness of leading firms in these markets.

Finland: The national innovation funding agency, Tekes, finances public procurement of innovation to lower risks associated with the development of innovative goods and services. In the first stage, planning of procurement, the government funds between 25% and 75% of the project's total expenses. In the second stage, procurement or implementation, Tekes provides financing support for the procurer and for suppliers' R&D and innovation expenses.

France: Article 26 of the French Economic Modernisation Act of March 2009 promotes procurement of innovation from SMEs. It reserves 15% of small technology contracts for innovative SMEs. The article applies to all firms eligible for FCPI (*Fonds commun de placement dans l'innovation*) funding, *i.e.* SMEs which spend 10-15% of their expenditures on R&D or meet other conditions related to innovation.

Germany: Via its Innovation with Norms and Standards, the BMWi is supporting the German Institute for Standardisation (DIN) in early, systematic identification of standardisation requirements in high-technology fields covered by the High-Tech Strategy (such as aero-space technology, micro-system technology, nanotechnology, medical technology and biotechnology). The aim of the (partially demand-side) effort is to provide an optimal framework for future innovation and thereby to promote the marketability of such innovations.

Italy: The government has recently re-oriented its innovation strategy towards societal challenges, notably the transition to a low-carbon economy. The government aims to achieve this by linking supply- and demand-side policies in the area of green technologies, especially in energy co-generation, photovoltaic plants, solar thermic plants and new high-tech long-distance power lines.

Japan: In a new innovation strategy, Japan shifts from scientific innovation in four strategic fields (biotechnology, ICT, nanotechnology, environment) to demand-pull innovation (low carbon society, ageing).

Korea: The New Technology Purchasing Assurance scheme requires public agencies to give preference to the procurement of goods and services from SMEs, which also receive a new technology guarantee from the government. Under this programme, the Korean Small and Medium Business Administration finances the technological development of SMEs, and public institutions purchase the products for a certain period.

Netherlands: The Launching Customer Scheme is an awareness and information scheme on the use of public procurement by government procurers and suppliers. The Dutch Innovation Agency, NL Agency, complements this scheme by advising municipalities and other agencies on how to promote innovation through tendering.

South Africa: To ensure that local companies participate in the major infrastructure built by state-owned enterprises (SOE) the Competitive Supplier Development Programme (CSDP) requires foreign-based original equipment manufacturers (OEMs) to subcontract local companies as Tier 2 and 3 suppliers.

Box 2.5. **Examples of demand-side innovation policies** *(cont.)*

Spain: The Spanish State Innovation Strategy is developing measures for an innovation policy based on specific markets: health and welfare, green economy, e-government, science, defence, tourism and ICT. For these markets, public procurement policies encourage innovation through public sector demand, under the legal framework recently endorsed by the new laws on public contracts and on the project of sustainable economy.

Sweden: VINNOVA, the Swedish innovation agency, started a pilot programme of Innovation procurement in late 2009. The programme aims to stimulate the development of new products/processes in the public sector.

United Kingdom: The United Kingdom aims to make government procurement more conducive to innovation. Government departments are required to establish and develop an Innovation Procurement Plan. The procurement agency (OGC) and the innovation ministry (BIS) provide practical advice to procurers on how to ensure that innovation is incorporated into procurement practices. In addition, the government is using standards to support demand for biometrics by supporting the development of technical standards that support interchangeability and interoperability. The idea is that standards can help reduce risk for the procurer, system integrator and end user, because they simplify integration and enable vendor substitution, technology enhancement and development.

United States: To stimulate demand for advanced health information technology systems, the United States has established a system of incentive payments under two large, public health programs (Medicaid and Medicare) for physicians and hospitals that demonstrate "meaningful use" of electronic health records (EHRs). As complementary measures, the United States established standards for certifying that qualified EHRs meet specified "meaningful use" criteria, and has funded regional extension centres to assist users in selecting and implementing qualified EHR systems.

Enhancing networking among actors

Countries' innovation performance depends increasingly on their ability to catch and make the most of globalised knowledge flows. Co-operation across sectors, fields and borders has become indispensable. Firms collaborate more with customers, providers or competitors on innovation processes. The production of scientific knowledge is shifting from individuals to groups, from single to multiple institutions and from national to international (OECD, 2010b). Not surprisingly, policies to support networking and collaboration among innovation actors are intensifying throughout the OECD area.

Encourage the development of STI platforms and open infrastructures

It is widely recognised that the effectiveness and efficiency of innovation systems are determined to a considerable extent by the degree and quality of linkages and interactions among various actors, including firms, universities, research institutes and government agencies. Four indicators can be used to measure the connectivity of innovation infrastructures: *i)* the regional concentration of patenting as a percentage of Patent Cooperation Treaty (PCT) patent applications; *ii)* the number of broadband subscribers per 100 inhabitants; *iii)* the share of innovative firms engaged in collaboration on innovation and *iv)* the degree of collaboration on scientific publications (per capita). The regional concentration of patents indicates the presence of research hubs that host public labs, leading research universities and innovative firms. The broadband penetration rate reflects how widespread are high-speed networks that serve as a platform supporting innovation.

Broadband has become the leading delivery system for a wide range of content and has dramatically changed personal and business practices. The share of innovative firms engaged in collaboration and the degree of collaboration on research publications provide direct measures of collaboration in industry and in science (OECD, 2010b).

Virtually all countries give high priority to policies aiming to improve the physical STI infrastructure and to link public research to industry and society (Table 2.8). In fact, the development of STI platforms and infrastructures ranks as a top priority for Canada and Japan, where collaboration in industry for the former and in both industry and science for the latter, are weaker than in many other OECD countries. Finland and Sweden seem to show the best performance in terms of STI infrastructure.

Table 2.8. **Innovation infrastructure: performance, policy priority level and measures taken between 2008 and 2010**

	Performances in 2008 or nearest				Priority level		Develop STI platforms and open infrastructures			
	Regional concentration of patenting,[1] 2004-06	Broadband penetration rate,[2] June 2009	Share of innovative firms engaged in collaboration 2004-06	Scientific publications[3] in collaboration, 2007	Improve the physical infrastructure for STI	Link public research to industry and society	Improve ICT network	Foster clusters	Develop PPPs	Encourage public research diffusion
	Index 100 = Highest OECD value				Country self-reported[4] (1-8)		Measures/initatives taken between 2008 and 2010			
Austria	58	57	64	49	5	7			✓	
Canada	100	78	37	60	8	8		✓		✓
Czech Republic	36	48	67	32	6	8	✓	✓	✓	✓
Denmark	56	97	55	70	6	6		✓		
Finland	70	78	100	72	7	6		✓		✓
France	62	76		38	3	7	✓	✓	✓	
Germany	53	77	25	38	6	7	✓	✓	✓	✓
Hungary	67	44		20	7	8	✓			
Israel					6	6		✓	✓	✓
Italy	58	52	22	33	8	8	✓		✓	✓
Japan	75	64	41	26	8	8	✓		✓	
Korea	77	86	36	30	5	7	✓		✓	✓
Netherlands	49	100	65	64	6	6		✓	✓	✓
New Zealand	55	60	52	59	7	7				
Norway	65	91	59	66	7	7			✓	✓
Poland	75	30		17	7	6				
Slovenia					7	8				
South Africa			61		6	8				
Spain	65	55	26	36	6	8	✓		✓	
Sweden	71	83	68	75	6	8		✓	✓	
Switzerland	30	89		100	n.a.	n.a.				
Turkey	93	23		9	n.a.	n.a.				
United Kingdom	62	76	45	53	n.a.	n.a.				
United States	70	70		37	2	5		✓		✓

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.
n.a.: Response not available.
1. PCT patent applications.
2. Number of subscribers per 100 inhabitants.
3. Per capita.
4. Self-reported ranking of national STI priorities based on a scale whereby 1 = least important and 8 = most important.
Source: OECD, *REGPAT Database*, June 2009; OECD, *Broadband Statistics, June 2009*; OECD, Innovation Microdata Project based on CIS-2006, June 2009 and national data sources; OECD (2010b), "*Measuring Innovation: A New Perspective*", OECD, Paris; responses to the STI Outlook 2010 Policy Questionnaire.

Nurture world-class nodes and bridge industry and science

Reinforcing industry-science linkages continues to be a major thrust of innovation policies. Linkages between public research institutes and industry occur in many ways, from the most direct – joint research projects or joint ventures (spin-offs) – to the more indirect – training, consultancy, staff mobility – to informal co-operation.

Public-private partnerships have been encouraged at different levels and by different levers. Reforms in general policy, regulation or changes in organisational structures have created new areas of co-operation.

- Sweden has amended its Higher Education Act so as to introduce the building of external partnerships into the mission of higher education institutions, together with education and research, and to encourage them to actively exploit research outcomes. In this context, a model agreement has been developed to regulate responsibilities and rights in collaborative research.
- Similarly the Netherlands has adopted changes in regulations governing the types of agreements negotiated between public research institutes and businesses and their implications for access to and exploitation of research results.
- Since 2008 Austria has allowed the temporary research studios that were mainly based within the Austrian Research Council to be based at universities or non-university institutes.
- Israel has planned to implement 30 new centres of excellence for research, development and innovation (ICORE – Israeli Centers of Research Excellence) within the new national plan (2011-15) for a total budget of about USD 350 million (ILS 1.35 billion). A third of this programme will be financed by the government, while the rest will derive from universities' own funds and assigned donations. The first four centres of excellence will be established during the academic year 2010-11.
- Slovenia has established eight new centres of excellence for a four-year budget of EUR 77 million in priority areas including materials and nanotechnologies, complex systems and innovative technologies, health and life sciences, and technologies for a sustainable economy. In the near future seven more centres of excellence will complement the system.
- South Africa is developing a framework for its centres of competences (CoC) to provide them with guidelines for their establishment and management. These physical and virtual platforms serve to establish collaborative technology development partnerships between government, industry, higher education institutions and public research institutes. Public-private partnership arrangements are also encouraged through regulations administrated by the Department of National Treasury.

Governments have increased financial support to collaborative schemes and research projects involving public and private partners. This is the case for Spain but also for Norway where requirements of industry-science collaboration have been included into all major and minor funding schemes.

- One of the main tasks of the new Czech Technology Agency has been to strengthen industry-science co-operation. The Czech government supports collaboration platforms that provide infrastructure for business R&D, training and training of human resources to enhance the development of start-ups and academic spin-offs.
- In France, EUR 400 million have been allocated over four years (2009-12) to a new ADEME *démonstrateur* fund to facilitate the testing of new technologies at industrial scale and

help validate technological choices. New alliances have been created to co-ordinate main actors in an area and to design thematic R&D programmes that are consistent with the national strategy. These partnerships will provide the National Research Agency with S&T roadmaps and assist it in setting the national R&D agenda. In the near future they will also develop public-private partnerships.

- Israel has created a joint public-private sector fund to support investments in biotechnology and has announced the establishment of two technological centres dedicated to water and renewable energies that will promote the transfer of know-how from academia to industry. In addition the Magnet Programme funds industrial and academic partners involved in pre-competitive R&D on new generic technologies with the aim of creating a new generation of advanced products. The Users Association in Advanced Technologies also gives users from the private sector the opportunity to better exploit advanced technologies.
- In Japan, the Innovation Network Corporation of Japan provides capital and managerial support to public-private partnerships to next-generation businesses in promising new technologies.
- In Sweden the additional funding to be allocated by the central government to strategic research areas will indirectly support partnership programmes with industry since these areas have been specifically defined in fields in which government R&D funding strengthens the competitiveness of Swedish industry. The Swedish government has also allocated extra funding to bridge academic research, needs-based research, and company-related R&D (*Innovationsbron AB* for SEK 200 million).

Public schemes to strengthen public-private partnerships often include commercialisation partnerships. In 2008 Canada took a series of commitments in this direction and granted substantial investments to further develop the Networks of Centres of Excellence (NCE),[4] in particular with the creation of Business-Led NCEs (CAD 46 million in investments over four years), the Centres of Excellence for Commercialization and Research (CAD 350 million in investments over five years) and the College and Community Innovation Program (CAD 18 million over five years and will continue at CAD 30 million, as of 2011-12).

Clusters

Strengthening existing or developing clusters has become a pillar of national innovation policy. Clusters group together enterprises, higher education institutions and public research institutes that collaborate in a certain area. In all OECD countries, innovation is geographically concentrated owing to the existence of local clusters and the dynamics of regional economies (OECD, 2007).

Since the early 1990s many OECD countries have promoted a cluster-based approach to innovation in parallel with traditional sectoral R&D programmes policy. More recently health, energy, natural resources and food production have been particularly targeted.

- The Swedish programme Innovation Channels within the Health Service aims to support the development of ideas from the health service into needs-driven innovations within county councils and municipalities. These innovation channels should act as a contact node for companies and facilitate the introduction of innovations in the health service sector.
- The United States has announced a multi-agency funding opportunity to support an Energy Regional Innovation Cluster (E-RIC). This pilot initiative will spur regional economic growth while developing innovative energy-efficient building technologies, designs and systems.

- Canada has funded collaborative research in automotive, manufacturing, forestry and fishing industries as well as in health. The Canadian government has also enabled researchers to collaborate on large research projects related to nanoscience and nanotechnology. Regional economic development agencies have been provided new resources too. The Atlantic Canada Opportunities Agency receives CAD 19 million a year; Canada Economic Development for Quebec Regions CAD 14.6 million a year; and Western Economic Diversification Canada CAD 14.7 million a year.
- In 2010 Denmark established strategic platforms for innovation and research (SPIR) to pool the funds of the Danish Council for Strategic Research and the Danish Council for Technology and Innovation to encourage large industry-science collaborations within thematic areas. The initiative first addressed energy and food production issues.
- Finland set up new strategic centres for science technology and innovation (SHOK) to speed up innovation processes, renew industry clusters and create radical innovations. These multidisciplinary centres (EUR 40-60 million annually each) provide a permanent forum for companies and research organisations to orient innovation processes, open avenues for training and recruitment, and act as gateways to international co-operation. Six centres are in operation in forestry (Forestcluster Ltd), ICT industries and services (TIVIT Ltd), metal products and mechanical engineering (FIMECC Ltd), energy and the environment (CLEEN Ltd), environment innovations (RYM Ltd), health and well-being (SalWe Ltd). In addition Finland has reformed the organisation of the Centre of Expertise Programme (OSKE) on a cluster-based model to increase regional specialisation and to strengthen co-operation between centres of expertise.
- Japan has begun a reform to foster regional activities and revitalise urban areas, in particular by supporting regional autonomy through the autonomous settlement regions and by expanding the physical infrastructure. Japan promotes the development of regional networks for business creation, co-operation for commercialisation and business matching with clusters in others countries.
- In the framework of its High-tech Strategy, Germany has launched the Leading Edge Clusters Competition which supports the formation of strategic partnerships between business and science. In 2008 and 2010 ten clusters were selected, each of which receives a maximum of EU 40 million over five years. A third round is planned for the end of 2010. In the framework of its Excellence Initiative, university-centred excellence clusters have also been built up. The objective was to establish internationally visible and competitive research beacons at universities which can co-operate with non-university research establishments, universities of applied sciences and the private sector. Each of the 37 clusters selected during the two current funding rounds receive on average EUR 31.8 million over a five-year period.
- Greece established in 2006 its first innovation cluster the mi-Cluster (Nano/Microelectronics and Embedded Systems). It members have increased to include over 100 organisations from all over the country. The Corallia Clusters Initiative aims at boosting competitiveness, entrepreneurship and innovation in knowledge-intensive and exports-oriented technology segments in which Greece has the capacity to build a sustainable innovation ecosystem and can attain a worldwide competitive advantage.
- Switzerland has launched a research initiative, SystemsX.ch, to promote systems biology. SystemsX.ch is a network and partnership of nine universities and three research institutions and benefits from a CHF 100 million federal budget (2008-11) and an equivalent investment from industry and other funding agencies. Switzerland has also launched the

Nano-Tera.ch initiative which aims to put Switzerland at the forefront of a new technological revolution based on engineering and information technology for the health and security of humans and the environment in the 21st century. Several Swiss universities as well as private research institutions and companies are involved in Nano-Tera.ch for a total budget of CHF 120 million, of which 50% is funded by Nano-Tera and 50% by participants.

- In Belgium, the Walloon authorities have invested during the last decade in the development of 14 business clusters and six innovative partnerships (in the so-called Marshall plan.2 green). Since 2005, competitiveness poles have been a major plank of Walloon STI policy with a budget of EUR 280 million (2006-10). In Flanders the Flemish Science and Innovation Policy Council identified six strategic clusters: *i)* transport – logistics – services – supply chain management; *ii)* ICT and services in health care (e-health); *iii)* healthcare; *iv)* new materials – nanotechnology – manufacturing industry; *v)* ICT for socioeconomic innovation (e-health, e-government, e-learning; *vi*) energy and environment (smart grids and intelligent energy networks Voka).
- In 2007 the Netherlands launched a four-year regional policy programme, Peaks in the Delta, to foster excellence in key areas and enhance the growth and innovativeness of strong economic clusters of national importance in six Dutch regions. The programme includes a subsidy scheme, supports R&D co-operation among key regional players, provides incubator facilities, accommodates cluster needs for skilled workers via specific educational tracks, develops innovation campuses, and fosters organisational capacity. In 2011, when the current programme comes to an end, a new four-year programme will begin.
- France has entered the second phase of its cluster programme *Pôles de compétitivité* (2009-12) with EUR 1.5 billion allocated to support R&D, reinforce the governance of the poles of excellence, introduce new funding mechanisms and develop an innovation and growth ecosystem. In addition several technological research institutes (*instituts de recherche technologique – IRT*) have been created. These pool public and private labs from the same geographical area and same technological field and integrate education, training, research and innovation.

Strengthen physical infrastructures for STI

Sound physical infrastructure, especially high-speed broadband access and powerful IT equipment, are essential to support knowledge advancement, communication and co-operation.

As part of their stimulus packages many OECD and non-OECD countries have made large investments in ICT infrastructure and applications (OECD, 2009a). These investments will have lasting effects on STI infrastructures by closing the broadband gap and extending access to remote areas without connectivity, on the one hand, and by upgrading the existing network and accelerating the adoption of high-speed technologies, on the other.

Several countries are reinforcing their IT systems to permit faster communication and wider information dissemination among public and private agents.

- Denmark has set the goal that all citizens and businesses in Denmark should have access to high-speed broadband (at least 100 Mbit/s) by 2020 (the previous objective was 512 kbit/s by 2010). This new broadband objective will ensure that Denmark has an infrastructure ranking among the best in the world. In addition, as one of the country's largest owners of buildings, the Danish Science Ministry will focus on integrating ICT in its building processes.

- Spain is funding new ICT-based services through the RedIris optical fibre network that provides advanced communication services to the scientific community and national universities.
- Finland has set up the Funet network service, a superfast data communication network at the disposal of research and education. Funet services are the backbone network of academia and include high-speed national and international data communication connections to other research networks, access to the Internet, data security services, modern communications services (*e.g.* video conferences, media services, wireless network roaming) and consultancy and specialist services. In addition the IT Center for Science Ltd (CSC), a non-profit company, provides IT support and resources for academia, research institutes and companies. CSC offers a powerful supercomputing environment with access to supercomputers and IT consulting services, an internationally competitive set of services for computational science, and a wide collection of scientific software, training, in-depth support, software development and grid computing infrastructures. CSC provides solutions for data storage, management and analysis as well.
- Belgium has implemented the BELNET network based on over 1 650 km of fibre, covering the entire country, which provides high-speed access to the Internet and the global research network to about 200 institutions of research and education, research centres, governments and public services, representing more than 650 000 users.
- The Czech Republic has stimulated the implementation of information systems in SMEs in order to increase organisational innovation.
- Japan plans to encourage further utilisation of ICT, through improved training, better protection of personal information and increased security. Systems and regulations will be revised to this purpose. Furthermore, Japan has announced increased efforts to build infrastructure in areas such as rail transport, water supply and energy, to develop cities in harmony with the environment, and to consolidate physical infrastructure between regions.
- France has implemented the ICT&SME 2010 programme (TIC&PME 2010) to reinforce SMEs' competitiveness through better use of ICT. This programme aims to group the efforts of SMEs from the same business sector and to develop common tools based on international standards. The *PMI-Diag* guide has also been developed as a diagnostic guide to help SMEs to evaluate their IT system, organisation and strategy. In addition, the government proposes to small firms with fewer than 20 employees a new free awareness and initiation programme ("*Entrepreneurs, faites le choix de l'économie numérique*") on ICT use.

Encouraging innovation diffusion and enhancing access to scientific information

Governments foster diffusion of public research results to enhance firms' productivity. In the Netherlands, the *Act of Higher Education* entrusts Dutch universities with the task of ensuring the transfer of knowledge transfer, in addition to their mission of research and education.

Many countries have promoted wider dissemination of public data in centralising public research output and developing ICT-based information systems that enhance access to information.

- Norway is implementing a new information system that will bring together all relevant research-related information. A key aspect and main priority of this new information system is the creation of a bibliographic database, the Norwegian Scientific Index, to cover all scientific publications in the public research sector.

- Similarly Finland has developed a national resource centre, the Social Science Data Archive (FSD), which archives, promotes and disseminates digital social science research data for research, teaching and learning purposes.
- The United States government has established a centralised Data.gov website from which datasets generated and held by the US federal government can be easily found and downloaded. The purpose is not only to improve access to federal data but also to expand their creative use beyond the walls of government and drive innovation.
- Although access to data and results from publicly funded research is left to the discretion of public research institutes in Germany, the Alliance of German Science Organisations is working to establish structures for the collection, archiving and re-use of primary research data in all applicable disciplines. This open access programme includes the formulation of a common data policy, close co-operation between scientists and information providers (possibly through the funding of pilot projects) and the establishment of a system of internationally networked discipline-specific repositories for primary research data.
- Canada has developed new infrastructure as well as new services (*e.g.* IT and cloud computing services) to enable greater public access to public research results and to accelerate the translation of knowledge into more effective health products and services.

Some countries also report initiatives at institutional level. In April 2008, the US National Institutes of Health (NIH) made its public access policy mandatory, requiring all funded investigators to submit an electronic version of their final, peer-reviewed manuscripts to PubMed Central, the agency's free digital archive of biomedical and life sciences journal literature. Manuscripts must be submitted upon acceptance for publication, but public access may be delayed for up to 12 months following the official date of publication. Furthermore the NIH and some of its individual institutes have established policies that expect funded investigators conducting specific types of research (*e.g.* genome-wide association studies, autism research) to submit data to repositories for long-term storage and sharing with other investigators according to specified timelines and procedures.

Finland has launched the National Digital Library project which puts the achievements of culture and science at everyone's fingertips and aims to improve the long-term preservation of the electronic materials of libraries, archives and museums. The public interface is a website that will give universal access to the electronic information resources and services of libraries, archives and museums from 2011. Finland has also launched a competition, Apps4Finland – doing good with open data, to find new ways to use public sector data. Developers and designers compete by creating ideas, functional web applications and digital utilities that make use of public data and facilitate collaboration between citizens and public organisations.

Improving the access to public information ensures that public research has a broader impact in the economy. Additional initiatives along these lines include:

- Denmark has centralised R&D statistics at Statistics Denmark in order to move the production of the national statistics to a central agent. In the framework of its digital work programme, the Danish government recently introduced an improved digital signature, NemID (EasyID), which makes it easy and secure to be a citizen in digital Denmark. Denmark is also promoting the use of open standards in the public sector, including standards for document formats. The intention is to strengthen competition and freedom of choice between IT suppliers through the greater interoperability of IT systems that open standards make possible.

- The United States issued in 2009 a Memorandum on Transparency and Open Government in order to establish the principles of transparency, participation and collaboration across the whole of government and bridge the gap between citizens and the government. The US National Science Foundation has implemented the Research.gov website to enable organisations and researchers to access streamlined research grants management services and other resources for multiple federal agencies in one single location.
- Similarly Norway plans from 2011 to lay the foundations of a common information system for all Norwegian research to bring together relevant information on most important research output (*e.g.* publications, citations, innovations), ongoing research activities (*e.g.* researcher projects), available research infrastructure and human resource competences. The Current Research Information System (Cristin) will be designed in co-operation with universities, research institutes and research hospitals; industry is expected to be invited to take part later.
- Canada is aligning the programmes and activities of the federal research funding agencies. Efforts to better serve clients include the harmonisation of diligence processes and the co-location of some services delivered by the Canadian research funding agencies. For instance, in April 2008, the two Canadian research funding agencies NRC (National Research Council) and NSERC (Natural Sciences and Engineering Research Council) launched a joint call for technology-driven research proposals in nanotechnology.
- Japan will promote the computerisation of various types of administrative procedures and provide "one-stop" government services. In addition Japan wishes to speed up investigations in linking various types of identification numbers to resident code numbers. ICT will be used to improve the quality of medical, education and other services, such as by facilitating collaborative education, in which children teach and learn from each other.
- Australia announced as part of its stimulus package the development of standard procurement documents and the introduction of a guarantee of payment for new small businesses' contracts with Commonwealth government departments (OECD, 2009a).

IPRs and knowledge diffusion

Appropriate IPR regimes and practices are necessary to secure returns on investments in innovation and to encourage knowledge sharing. A key issue for policy is finding a balance between rights to control use of an invention via IPR and the diffusion of knowledge about the invention (through licensing, publication, open networks, etc.). Getting the balance "right" is the key goal of the knowledge networks and markets that are emerging as a means to trade and exchange knowledge within more open networked systems of innovation.

Although few internationally comparable data are available at this stage, three indicators may reflect the emergence and spread of knowledge networks and markets, or at least the parts of these that focus on patent development and exchange: *i)* the average share of patents filed by public research institutes between 2000 and 2007; *ii)* the country share in total OECD exports of royalties and licence fees, compared to the country share in total OECD services exports; and *iii)* the growth index of triadic patent families over the last decade, between 1995-97 and 2005-07. The share of patents filed by public research institutes shows the degree to which inventions resulting from public research are marketable. A country's relative share in OECD exports of royalties and licence fees highlights its capacity to market internationally inventions developed locally (inventions as codified in patents). The rise in patenting is a direct measure of the expansion of patenting activities. Table 2.9 presents evidence on patenting and policy measures to foster the commercialisation of public research and, more broadly, knowledge networks and markets.

Table 2.9. **Fostering IPRs, licensing and commercialisation: performance and measures taken between 2008 and 2010**

	Performances			Foster IPR licensing and commercialisation				
	Patents[1] filed by PROs, 2000-07	Relative share[2] in OECD royalties and license fees exports, 2008	Growth[3] in patenting between 1995-97 and 2005-07	Encourage commercialisation of public research results	Reform rules governing ownership and licensing of publicly-funded research results	Reform IPR legislation	IPR support towards SMEs	IPR courses
	Index 100 = Highest OECD value			Measures/initatives introduced between 2008 and 2010				
Austria	25	9	25	✓				
Canada	92	30	24	✓				
Czech Republic	42	1	31		✓		✓	
Denmark	41	21	22					
Finland	3	27	13	✓	✓			
France	89	36	17	✓	✓	✓		
Germany	15	21	17		✓	✓	✓	
Hungary	14	23	24				✓	
Israel	92	22	31	✓		✓	✓	
Italy	41	4	17					
Japan	39	100	20			✓	✓	
Korea	42	18	100					
Netherlands	16	90	19			✓	✓	
New Zealand	19	11	26					
Norway	11	9	21				✓	✓
Poland		4	33					
Slovenia		3	45	✓				
South Africa	35	2	16	✓				
Spain	100	3	35		✓	✓		
Sweden	1	39	13	✓			✓	
Switzerland	21	91	16					
Turkey			90					
United Kingdom	95	27	15		✓		✓	
United States	83	97	18					

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.

1. Average percentage of PCT patent applications.
2. Compared to the country share in total OECD services exports.
3. Growth index in triadic patent families, 1995/97 = 100.

Source: OECD, *Patent Database*, January 2010; OECD (2010a), "*Main Science and Technology Indicators: 2010-1*", OECD, Paris; Responses to the STI Outlook Policy Questionnaire 2010.

Reforms to IPR

In the Netherlands, reforms of patent legislation came into force in 2009 with a change in the fee structure that means lower entrance costs, the abolition of the so-called six-year (non-examined) patent and the introduction of the possibility of filing (national) patent applications in English. In line with the EU London protocol, the translation requirement is limited to the conclusions of the patent.

France adopted in 2009 a new decree relative to IPRs and implemented the specialisation of IP jurisdictions that would enforce guarantees offered to claimants.

In Germany, since 2008 SIGNO has been supporting higher education institutions, SMEs, start-up entrepreneurs and inventors for legally protecting and commercialising their innovative ideas. In addition IPRs have been enforced by law with the *Act on Better Enforcement of Intellectual Property Rights* that came into force in 2008.

Israel has recently undertaken to enhance and strengthen its IPR mechanisms. Steps were taken to streamline the patent registration process and shorten the examination period. A new Exposure Bill requires the publication of patent applications promptly after the expiration of an 18-month period from the filing date at Israel's Patents Authority (or earlier if a Paris Convention priority right has been claimed). Furthermore a draft is under preparation to amend the Patent Law to reduce the number of reference countries (from 21 to the five major EU countries and the United States). Israel is also about to extend the term of protection of pharmaceuticals tests after marketing approval.

In the context of the economic crisis, the European Union urged its member states to reduce fees for patent applications and maintenance by up to 75% (OECD, 2009a). Furthermore the European Commission adopted in 2009 a recommendation to the Council that would provide the Commission with negotiating directives for the conclusion of an agreement creating a Unified Patent Litigation System (UPLS). This European and EU Patents Court (EEUPC) would lead to significant savings compared to the costs of piecemeal litigation. Such reductions in legal costs could permit many SMEs to enforce their patent rights in all EU and European Patent Convention (EPC) countries.

Japan has tested the Super Accelerated Examination System on a pilot basis since 2008. Green-technology-related patent applications have been eligible for treatment under the conventional accelerated examination system on a pilot basis since 2009. In addition, examination guidelines have been revised in order to expand the patentable subject in advanced medical technologies and the Patent Law was amended in spring 2009 to revise the registration system for non-exclusive licences and to expand the claim period during which one may request an appeal against a refusal.

Encouraging SMEs to patent innovations and build IP capacity is another goal of policies. In the Czech Republic, SMEs can apply for support on IPRs through the Innovation Patent programme. The Japan Patent Office (JPO) provides aid to SMEs for overseas development through the SME support centres of prefectural governments. Sweden has implemented a pilot action to fund SMEs for professional IP consultancy. As the cost of this programme was relatively low and the impact comparably high, the Swedish government is considering the extension of the programme in 2010/11. The Netherlands allows the use of innovation vouchers to cover (part of) the costs involved in an SME's first patent application. The measure, introduced in 2008, involves both direct application costs and the costs of patent attorneys, both domestically and abroad.

Facilitating the commercialisation of public research

The commercialisation of the results of public R&D through patenting or spin-offs is an important channel for transferring knowledge. Recent initiatives in this area include:

- In the framework of the performance agreements concluded with the Austrian government for 2010-12, Austrian universities are obliged to develop IP strategies and improve IP management. Regular meetings involving ministries, public research institutes and the private sector take place as well in order to exchange information and discuss ways to improve knowledge transfer.
- In Finland the new *Act on University Inventions* would improve the environment for innovation at the universities by simplifying questions of ownership. In contract research, the universities are now entitled to get the rights. The concentration of rights makes transfer more efficient and simpler than before. In addition labour contracts in universities include several forms of agreement, such as non-disclosure agreements or agreements on assignment of rights to the university.
- France introduced in 2009 the principle of a unique mandate for IPR management that will be granted to public research institutes that hosted research activities conducive to the invention, in most cases the university. The new decree would allow co-inventors to reduce transaction costs and facilitate technology transfer.
- The adoption of the European Charter for the management of IP in 2008 provides a framework for the treatment and negotiations of IP between public research institutes and companies.
- In 2008 South Africa enacted new legislation on IPRs from publicly financed research. In addition the *IPR-PFR Act* established the National Intellectual Property Management Office (NIPMO) which will facilitate the creation of offices of technology transfer (OTTs) at higher education institutions and public research institutes in order to support them in the identification and management of IP, oversight of IP legislation and negotiation of benefit-sharing agreements.

Some countries have added funding schemes to support technology transfer and commercialisation in academia:

- Sweden is offering universities and university colleges specialised in technology, medicine or science funding to carry out strategies for knowledge transfer and commercialisation. More broadly, the VINNOVA Key Actors programme aims to develop expertise, methods, processes and structures for utilising knowledge and commercialising research results.
- Finland is offering researchers and students funding capacities to access business expertise (*e.g.* purchasing surveys to evaluate the business potential) through the Tuli programme (EUR 50 million for 2008-14).

Countries have also provided public research institutes with infrastructure and non-financial support. Sweden is building up special innovation services offices at universities for researchers whose research may be commercialised. Slovenia has supported the implementation of technology transfer offices at major universities and public research institutes. Austria has implemented an IP National Contact Point in the Ministry for Science and Research to help public research institutes to establish IP policies and IP management procedures. Norway provides grants to academic institutions that incorporate courses on IPRs in their curriculum.

Adjusting to the globalisation of R&D and innovation

The globalisation of R&D and innovation also affects the scope for national policy intervention. Consequently, more OECD and emerging economies increasingly take into account recent trends in the globalisation of R&D when formulating their national strategies. Levels of policy priority given to the internationalisation of national STI vary markedly from one country to another (Tables 2.10 and 2.11). In Finland, Japan and Norway, this ranks high among STI policy priorities; it ranks lower in Austria, the Netherlands and the United States, countries that at the same time are open and internationalised.

Three indicators reflect the internationalisation of STI and the extent to which a country may access international knowledge: *i)* foreign direct investment as a percentage of GDP, *ii)* the share of international students in tertiary enrolment; and *iii)* the percentage of patent applications filed under the Patent Cooperation Treaty (PCT) with co-inventors located abroad. The intensity of FDI inflows reflects the degree to which a country may benefit from knowledge spillovers and additional R&D investment from multinationals. The presence of many international students suggests the contribution of foreign talent to research and the building of connections with international university networks. The share of PCT patents with foreign co-inventors is a direct measure of international co-operation in research.

Linking domestic firms to foreign sources of knowledge, attracting knowledge-intensive businesses and foreign highly skilled workers, providing opportunities for inward and outward international mobility are key aims of policies to adjust to and benefit from globalisation.

Encouraging the internationalisation of innovation actors

With the continuing internationalisation of science and innovation, tapping into foreign sources of knowledge becomes more important. This has led to a range of policy initiatives in various countries and at EU level.

Regional, cultural and historical dynamics are efficient drivers of R&D internationalisation and international co-operation. The European Research Area (ERA) plays a key role in helping EU member countries and associated states to link domestic firms with foreign sources of research and innovation. Many EU members report participation in the EU 7th Framework Programme for Research and their involvement in ERA initiatives to access foreign knowledge and contribute to international research. This is also the case for countries such as Norway and Israel. Similarly, Nordic co-operation provides Nordic countries with the opportunity to collaborate through Nordic centres of excellence and researcher networks, and to create regional synergies.

The Iberoeka projects are instruments which support technological business co-operation in Latin America. This initiative is part of the Latin American Programme of Science and Technology for Development (CYTED) in which 19 Latin American countries, Portugal and Spain participate. CDTI, the Spanish management organisation of Iberoeka projects, promotes the participation of Spanish companies in this initiative by advising on the presentation of new proposals, on the search for partners and on access to sources of financing.

Enhancing the internationalisation of the national innovation system requires governments to reinforce their own capacities. Sweden has implemented a Global Links for Strong Research and Innovation Milieus (*starka FoI-miljöers globala länkar*) programme to

Table 2.10. **Internationalisation of knowledge: performance, priority level and measures taken between 2008 and 2010**

	Performances		Priority level	Link domestic firms to foreign sources of research and innovation							Attract foreign firms and FDI										Support the internationalisation of domestic PRIs			
	FDI inflows,[1] average 2003-08	Share[2] of PCT patents with co-inventors located abroad 2004-06	Internationalisation of STI	Additional or preferential funding	Co-funding	Support to find international partners	R&D tax incentives	Provision of infrastructures and support	Cluster initiatives	Other	Direct financial support	General fiscal incentives	R&D tax incentives	Taxation of intellectual assets and revenues	Administrative support	Provision of infrastructure	Public procurement	Active recruitment of foreign firms	Advertising and international campaigns	Other	Additional funding	Co-funding	Support for the establishment of affiliates abroad	Other
	Index 100 = Highest OECD value		Country self-reported[3] (1-8)	Measures/ initatives in place in 2010																	Measures/initiatives taken between 2005 and 2010			
Australia	12	34	n.a.		✓				✓				✓	✓	✓	✓			✓					
Austria	37	59	4			✓			✓		✓	✓	✓			✓		✓						
Canada	16	63	6	✓		✓		✓			✓	✓	✓			✓		✓	✓	✓				✓
Czech Republic	27	71	6			✓			✓			✓	✓		✓	✓		✓			✓	✓	✓	
Denmark	9	45	6	✓	✓	✓			✓						✓						✓	✓		
Finland		35	8	✓		✓			✓		✓				✓	✓	✓	✓	✓		✓			✓
France	19	48	3	✓		✓							✓			✓		✓						
Germany	6	36	7	✓		✓		✓	✓		✓				✓	✓		✓	✓		✓		✓	
Hungary	100	68	7	✓		✓					✓		✓		✓				✓		✓			
Israel		35	7	✓	✓	✓			✓			✓			✓			✓	✓		✓	✓		
Italy	7	31	7			✓	✓	✓		✓		✓	✓						✓					✓
Japan	1	7	8										✓											
Korea	3	11	7	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓						✓
Netherlands	25	42	6	✓		✓			✓			✓	✓	✓		✓		✓			✓			
New Zealand	16	42	7										✓											
Norway	6	43	8	✓		✓							✓								✓	✓		
Poland	22	78	5								✓	✓	✓		✓	✓		✓	✓		✓			✓
Slovenia		43	5	✓							✓		✓						✓					
South Africa		25	7			✓	✓				✓	✓	✓						✓					
Spain	17	44	7	✓		✓					✓		✓											
Sweden	24	42	n.a.			✓			✓							✓	✓							
Turkey	11	28	n.a.										✓											
United Kingdom	25	55	n.a.			✓							✓					✓						
United States	8	24	4																	✓				

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010 and those that answered the TIP policy questionnaire on adjusting policy to the globalisation of R&D and innovation. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.

n.a.: Response not available.

1. As a percentage of GDP.
2. Percentage of PCT patent applications.
3. Self-reported ranking of national STI priorities based on a scale whereby 1 = least important and 8 = most important.

Source: IMF, *Balance of Payments Statistics*, July 2009; OECD, *Patent Database*, June 2009; responses to the STI Outlook Policy Questionnaire 2010.

Table 2.11. **Internationalisation of human resources: performance, priority level and measures taken between 2008 and 2010**

	Performances	Priority level	Increase international mobility						
	Share[1] of international tertiary students 2008	Internationalisation of STI	Changes in immigration legislation	Changes in employment law, University Act, etc.	Funding (scholarships, grants, etc.)	Creation of special positions in academia	Fiscal incentives	Return migration programmes (incl. funding)	Other
	Index 100 = Highest OECD value	Country self-reported[2] (1-8)	Measures / initiatives taken between 2008 and 2010						
Australia	100	n.a.	✓		✓			✓	
Austria	75	4	✓	✓	✓			✓	✓
Canada	32	6	✓		✓		✓	✓	
Czech Republic		6	✓		✓	✓			
Denmark	13	6			✓		✓		
Finland	15	8	✓	✓	✓	✓		✓	
France		3	✓		✓	✓		✓	
Germany	45	7	✓	✓	✓			✓	
Hungary	16	7	✓		✓			✓	
Israel		7			✓			✓	
Italy		7		✓	✓	✓	✓	✓	
Japan	14	8			✓			✓	
Korea		7			✓	✓			
Netherlands	24	4							
New Zealand	63	7							
Norway	10	8	✓		✓				
Poland		5							
Slovenia	6	5	✓		✓		✓	✓	✓
South Africa		7							
Spain	10	7			✓	✓		✓	
Sweden	27	n.a.			✓				
Turkey		n.a.							
United Kingdom	71	n.a.							
United States	17	4							

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010 and those that answered the TIP policy questionnaire on adjusting policy to the globalisation of R&D and innovation. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.

n.a.: Response not available.

1. As a percentage of all tertiary enrolment. Except for Germany where the index is based on the share of international students enrolled at tertiary-A level. Year of reference 2007 for Canada. Data are underestimated for the Netherlands and Switzerland.
2. Self-reported ranking of national STI priorities based on a scale whereby 1 = least important and 8 = most important.

Source: OECD (2010), *Education at a Glance 2010: OECD Indicators*, OECD, Paris; responses to the STI Outlook Policy Questionnaire 2010.

increase the international attractiveness and competitiveness of strong R&D milieus in Sweden. Switzerland approved in 2010 its international strategy for education, research and innovation to strengthen the definition of goals and priorities where Switzerland demonstrates excellence; its aim is to further develop Switzerland as a competitive international hub for education, research and innovation.

Germany has accelerated the internationalisation of its public research institutes. Universities have been encouraged to develop their own internationalisation strategies and been provided support and advice by the German Rector's Conference. In 2008, the German federal government launched an internationalisation strategy: *i*) to strengthen research co-operation with global leaders; *ii*) to improve international exploitation of innovation potential; *iii*) to intensify co-operation with developing countries in education, research and development on a long-term basis; and *iv*) to use German research and innovation potential to meet global challenges in the areas of climate, resources, health, security and migration.

The German federal government is also strengthening the international profile of national networks and clusters, for instance by initiating contacts with relevant technological or scientific clusters worldwide. Twelve projects have been already selected in environmental technologies, medical technology, life sciences, transport and ICT. In addition the federal government supports international higher education marketing and since 2001 helps universities to develop their own study programmes abroad. The Max Planck Society established in 2008 a Max Planck Florida Institute in the new biosciences cluster in South Florida.

The German Academic Exchange Service (DAAD) adopted in 2008 "Quality through internationality" guidelines for academic exchange as well as plans to encourage support for international students and developing countries. The German universities have also adopted a National Code of Conduct through the Rector's Conference which ensures that foreign students receive support and advice when studying in Germany.

Denmark is strengthening its co-operation with China on research and university education by establishing a Danish University Centre in Beijing at one of China's most prestigious universities, the Graduate University of the Chinese Academy of Sciences (GUCAS). This new structure is expected to accommodate 300 master's degree students, 75 PhD students and 100 researchers evenly divided between both countries. It will cost about EUR 13 million (DKK 100 million) a year and will be financed jointly by the Chinese University, the Danish universities and the Danish state.

Direct funding, fiscal incentives and provision of infrastructures are also used to promote the involvement of national firms in international co-operation.

- The Czech Republic has implemented a complex support system to encourage research organisations and SMEs to participate in the European Research Area. This includes organising large-scale awareness and training events on the EU 7th Framework Programme, providing professional consultation, offering financing support for the preparation of large projects, and building relationships with entities in ERA countries. The government also manages an Internet portal to inform foreigners about local R&D structures and enable Czech teams to publish their proposals on European co-operation.
- The Finnish Funding Agency for Technology and Innovation (Tekes) has integrated conditions of international co-operation into criteria of eligibility for almost all of its funding schemes.
- Greece also includes criteria on international co-operation for all new funding schemes introduced since 2009.
- Israel maintains a Global Enterprise R&D Cooperation Framework to facilitate co-operation with Israeli SMEs.
- Spain is granting funding under preferential conditions (soft loans of up to 75% of the budget of Spanish participation and possibility of a non-refundable part of 33% of the loan granted) to Spanish companies that are involved in the Bilateral Programme for Technological Co-operation with foreign entities in Canada, China, India, Japan or Korea. This programme supports the execution of joint technological projects oriented towards

the development and/or adaptation of new products, processes or services intended for international markets.

- Within the Central Innovation Programme for SMEs (ZIM), Germany provides 20% additional funding for personnel costs to projects with foreign partners outside Europe. The International Bureau of the Federal Ministry of Education and Research (BMBF) assists public research institutes and SMEs in international networking. In addition to providing financial support on behalf of BMBF, the Bureau arranges networking opportunities, provides advice and runs a web portal "Kooperation International" which is considered a gateway to extensive information on international co-operation opportunities.
- Israel has four bi-national R&D funds with Canada, Korea, Singapore and the United States to support collaboration between Israeli and foreign companies.

Countries are also seeking to improve their attractiveness to foreign firms. In Finland, registered foreign-owned companies are also eligible for public funding, and foreign entities, firms or research institutions are treated on equal terms with Finnish ones. Finland has also created the FinNode Innovation Centre Network as a gateway for international enterprises looking for business contacts, cutting-edge research or R&D resources to link with partners in Finland. FinNode is already operating in China, Japan, Russia and the United States. Germany has implemented international advertising campaigns (*e.g.* South Korea Pilot Measure) under the umbrella campaign "Research in Germany" to facilitate the initiation of R&D co-operation with new partners abroad. Canada is reforming its system of international taxation to facilitate investment, cut red tape and streamline the compliance process associated with the taxation of cross-border activity.

Support for the internationalisation of SMEs is also emphasised in strategies to improve attractiveness. Sweden has set up at public cost support offices to help SMEs in strategic sectors, such as biotechnology, forestry and transport. The Swedish government also launched in 2009 a pilot programme, VINN EXPORT, to support SMEs financially to develop their innovation capacity with partners or customers on export markets. The Netherlands launched in 2009 a "prepare2start" scheme (2009-10) to help 600 SMEs to enter international markets by subsidising feasibility studies for investments in emerging markets. Germany supports SMEs in building international technology collaborations with partners from non-EU countries. Israel has signed a framework agreement to facilitate international co-operation involving SMEs.

To address global challenges, Canada has fostered international collaboration with developing countries. In 2008 the Canadian government initiated a CAD 6.2 million programme to link research teams at home and in the developing world in S&T priority areas including the environment and natural resource management and ICT for development.

International mobility of highly skilled researchers and students

The migration of people across national borders is part of the globalisation process. However, competition for talent has intensified worldwide and the highly skilled are more internationally mobile than medium- or low-skilled workers. The mobility of the highly skilled is now a concern for a broader range of ministries, beyond the immigration ministry, these include higher education, research and economic ministries.

Not surprisingly, most OECD and non-OECD countries consider international mobility fundamental and have implemented policies both to retain and attract HRST and to accompany national talent out and back.

In 2009, Austria amended its *University Act 2002* to require Austrian universities to post research job vacancies internationally, at least EU-wide (EURAXESS Jobs are mentioned in the legal commentary as a possible cost-free tool to do so). In addition, according to the Programme of the Austrian Federal Government 2008-13, by 2020, every two graduates from higher education should be able to demonstrate at least one period of residence abroad. Special fast-track immigration procedures have traditionally been introduced to ease foreign students' and researchers' entry and to facilitate their access to the labour market.

- The Czech Immigration Act was amended in 2008 to introduce a specific admissions procedure for third-country nationals for the purposes of scientific research.
- Denmark has several schemes to make it easier for highly qualified foreigners to work and live in Denmark. International students are granted a green card which enables them to stay and look for a job for six months after graduation. Other initiatives aim to improve the opportunities for researchers coming to Denmark by developing fast-track procedures for residence permits.
- Norway has introduced an early employment scheme that entitles employers to recruit directly and let employees start working before their immigration application has been processed. The scheme applies to skilled workers, defined by expertise, and specialists, defined by pay. It is left to the employer to ensure that the employee meets the conditions for being granted a permit as a skilled worker or specialist.
- France has softened the requirements and the *habilitation* process for foreign scholars and researchers who apply to national universities for positions similar to those they hold in their country of origin. Furthermore, employees and representatives of resident firms who have entered the country through internal mobility or have been directly recruited from abroad benefit from an additional income tax credit since 2009.
- Germany has lowered from EUR 86 400 to EUR 64 800 the income threshold for an open-ended residence permit. Such residence permits include work permits. Furthermore the federal government laid the foundations of a legislative process to improve recognition procedures for vocational qualifications, diplomas and skills earned in foreign countries.
- Canada has introduced several measures to make the Canadian immigration system more competitive, in particular recognition of foreign credentials for trained individuals to help them better use their skills in the local labour market. The Canadian government is also allocating CAD 50 million to develop a common approach across provinces and territories to assess foreign credentials and ensure better integration of immigrants.

Box 2.6. **The Dutch analysis of highly skilled immigrant behaviour**

The Netherlands has conducted an analysis of the behaviour of highly skilled migrants, defined as every migrant with an educational level up to ISCED 5 or ISCED 6 (International Standard Classification of Education 1997).

Box 2.6. **The Dutch analysis of highly skilled immigrant behaviour** *(cont.)*

The analysis involved an overview of theoretical and empirical research into motives of migration, a double survey among the highly skilled currently living in the Netherlands and among Dutch highly skilled emigrants, the construction of an index measuring the competitive strength of countries in attracting highly skilled migrants, and finally an exploration of possibilities for calculating reliable, recent and internationally comparable statistics of migration flows.

It appeared that national admissions policies have little impact on the choices of highly skilled migrants and thus on the recruitment of highly skilled. Indeed salary and career motives appeared to be the main drivers of migration, as well as an appealing living environment.

Similarly researchers, in the framework of this survey, valued the quality of the knowledge infrastructure and the knowledge intensity of the economy, the reputation of the academic climate and the high quality of the scientific output.

Direct funding and fiscal incentives remain the most frequent policy instruments to support international mobility of HRST:

- Austria has reformed its usual funding programmes for international mobility to attract a larger number of postgraduates, postdocs or lecturers from abroad (enlarged eligibility of the Ernst Mach Programme) and to incite young Austrian scientists previously encouraged to work abroad to return to Austria to pursue an academic career (return phase of the Erwin Schrödinger fellowships). New schemes have also been introduced to support highly qualified young researchers who pursue doctoral studies at an Austrian university to carry out 6-12 months of their research work abroad (Marietta Blau Scholarship Programme).
- Belgium offers return schemes set up by all of the different regions.
- In 2010 the Canadian government allocated CAD 45 million over five years to establish a new internationally competitive postdoctoral fellowship programme to attract top-level talent to Canada. These fellowships will be valued at CAD 70 000 a year for two years. The first fellowships will be awarded in 2010-11. At maturity, the new programme will fund 140 fellowships annually.
- As part of its China strategy, Denmark has allocated 13 industrial PhD projects to students with a master's degree from a Chinese university. The company has to be a private company with divisions or subsidiaries located in Denmark and China. The student is employed in a Danish division and receives a salary (minimum pay rate of the collective agreement for PhD students employed in the Danish state).
- Finland has implemented competitive grants through the Finland Distinguished Professor Programme (FiDiPro) to attract both international and expatriate researchers who are able to commit to long-term co-operation with a Finnish university or research institute.
- In 2009 France adopted a return postdoc programme managed by the National Research Agency (ANR) to encourage young researchers abroad to return and develop a research project in France. This programme has EUR 11.5 million to be distributed in the form of

individual financial aids which can cover labour, equipment and overhead costs during project initiation. Grants are up to EUR 700 000 over three years.

- In 2009, Denmark, Norway and Finland introduced the Nordic Research Opportunity. This new mobility measure addresses US graduate research fellows from the US National Science Foundation and offer them the opportunity to do part of their research at a Nordic research institution. The research fellows may stay from two to 12 months during which they keep their NSF fellowships and receive additional funding from the Research Council of Norway, the Academy of Finland and the Finnish Funding Agency for Technology and Innovation (Tekes), or the Danish National Research Foundation (DNRF).
- Israel plans a new Fulbright Scholarships programme for 2011, geared to encourage American postdoctoral students to perform research in Israel. This programme will also promote student and researcher exchange between Israel and the United States. The creation of new centres of excellence would also encourage the return of national researchers back to Israel.
- In addition to the many scholarships Japanese government grants for international students or scholars, Japan launched in 2009 the JSPS BRIDGE Fellowship which provides the opportunity for former JSPS fellows to maintain and strengthen collaborative ties and networks with their Japanese colleagues by re-visiting Japan to attend meetings or seminars, plan or arrange joint research projects, give lectures or train young researchers.
- Slovenia, under the requirements of the European Framework Programmes, introduced in 2009 fiscal incentives for foreign researchers working in the country. In addition several programmes have been established by the National Bureau for Slovenes living abroad and by the Slovene Science Foundation to stimulate the return of expatriate researchers.
- Sweden finances postdoctoral researcher qualification opportunities for women in fields of strategic importance (VINNMER) and promotes collaboration between Sweden's centres of excellence in research and innovation (R&I environments) and prominent international environments abroad (such as the EU, North America, China, Japan and India).
- Italy introduced income tax incentives to scientific researchers residing abroad who return to Italy. These consist of a flat income tax rate of 10% for researchers and the exclusion of their income from certain regional taxes (OECD, 2009a).
- Germany provides expatriate researchers with travelling grants for job interviews and conferences as well as reintegration grants of up to six months. The federal government has also sponsored the Green Talents competition, inviting 15 outstanding young scientists from around the world to visit research facilities throughout Germany and learn about opportunities for co-operation with German partners.
- In the framework of the National R&D&I Plan 2008-11 Spain has created special positions at universities or public research centres for expatriate and foreign researchers (Programme I3). Spain grants postdoctoral junior and senior grants to promote the return of expatriate students, scientists and engineers (National Programme for Recruitment and Incorporation of Human Resources).
- Some countries are reinforcing communication efforts and non-financial support for foreign highly skilled workers. The Austrian government provides foreign researchers

with a guide to residence and employment available in English and plans to complete the English translation of its website (*www.help.gv.at/*) with information on living and working in Austria.

- In 2008-09 Denmark developed a national brand – Study in Denmark – based on the pay-offs: Think, Play, Participate. The process included a national survey of international students and resulted in a strong framework for the recruitment and retention of international talent by Danish higher education institutions. In addition Denmark established in 2010 a global network of international students who were awarded the title of youth goodwill ambassador. The network represents a diversity of nationalities and reflects relevant target markets for Danish institutions of higher education, Danish companies and other relevant stakeholders. The goal is to brand Denmark, Danish business, culture and academic programmes worldwide. A joint effort by the Danish government and higher education institutions has also led to national guidelines for the recruitment of international students into higher education programmes. The so-called Code of Conduct aims to provide an ethical approach to marketing and sets high standards for how international students are recruited.

Developing and strengthening human capital

Human resources in science and technology are essential for advancing science and innovation and generating productivity growth. In most OECD countries they represented in 2008 more than a quarter of total employment and over a third in northern Europe (Sweden, Denmark, Norway), Australia, Canada and the United States (OECD, 2009b).

Over the past decade, employment in HRST occupations has grown faster than total employment, owing to the increasing participation of women and the fast-growing demand for professionals and technicians in the services sector. Some countries with low HRST shares have been catching up too (*e.g.* Greece, Hungary, Ireland and Spain).

At the same time several OECD countries have expressed concerns that the supply of highly skilled workers is diminishing and will not be able to meet demand. With an ageing population, the current supply of new graduates may not be sufficient to replace outgoing cohorts. Many OECD and non-member countries have therefore sought to increase the supply and quality of HRST. Policy actions take place at various levels during general education, scientific university studies, advanced research programmes and postdoc training or after workers have entered the labour market. Policy actions target pupils, students, households, employees and employers.

In general OECD countries give a high level of priority to developing HRST in their national STI strategy (Table 2.12). Consequently, many have policies to increase HRST. Governments' intervention aim broadly to: *i)* raise interest in science among youth and wider civil society and create a culture of innovation; *ii)* improve formal education at all levels and beyond S&T fields; *iii)* improve employment conditions, especially in researcher careers, and lifelong learning opportunities.

Innovation for all: creating an innovation culture

A culture of innovation is a common feature of any innovation system. It supposes a positive attitude towards novelty and change and requires a general acknowledgement by society of the beneficial effects of science for social progress and well-being.

Table 2.12. **Innovation for all: performance, priority level and measures taken between 2008 and 2010**

	Performances			Priority level	Raising interest of science among youth					Steering households' demand for innovative products/ services
						of which				
	Educational attainment at secondary level,[1] 2008	Prevalence of science proficiency[2] at 15, 2006	Share[3] of households consumption on health, communication and education 2008	Developing HR for STI	All kinds	National communication campaigns	Mentorship	Exemplify S&T achievements (awards and prizes…)	Hand-on learning (direct participation to research projects, contests…)	
	Index 100 = Highest OECD value			Country self-reported[4] (1-8)	Measures/initatives taken between 2008 and 2010					
Austria	89	48	29	7	✓				✓	✓
Canada	96	69	36	7	✓	✓	✓	✓		
Czech Republic	100	55	30	7	✓	✓				
Denmark	82	32	23	6	✓					
Finland	89	100	32	7	✓				✓	
France	77	38	31	5	✓	✓		✓	✓	
Germany	94	57	37	6	✓					
Hungary	88	33	37	6	✓					
Israel	89	25	50	5						
Italy	59	22	28	n.a.	✓					
Japan		72	41	8	✓	✓	✓			
Korea	87	49	78	6	✓					
Netherlands	81	63	32	5	✓	✓				✓
New Zealand	79	84		7	✓			✓		
Norway	89	29	28	7	✓			✓		
Poland	96	32	36	8	✓					
Slovenia	90	62	34	8	✓					
South Africa				8	✓					
Spain	56	23	32	6	✓	✓		✓		
Sweden	94	38	29	6						
United Kingdom	77	66	23	n.a.	✓		✓			
United States	98	43	100	6	✓	✓	✓		✓	✓

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.
n.a.: Response not available.
1. As a percentage of the population aged 25-64. Year of reference 2002 for the Russian Federation.
2. Percentage of top performers in science based on PISA score.
3. Share in total households' final consumption.
4. Self-reported ranking of national STI priorities based on a scale whereby 1 = least important and 8 = most important.
Source: OECD, *Education at a Glance 2010*, OECD, Paris; OECD, *PISA Database* 2006; OECD, *National Accounts Database*, February 2010; OECD, *OECD Science, Technology and Industry Outlook 2008*, OECD, Paris; responses to the STI Outlook Policy Questionnaire 2010.

Three indicators may reflect the presence of an S&T and innovation culture among OECD countries: *i)* the percentage of the population aged 25-64 with at least a secondary level degree; *ii)* The percentage of top performers in science among 15-year-old students (PISA); and *iii)* the percentage of households' total consumption spent on health, communication and education. Educational attainment shows the extent to which a population is equipped with the minimum knowledge required to operate and perform well in a knowledge-based society. The prevalence of top science performers at 15 mirrors youth's attitudes and motivations regarding science and to some extent their enjoyment and active engagement in science learning (OECD, 2009d). Household consumption of health, education and communication is an indicator of consumer demand in three areas in which technological and organisational innovation is important and in which users and consumers can play an active role by orienting innovation efforts (OECD, 2010b).

Norway and the Netherlands have taken a global approach in addressing the issue of HRST. In February 2010 the Norwegian government launched a new strategy plan, "Science for the future – strategy for promotion of mathematics, science and technology 2010-2014" which takes into consideration the entire education and research system, from kindergarten to high-level research, and involves stakeholders from various sectors including the business sector (Confederation of Norwegian Enterprise [NHO] and the Federation of Norwegian Industries). The integration of the entire education system from primary education up to the labour market is an approach in force in the Netherlands since 2004. The Dutch Delta Plan for science and engineering and technology supports initiatives in both educational and research institutions.

Raising interest in science among youth

OECD countries continue to place particular emphasis on raising interest in science among youth. Measures range from large public communication campaigns to the organisation of joint research projects involving youth and senior scientists. Spain has created, in the framework of the National R&D&I Plan 2008-2011, the National Programme for Scientific Culture to promote the interest in and awareness of science among youth and the society. South Africa adopted in 2007 the Youth into Science Strategy (YISS) targeting school-going youth and undergraduates in science, engineering, technology and mathematics. The YISS is currently implemented through different national plans: the National Educator Support Programme; the National Plan for Camps, Competitions, Olympiads; the National Rollout Plan for the Establishment of a Network of Science Centres; and the National Plan to Place and Support Successful Graduates in the National Youth Service Programme.

Many countries also intend to communicate more effectively regarding the general benefits of science. National events such as Science Weeks or Science Days bring together partners from across government, industry and academia and offer young people but also to a wider public a variety of events (workshops, visits, talks, exhibitions, games, contests, etc.). Such initiatives are also arising in emerging economies (South Africa, India).

At European level the EUREKA network has implemented the I AM EUREKA advertising campaign to appeal to the public and to increase recognition of the EUREKA brand. The publication of six advertisements in the Brussels Airlines in-flight magazine from November 2008 to April 2009 was a pilot project and a cost-effective and efficient way of launching a pilot campaign and reaching a large number of influential people flying in and out of Brussels.

In its national R&D and Innovation Policy (2009-15), the Czech Republic has emphasised increasing publicity and promotion of research, development and innovation in media.

Some governments attempt to personalise communication to young people through either a mentorship approach or the use of entertaining digital tools.

- Canada has recently created Synapse Youth Connection, through which some 4 000 researchers, graduate students and postdoctoral fellows voluntarily mentor youth to expose them to their passion about careers in health. In its first year, the programme reached more than 20 000 students directly and more than another 26 000 indirectly.

- The United Kingdom has introduced a new scheme, Researchers in Residence, which plans the placement of researchers in schools. A STEMNET network has also been developed to inform young people about science, technology, engineering and mathematics (STEM), enable them to engage in debate and make decision about related issues.
- In the framework of its new Educate to Innovate programme, the United States harnesses the power of media, interactive games and hands-on learning to inspire the next generation of inventors and innovators. Japan encourages junior high school girls to choose science courses by providing them with opportunities for exchanges with women researchers and engineers, during experiment lessons, visiting lectures or summer camps.

Japan also promotes dialogue between scientists and citizens and intends to increase opportunities for experiencing science and technology in familiar settings.

Italy has recently launched a call for proposals for the yearly week of "scientific and technological culture" with a budget of EUR 10 million (*http://attiministeriali.miur.it/anno-2010/luglio/dd-19072010.aspx*). The programme is financed by the Ministry for Education, University and Research.

Finally a few countries have encouraged the involvement of young people in science through participation in research projects or science contests. These initiatives essentially take a hands-on learning approach. Austria's Sparkling Science Programme involves students up to the age of 18 as junior scientists. They work side by side with senior scientists on over 100 interdisciplinary projects in which they actively take part (carrying out surveys, interpreting data, developing new products, publishing results). The programme's strategic plan is set for ten years (2007-17) with annual funding intended to be about EUR 3 million. The Academy of Finland arranges annually the science competition Viksu for upper secondary students who are invited to submit essays in all scientific disciplines. The best essays are awarded scholarships worth EUR 30 000. The United States has introduced programmes to engage young people in scientific inquiry and challenging designs (competitions to develop game options). Japan holds national student S&T contests and the best Japanese students are invited to compete with their peers from other countries in international contests.

Promoting science through recognition of STI achievements

Recognising STI achievements, creating role models and rewarding the best initiatives are also ways to raise interest in science among youth and to promote a broader culture of innovation.

Canada exemplifies this with outreach initiatives through its website *www.science.gc.ca*. For example, the Great Canadian Science Race reaches over 325 000 children and 14 000 teachers across the country. The website continues to grow in popularity and had a 32% rise in unique visitors in 2008.

New Zealand introduced in 2009 a series of five Prime Minister's Science Prizes. These are awarded to: a researcher or a team of researchers; a young scientist (within five years of completing a PhD); a science teacher; a secondary school student; a researcher on science media communication (the last of these prizes underlines New Zealand's interest in widespread communication on S&T issues).

First introduced in 2008, Norway's biannual Kavli Prize (*www.kavliprize.no*) recognises outstanding scientific research, honours highly creative scientists, promotes public understanding of scientists and their work, and fosters international co-operation among scientists.

Similarly EUREKA launched in 2008-09 a new EUREKA Innovation award to reward an R&D-performing SME for a project chosen on the basis of outstanding technological and commercial achievement and societal impact. This annual award comprises a range of EUREKA products (individual projects, Eurostars, Clusters and Umbrellas). It aims to ensure long-lasting visibility and has a clear and strong impact on the EUREKA image.

Improving the supply of skills for innovation

Higher education systems are the main source of HRST, together with immigration and job-to-job mobility (OECD, 2009b). Accordingly, OECD countries give a high or medium-high priority to improving education for innovation.

Four indicators can reflect the capacity of national education systems to supply skills for innovation: *i)* total public and private expenditures on education, as a percentage of GDP; *ii)* the percentage of new university graduates in science and engineering; *iii)* the graduation rate at doctoral level and *iv)* female participation in doctoral studies. The intensity of education expenditures measures the proportion of a nation's wealth that is invested in educational institutions and shows the priority a country gives to education in terms of its overall resource allocation[5] (OECD, 2009d). The percentage of university graduates in science and engineering indicates the country's potential to absorb, develop and diffuse knowledge, on the one hand, and to supply the labour market with scientists and engineers, on the other (OECD, 2009b). The graduation rate at doctoral level shows the country's capacity to provide students with the highest education level and train them specifically to conduct research and contribute to knowledge diffusion (OECD, 2009b). Finally the female participation rate in doctoral studies reflects the gender balance in doctoral programmes and early research career paths.

Finland, Sweden, the United States and Israel are among the highest OECD performers, with a large amount of GDP spent on education, numerous new S&E graduates, higher graduation rates at doctoral level and stronger participation of women in advanced research programmes. In addition Portugal has in recent years strongly reinforced its capacities for human capital formation and Switzerland benefits from a strong vocational education training and education system (OECD, 2008). Conversely Japan, Spain and the Netherlands lagged slightly behind others OECD countries in terms of HRST development.

Strengthening higher education

Improving education facilities for the 21th century is a key goal of many economic recovery plans. Germany and the United Kingdom have put support for education at the heart of policy action. Spain or Portugal took the crisis as a starting point for triggering reforms of their higher education institutions. Australia, Austria, Canada, Germany, New Zealand, Norway and Spain invested to renovate and build new schools and universities. Italy fostered digital innovation in schools. Next to the renovation and refurbishment of

Table 2.13. **Improve education for innovation: performance, priority level and measures taken between 2008 and 2010**

	Performances in 2008 or nearest				Priority level	Improve education for innovation						
	Expenditures on education,[1] 2006	% of university degrees in science and engineering, 2008	Graduation rate[2] at doctoral level, 2008	Female participation in doctoral studies,[3] 2008	Developing HR for STI	Revising academic curricula	Improving teaching in mathematics and science	Developing entrepreneurial and soft skills	Reducing gaps in S&T education (gender, minority)	Financing for PhD study and post-doc. training	Industry involvment in PhD training	Others
	Index 100 = Highest OECD value				Country self-reported note (1-8)[4]	Measures/initatives taken between 2008 and 2010						
	2006	2007										
Austria	69	82	59	71	7			✓	✓	✓	✓	
Canada	81	65	33	75	7					✓		
Czech Republic	60	89	43	62	7	✓	✓		✓	✓	✓	
Denmark	91	60	46	72	6		✓	✓		✓	✓	
Finland	73	85	72	91	7			✓		✓		
France	74	81	43	70	5				✓	✓	✓	
Germany	60	88	76	70	6	✓	✓	✓	✓	✓	✓	
Hungary	71	47	22	72	6					✓		
Israel	97	61	44	86	5		✓			✓		
Japan	63	79	33	46	8		✓	✓	✓	✓		
Korea	92	100	34	50	6			✓	✓			
Netherlands	70	44	50	70	5		✓	✓	✓			✓
New Zealand	78	56	42	84	7							✓
Norway	68	48	55	75	7		✓		✓	✓	✓	
Slovenia	76	58	41	80	8	✓			✓	✓	✓	
South Africa					8							
Spain	58	77	29	82	6					✓	✓	
Sweden	79	69	93	75	6							✓
United Kingdom	74	68	61	75	n.a.				✓	✓	✓	
United States	92	46	45	86	6	✓	✓		✓	✓	✓	

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.

n.a.: Response not available.

1. The value is from 1 to 100 based on data expressed as a percentage of GDP.
2. New doctorate graduates as a percentage of relevant age cohort. Year of reference 2007 for Australia, Canada, China and the Russian Federation.
3. Percentage of doctorates awarded to women. Year of reference 2007 for Australia and Canada.
4. Self-reported ranking of national STI priorities based on a scale whereby 1 = least important and 8 = most important.

Source: OECD, *Education at a Glance 2010*, OECD, Paris; OECD, *OECD Science, Technology and Industry Scoreboard 2009*, OECD, Paris; OECD, *OECD Science, Technology and Industry Outlook 2008*, OECD, Paris; responses to the STI Outlook 2010 Policy Questionnaire.

schools and universities, large investments in childcare facilities have highlighted the importance given to early childhood education for the future (OECD, 2009a).

To ensure that national education systems reach high standards, countries are reinforcing their education system, the budget allocated to education, their institutions and teachers' competences.

In response to the crisis, Australia allocated up to 1.4% of GDP for education, Germany spent a further 0.6% of GDP, the United States 0.58% of GDP and Portugal 0.41% of GDP (*ibid.*). In 2008-09, the federal government of Canada provided through its 2007 budget CAD 3.2 billion in support for post-secondary education and federal investments are planned to grow in the future at a 3% annual rate.

Hungary has launched new training programmes for teachers with a budget of EUR 70 million (*ibid.*) Denmark, which has a high dropout rate in secondary studies and has demonstrated low PISA performance in science (OECD, 2008), established in autumn of 2009 a new national centre for education in science, technology and health which will cover and focus on improving the quality of the education and on interest and recruitment in these areas in the educational system. Japan plans to improve the quality of teachers and develop local systems for supporting education, including through the participation of private citizens.

A reform of the national university system is underway in Italy, and is currently evaluated by Parliament. The reform aims at strengthening higher education and reinforcing the quality of teaching (*www.senato.it/service/PDF/PDFServer/BGT/00446650.pdf*) through a stronger and more internationally recognised system of evaluation of professors, on the one hand, and clusters of universities and scientific institutions that will improve the quality of the educational offer, on the other. The law also foresees greater use of fellowships and other student incentives.

Governments have also increased the financial resources allocated to universities and higher education institutions. Germany has created new capacities at university level with additional funding (Higher Education Pact 2020). This has already stopped the downward trend in numbers of new university entrants. The second phase (2011-15) would enable universities to accept 275 000 additional new entrants with a contribution from the federal government of more than EUR 5 billion.

In addition to the financial resources newly allocated to schools, universities and higher education institutions, some countries enlarged public support to students to pursue tertiary studies (grants, subsidies, loans, reduced tuition fees, etc.).

- Canada has modernised the system of financial support for nationals who pursue a college or university education. The new consolidated Canada Student Grant programme channels about CAD 350 million and will receive additional funding to reach CAD 430 million by 2012-13. Since 2009, some 245 000 students have benefited from this programme. Canada also plans to reform the Canada Student Loans programme to make it easier for students to access financial assistance and to manage their loans. CAD 123 million will be invested for four years starting in 2009-10.
- In December 2009, Denmark hosted the United Nations Climate Change Summit. To emphasise the importance of sustainable climate solutions, the Danish government decided not to give any gifts or conference kits to COP15 participants and the resources saved were put into eleven COP15 Climate Scholarships for highly qualified students. The scholarships, which cover both tuition fees and living expenses, were made available for a range of excellent two-year master's programmes, including MSc programmes in wind energy, environmental engineering or sustainable energy planning.
- Russia plans to help students with low interest rate loans, state scholarships, free student accommodation and a potential freeze on tuition fees. Some students have also been transferred to government-paid programmes (OECD, 2009a).
- The United States' stimulus package includes new programmes of student aid and higher education tax cuts to allow certain students to enter higher education.

Ensuring that education delivers the right mix of skills

Mathematics and science proficiency used to be considered the foundation of a knowledge-based and innovation-driven society. However recent developments and the growing importance given to non-technological innovation have stressed the need for complementary skills, including entrepreneurial capacities and "soft" skills.

Some countries have emphasised reinforcing mathematics and science education. Improving teaching has been a first axis of policy action. Norway has significantly increased the number of teachers in mathematics and natural sciences (at least 1 000 more by 2014). The United States has introduced various programmes to improve teaching in mathematics (*e.g.* Race to the Top), to build local communities of support around teachers and develop civic participation in bringing discovery-based science experiences to students in grades K-12 (*e.g.* National Lab Day), and to foster private and philanthropic involvement in support of STEM teaching and learning. Japan has developed initiatives to enhance teachers' educational activities in science, mathematics and technology. Israel is offering the three-year Guastella Fellowship to outstanding doctoral students to promote research and development in the field of science teaching.

Revising the curriculum is another way to improve students' participation and literacy in mathematics and science. The United States has announced a comprehensive federal education initiative with an initial federal investment of US 74 million to develop courses on clean energy at universities, community and technical colleges, and K-12 schools (Regaining our Energy Science and Engineering Edge). The Netherlands are thinking about integrating science and technology in primary education and involving organisations that operate at the cutting edge of these disciplines. In contrast, Austria, for example, has specifically targeted higher-level students or researchers, while Finland and Germany have adopted a system-wide approach to skills and education.

Entrepreneurship education is also part of the focus on innovation skills. In 2010, Denmark launched a new Strategy for Education and Training in Entrepreneurship, including education in management, start-up and interdisciplinary co-operative skills. The idea is to develop pupils' and students' knowledge about entrepreneurship, as well as their ability to act entrepreneurially, by stimulating their ability to think innovatively, to see opportunities and to turn ideas into value. A new fund, the Foundation for entrepreneurship, has been established to pool efforts in this area (*http://en.fi.dk/publications/2010/strategy-for-education-and-training-in-entrepreneurship/*). The Netherlands also supports entrepreneurial education and introduced entrepreneurship education from primary school up to university to help students acquire knowledge, competences and positive attitudes to entrepreneurship. Germany's EXIST start-up programme provides special training and support for future entrepreneurs. Japan is also promoting vocational education to cultivate students' entrepreneurial abilities. Meanwhile, South Africa, as part of the 2008 IPRs Act, is supporting entrepreneurial skills together with IP management skills and industry training.

Widening access to scientific studies and promoting equity

The low level of female participation in scientific studies and doctoral programmes is a long-standing concern in OECD countries. On average 45% of women at the relevant age graduate at university level compared to less than 30% of men. And yet they are much less represented in science and engineering fields, notably in OECD countries such as Japan or

Korea (OECD, 2009b). Some countries have implemented specific measures to reduce gender gaps in S&T education and researcher employment. While women outnumber men among graduates from tertiary education, they account for less than half of doctoral students and are underrepresented in the research workforce. Furthermore they are less likely than their male colleagues to advance, as they obtain fewer research grants or subsidies and publish less. Some countries have provided women with preferential access to research funding and better opportunity to make cutting-edge advances. The Austrian Federal Ministry of Science and Research (BMWF) proposes a two-semester course to help women put together successful grant proposals. This programme also provides information on various sources of funding, personality development, etc. (the Forte Coaching programme).

For its part, the Netherlands has adopted targets for women in academia. In 2010, it adopted a target of 15% of female professors, still far beneath the European target of 25%. The Dutch Aspasia programme, initiated in 1999, was a scheme to increase the number of female senior lecturers. The programme is set to be extended with a larger budget of EUR 4 million a year. Norway also announced an incentive for the recruitment of women to senior positions in higher education institutions within S&T disciplines, with financial effect from 2011. Institutions recruiting women for senior positions will receive an amount which depends on the number of women recruited. EUR 1.2 million (NOK 10 million) will be allocated to follow up this incentive.

Other recent initiatives to broaden access to scientific studies to underrepresented populations include:

- The United States launched a Broadening Participation programme managed by the National Science Foundation (NSF) in the framework of the "Educate to Innovate" initiative in order to reduce gender and ethnic minority gaps.
- Norway has identified the issue of gender equity in mathematics, science and technology in its main STI strategy goals and initiated both a statistical survey aiming to see if more females select the natural sciences as part of their higher secondary education and a two-year project aiming to stimulate more women to study the natural sciences (Action Plan for Gender Equality in Kindergarten and Basic Education 2008-10).
- The Netherlands has developed a Mozaïek programme focused on immigrant research talent. Based on the results of a national survey which showed that graduates from ethnic minorities were not moving on to doctoral research because of a lack of information, a lack of personal networks and the deficiency of academic institutions in identifying their potential, the Netherlands deployed in 2004 a funding scheme that awards personal grants for a four-year period of doctoral research. A total subsidy of EUR 4 million was allocated in 2010 to 20 Mozaïek grants.
- Sweden helps disadvantaged populations to access S&T education by offering science classes to people with grades that are too low to enter university. After completing one year (and passing the exams) they are guaranteed a place at university in natural science or engineering. The number of graduates has increased by more than 60% during the past ten years.

Doctoral and postdoc training

Fostering advanced research programmes and postdoc training requires both financial resources and regular evaluations. Governments have increased support for this purpose.

- Canada has established the Vanier Canada Graduate Scholarships programme to support 500 Canadian and international doctoral students each year with three-year scholarships valued at up to CAD 50 000 per year. The government has also increased the funding of Canada Graduate Scholarships for an additional 500 doctoral scholarships valued at CAD 35 000 per year.
- France introduced in autumn 2009 the *contrat doctoral*, a three-year labour contract that offers social benefits to doctoral students equal to those afforded under public law. This contract is identical across public research institutes and higher education institutions. The minimum wage is fixed at the national minimum level but the remuneration can be freely negotiated (there is no upper limit) between doctoral students and research institutions.
- Germany has reinforced its doctoral programmes and financial support.
- Japan has kept increasing the number of JSPS Research Fellowships for Young Scientists granted to young Japanese postdoctoral researchers and graduate students who conduct research activities at Japanese universities or research institutions. In 2010 5 944 fellowships were awarded (5 428 in 2008 and 5 648 in 2009). Japan also plans to further expand its scholarship system in higher education. Spain has offered financing opportunities for PhD study and postdoctoral training through the National Programme for Training Human Resources and the National Programme for Recruitment and Incorporation of Human Resources.
- Switzerland has strengthened and complemented its support for different phases of scientific careers. It has expanded its doctoral programmes and will continue to do so in the years to come, with a new division of labour between the funding agency and the Rector's Conference. It has also introduced a new funding scheme to support highly qualified postdocs.
- The US Administration has announced its intention to triple the number of National Science Foundation Graduate Research Fellowships over four years. The United States had already granted new fellowships for science as part of its stimulus package (OECD, 2009a).
- In the framework of the general reform of universities, the Academy of Finland has paid more attention to supporting young doctorates to become independent researchers. Young PhDs are receiving a three-year postdoctoral post including funding for research cost.

Evaluations of national doctoral programmes will be undertaken in Norway in 2010/11. Norway has however announced that it is maintaining its current policy towards PhDs (the PhD position is salaried in Norway, PhD candidates are categorised as scientific staff rather than as graduate students, and resources for PhD positions are allocated to higher education institutions with a priority for positions in S&T and medicine).

Industry post-docs

Industry involvement in the funding, design and steering of PhD and postdoc training continues to be used to ensure that public academic research better responds to business and societal needs. The industry PhD programmes allow for instance a PhD student to carry on an industry-oriented research project and share time between a university lab and a firm. Such programmes bring together academic research projects and the business world and give PhD students the opportunity to experience both working environments. The industry PhD programmes are also effective ways to build organisational and personal networks that bridge the gap between academia and the private sector.

- Canada invested over CAD 25.5 million in new Industrial Research and Development Internships (IRDI) launched in 2008-09 for graduate students and postdoctoral fellows.
- In 2010, Denmark has allocated DKK 135 million (DKK 104 million in 2009) for new industrial PhD projects. This is equivalent to 100-120 new PhD projects. Accordingly, it is assumed that all qualified applications from the private sector will receive funding; more than half were approved in 2009.
- In France doctoral patronage by firms (*Mécénat de doctorat*) has been in place since 2008. The scheme grants a 60% tax credit on funds used for the remuneration of PhD students.
- In Norway the training scheme for industrial PhDs was established in 2008. The students are employed by the firms, and the costs (salary and other expenses) are shared between the firms and the Research Council of Norway. The growing number of participants shows the success of the programme.

Employment conditions for researchers and opportunities for lifelong learning

HRST are major actors in innovation but many university graduates drop out of the labour market or are employed in occupations below their educational level. Differences by gender at lower levels of education persist among the highly skilled. Women with university degrees are more likely to remain unemployed and obtain lower wages than their male counterparts (OECD, 2009b). The place of women in science has already been largely documented.

Four indicators can illustrate employment conditions for highly skilled: *i)* HRST occupations as a percentage of employment; *ii)* researchers per thousand employment; *iii)* unemployment rate of university graduates and *iv)* gender differentials in earnings for 30-44 year-old university graduates. The share of HRST occupations reflects the structural demand for workers in S&T occupations with a high innovation potential. The density of researchers indicates the relative size of human resources engaged in R&D. Unemployment rates mirror labour market failures to allocate human capital to the production process. Gender differentials in earnings show unequal working conditions in early career paths between women and men (OECD, 2009b).

The Nordic countries (Sweden, Denmark, Norway and Finland) and Luxembourg have the highest OECD performance. The labour market for the highly skilled is broader and the human capital devoted to R&D is relatively larger. Furthermore university graduates are less likely to be unemployed and, although women still earn less than men, earnings differentials by gender are less than in other OECD countries. Portugal, Spain, Turkey and Greece have among the weakest OECD performances.

Attractiveness of careers in research and innovation

Changes in the international labour market for researchers have deeply affected employment conditions and the career paths of researchers, even in the public sector. The polarisation of legal status and the growing number of temporary contracts in universities

Table 2.14. **Improve employment conditions and opportunities of life-long learning: performance, priority level and measures taken between 2008 and 2010**

	Performances				Priority level	Improve employment conditions and opportunities of life-long learning					
	Share of HRST ocupations in total employment, 2008	Researchers per 1 000 employment, 2008	Unemploy-ment rate of university graduates[1] 2008	Gender equity in earnings[2] for 30-44-year-old university graduates, 2007	Developing HR for STI	Improving women's access to research and academia	Make research and innovation careers more attractive	Quality of university labs and infra-structure	Improving sectoral mobility	Favorising recruitment of HRST in enterprises and or public organisations	Enforcing life-long learning
	Index 100 = Highest OECD value				Country self-reported note (1-8)[3]	Measures taken between 2008 and 2010					
Austria	72	52	29	78	7	✓	✓	✓	✓		✓
Canada	85	51	55	86	7	✓		✓		✓	✓
Czech Republic	81	35	21	85	7						
Denmark	94	66	32	84	6	✓		✓		✓	
Finland	82	100	44	81	7		✓		✓	✓	
France	78	52	60	88	5	✓	✓	✓			
Germany	87	45	46	84	6	✓					✓
Hungary	67	26	31	82	6	✓		✓		✓	
Israel			45	77	5					✓	
Japan	36	68	36		8		✓			✓	✓
Korea	45	59	33	98	6		✓	✓			
Netherlands	90	36	21	82	5	✓			✓	✓	✓
New Zealand	69	67	29	81	7						
Norway	91	62	19	83	7	✓	✓	✓	✓		
Slovenia		44	43	99	8			✓			
South Africa		9			8						
Spain	60	40	74	98	6		✓	✓		✓	
Sweden	95	66	42	85	6						
United Kingdom	65	51	26	90	n.a.	✓					
United States	78	60	28	80	6			✓			

Note: The table only includes countries that provided responses to the STI Outlook 2010 Policy Questionnaire as of 31 August 2010. However, indicators of performance are calculated for all OECD countries for which data are available. Therefore the highest OECD value may not appear in the table and the ranking takes into account a larger number of countries than those presented here.
n.a.: Response not available.
1. As a percentage of the labour force aged 25-64 at this level of education.
2. Annual average female earnings as a percentage of male earnings.
3. Self-reported ranking of national STI priorities based on scale whereby 1 = least important and 8 = most important.
Source: OECD, *Education at a Glance 2009*, OECD, Paris; OECD, *OECD Science, Technology and Industry Scoreboard 2009*, OECD, Paris; OECD, *OECD Science, Technology and Industry Outlook 2008*, OECD, Paris; responses to the STI Outlook 2010 Policy Questionnaire.

and public research institutes have led to the emergence of a "secondary" labour market where lack of clear rules on recruitment, employment and promotion may lead to job insecurity and inequity. Consequently, OECD countries are addressing issues of career development in research more broadly.

- Austria has initiated a broad reform of career prospects and working conditions in universities. Collective agreements between university representatives and the union of public employees which came into force in October 2009 foresee a standard career model which offers more flexibility, regular evaluation and higher minimum wages for researchers. They prolong the duration of short-/fixed-term contracts by the length of maternity leave and offer the possibility of leave for study, training or research purposes. Universities can act flexibly in the framework of the performance agreements they have with the ministry for the period 2010-12. In return the Ministry of Science and Research supports the implementation with additional funds.

- France adopted in 2010 a decree introducing profit-sharing with public research institute personnel involved in scientific research or services. In addition the government has invested EUR 252 million in the *Plan carrières* (2009-11) to support the career development of researchers. This programme plans an upward revision of salaries, mobility allowances, pedagogical responsibility allowances, and scientific excellence bonuses. It offers greater career opportunities and faster career tracks, work flexibility according to education *versus* research priorities and the acknowledgement of practical training activities. Another policy initiative in favour of researchers' careers is the creation of mixed chairs between universities and public research institutes.
- Germany has addressed the question of equal opportunities and work-family balance in its Initiative for Excellence for young scientists.
- Japan has announced its intention to diversify career paths for young researchers and to prepare an appealing environment for research, including funding and support systems, as well as desirable living conditions, to attract superior researchers from around the world. In particular, Japan is undertaking new initiatives to improve work-family balance, extending childcare leave and offering preferential consideration to businesses that take the lead in developing working arrangements for parents with small children. The government also plans to provide enhanced support for resumption of employment and reemployment following the birth of a child and infant care.
- Norway has pledged in its White Paper on Research in spring 2009 to increase the ability of the higher education institutions to create good career paths and particularly better conditions for qualifying to professor positions.
- South Africa launched in 2009 the National Postdoctoral Research Forum and its website to facilitate interaction among postdoctoral students and provide them and recruiters the platform for posting job opportunities. In addition the South Africa PhD Project, a non-funding programme of the National Research Foundation, encourages master's graduates to register for doctoral studies and serves as a market place for PhD students, supervisors and funders to look for and give information on job and funding opportunities.
- Slovenia is undertaking an evaluation of its higher education and research programme.

Mobility of human resources is a key component of knowledge diffusion among firms and from academia to industry. Governments can encourage the employment and mobility of the highly skilled, first as employers themselves, then by providing incentives to firms. Several countries are addressing the issue of researcher mobility.

- Austria has implemented a new programme on human resources for the economy that, among others things, provides an incentive for higher sectoral mobility.
- In Finland's reform of the universities at least 40% of the members of the new university Board of Directors must come from outside the university.
- In 2010 the Swedish Foundation for Strategic Research (SSF), an independent research foundation, allocated around SEK 15 million for a strategic mobility programme covering a period of two years. The purpose of the programme is to increase personal mobility and cross-fertilisation between academia and industry and thereby increase knowledge of the different conditions under which people work in academia and industry.

Outlook: future challenges

The contribution of innovation to productivity growth and competitiveness remains a key issue for OECD countries but also for emerging economies. As this chapter shows, OECD countries continue to reform their science, technology and innovation policies to improve the efficiency of their national innovation systems. The increasing focus on STI to address environmental sustainability, energy security and at the same time to foster new growth industries and services illustrates the convergence of competitiveness goals with efforts to mobilise STI to address social challenges. Indeed, these challenges are increasingly driving countries' research and innovation agendas.

Public support to the "supply side" of research and innovation remains a key area for STI policies although attention to the "demand side" of innovation, such as public procurement, standards and involvement of users to "pull" innovation, continues to gain ground. Changes in innovation processes, not least those driven by the broadening of innovation, the rise of new global players and global value chains, and technological convergence also affect how governments design, develop and implement policies to support scientific and innovative performance. This places pressures on governments to monitor and adjust the effectiveness of national STI governance structures and policies to ensure co-ordination and coherence at the regional, national and, increasingly, international level.

The near-term outlook for public and private investment in research and innovation remains positive as governments continue to support investments in STI to foster longer-term growth. But fiscal pressures and continued slow growth in OECD countries will affect business investment decisions as well as the scope for public support. One implication is that there will arguably be greater pressure on governments to set strategic as well as thematic priorities for research and to improve effectiveness of innovation policies and instruments, given limits to public investments in research and innovation.

In the longer term, the participation of emerging and developing economies in global R&D and innovation networks will re-draw the global map for STI, even if OECD countries will continue to predominate in R&D. Increasingly, countries as diverse as China, South Africa, Indonesia or Vietnam are developing broad-based innovation strategies that encompass existing and new technologies as well as social innovations. This reflects a change in the understanding of the role of and interplay between the creation and diffusion of technology. The notion in developmental theories that countries need to "exhaust" their potential for catching up before embarking on their "own" innovation and R&D activities is being challenged. This opens up avenues for mutual learning and multilateral collaboration on science, technology and innovation between OECD and developing countries.

Notes

1. This chapter is based mainly on the responses from countries to the STI Outlook 2010 Policy Questionnaire received as of 5 August 2010. It also draws on responses to related questionnaires or requests for policy information (*e.g.* on R&D tax credits) in other OECD working parties and committees.
2. Institutes that mainly perform public administration-related tasks are not included under this scheme, which therefore encompasses 51 research institutes.
3. The most recent data are for 2005.

4. The core NCE programme consists of 15 networks working in the four national strategic areas and partnering close to 2 000 organisations (companies, government departments/agencies, hospitals, universities) in Canada and around the world. The NCE employed in 2006-07 more than 6 000 researchers and highly qualified personnel. The NCE supported its scientists in filing 110 patents and publishing 4 309 papers in referred journals, obtained or launched negotiations on 20 licences and generated four spin-off companies.
5. The proportion of total financial resources devoted to education in a country results from choices made by government, enterprises and individual students and their families, and is partially driven by the size of the country's school-age population and enrolments in education. Moreover, if the social and private returns to investment in education are sufficiently large, there is an incentive to expand enrolment and increase total investment (OECD, 2009d).

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