OPEN SCIENCE

Rationale and objectives

While science has always been open – indeed openness is critical to the modern scientific enterprise – there are concerns, and some anecdotal evidence, that the processes for producing research and diffusing its results have become less open. There are several reasons. First, science is increasingly data-driven and expensive, but access to scientific data is often subject to administrative, legal and privacy regulations. Access also requires adequate information and communication technology (ICT) infrastructure. Other limits on openness in science include policies and practices at universities that place a premium on patenting over publishing and weak incentives for researchers to share data. This can also act as a barrier to the replication and validation of scientific experiments. Finally, the policies and practices of scientific publishers that limit web-based access to research results may also make access to scientific data less open.

In response to these concerns, governments and the research community, including publishers, are seeking to preserve and promote more openness in research. "Open science" refers to an approach to research based on greater access to public research data, enabled by ICT tools and platforms, and broader collaboration in science, including the participation of non-scientists, and finally, the use of alternative copyright tools for diffusing research results.

Open science has the potential to enhance the efficiency and quality of research by reducing the costs of data collection, by facilitating the exploitation of dormant or inaccessible data at low cost and by increasing the opportunities for collaboration in research as well as in innovation. Greater access to research data can also help advance science's contribution to solving global challenges by enhancing access to data on a global scale (*e.g.* in the case of climate change data). Open science can also be used to promote capacity building in developing countries while generating opportunities for scientific collaboration and innovation between OECD and developing countries.

Major aspects

Governments, as key funders of public research, play an important role in developing policies to foster greater access to and use of scientific research. For example, public policies and guidance from research funding agencies can facilitate the sharing of data resulting from publicly funded research. They can help research institutions better manage research data through the development of infrastructure and training. They can also provide guidance to researchers on compliance with the various policies governing data access and sharing (*e.g.* intellectual property rights, privacy and confidential issues).

Recent policy trends

Most OECD countries recognise the potential efficiency gains to research from data sharing and use of data generated by publicly funded research. Many countries have worked to strengthen regulatory frameworks and technical and human capabilities so as to encourage data sharing and collaboration (Table 7.2). A number of areas have received significant policy focus.

One is digital infrastructure. Most OECD countries as well as some non-member economies are developing the ICT infrastructure required for the collection, archiving, storage and dissemination of public data and publicly funded research results. Initiatives

include the creation of online repositories, digital libraries, online platforms and public databases. In addition, some countries are trying to equip scientific institutions with modern technological resources in order to foster inter-institutional networks and collaboration between research institutions. The development of an information technology (IT) infrastructure also requires policy co-ordination to make the network of digital data repositories and digital libraries interoperable with other national and international data networks.

Several OECD countries are adopting policies to promote open research data, for example by requiring the archiving of research outputs in a digital format (*e.g.* digitised works, e-print archives and electronic databases, open software). This also requires the development of international open standards (*e.g.* the portal for the Systems Biology Markup Language, a free and open interchange format for computer models of biological processes).

A broad range of government data can be important for research purposes. Australia, Canada, France, the United Kingdom have launched open government data initiatives. In view of government's limited ability to create value and new services from public data, these initiatives increase the opportunities for entrepreneurial researchers to use government databases (OECD, 2011). Some OECD governments are also creating public databases to unify and standardise information about the country's research community, such as scientific publications, profiles of research expertise, research institutions, and research projects (Argentina, France, Norway), which allow researchers to interact.

There is a long-standing trend towards promoting open access to publicly funded research. The most common policy instrument is the requirement to publish in digital format. For example, the US National Institutes of Health (NIH) has made its public access policy mandatory: all funded researchers must submit an electronic version of their final peer-reviewed manuscripts to PublicMed Central (OECD, 2010). New Zealand and Spain also require publication of publicly funded research results in digitised format in an open access repository. A number of countries are promoting the use of free licences by research institutions and public bodies. Public research funding in Estonia, for example, covers the costs of publishing in open access journals.

The push towards open access has also led to the emergence of new business, public funding and co-operative financing models. One is the initiative developed by Co-Action Publishing with Lund University, the National Library of Sweden and *Nordbib* to adopt online guides to open access journals publishing and self-archiving for researchers; another is the creation of a Directory of Open Access Journals to rank countries' national policies on access.

There is a growing interest among policy makers in open collaborative work (Canada, the United States). This implies identifying and reducing barriers to inter-institutional, inter-disciplinary and international collaboration among research institutions, industry and citizen groups. For example, science-industry initiatives are increasingly used to reduce the costs of and barriers to drug discovery by applying semantic technologies to available data resources (*e.g.* Open PHACTS, Open Pharmacological Concepts Triple Store). Government is not the only actor: entrepreneurial initiatives are also emerging, such as ResearchGate, a social networking site for scientists to connect, raise and answer questions, and share papers and data.

Table 7.2. **Recent policy measures to promote open science**

Digital data storage infrastructure (Creation of online)	Open Data (Promotion of)		Open Access (Promotion of)		Collaborative work (Online)
Repositories and archives, libraries in research centres and governments	Digital format for research outputs (*e.g.* funds)	Open Government	Open licenses for datasets, libraries	Publication in open access journals or open resources (*e.g.* funds)	Researchers industry society
Argentina		×			
Australia	×	×	×	×		
Canada	×		×			
People's Republic of China	×		×	×		
Colombia	×					
Czech Republic	×					
Denmark	×			×		
Estonia	×			×	×	×
Finland	×			×		×
France	×		×	×		
Germany	×	×		×	×	
Greece	×			×		
Hungary	×		×	×		
Luxembourg	×			×	×	
New Zealand	×		×		×	
Norway	×		×	×		
Poland	×			×		
Russian Federation	×					×
Slovak Republic	×					
Slovenia					×	
South Africa	×					
Spain	×	×		×	×	×
Switzerland	×					
Turkey	×	×			×	
United Kingdom	×		×			×
United States	×		×	×	×	

Source: Country responses to the *OECD Science, Technology and Industry Outlook* 2012 policy questionnaire and OECD (2010), *OECD Science, Technology and Industry Outlook* 2010, OECD, Paris.

References and further reading

OECD (2010), *OECD Science, Technology and Industry Outlook 2010*, OECD, Paris, *www.oecd.org/sti/outlook*.

OECD (2011), "Open Science: Policy Challenges and Opportunities", internal working document, Country Studies and Outlook Division, Directorate for Science, Technology and Industry, OECD, Paris.