State-of-art analysis of OA strategies to peer-review publications

RTD-B6-PP-2011-2: Study to develop a set of indicators to measure open access

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Executive Summary

The present report examines policies and strategies that aim to foster open access (OA) and discusses how OA policies are monitored and enforced. The analysis is supported by findings from the literature on the global progression of OA since 1996, and comments on themes and debates that have emerged from the OA movement.

Governmental OA Strategies

Most national governments have not proposed or implemented direct legislation on OA. Instead, OA is often addressed through less formal means, such as the production of guidelines for research funding agencies. Related legislation often includes laws on copyright and licensing; in fact, all countries covered in this study—with the exception of Cyprus—have copyright legislation that may apply to peer-reviewed publications. Legislation directly addressing OA has been implemented in the US, Spain, and Germany. Italy and Lithuania have also recently passed laws that have direct implications for OA in those countries.

- In the US, the Consolidated Appropriations Act, 2008, is the legislative basis for the OA policy of the National Institutes of Health (NIH). With this legislation, the US became the first country to adopt a national OA mandate. The Fair Access to Science and Technology Research Act (FASTR) was introduced in Congress in February 2013. At the same time, the White House's Office of Science and Technology Policy (OSTP) issued a Directive on Public Access. Both require all federal agencies with extramural research expenditures of over $100 million to develop a federal research public access policy. On January 17, 2014, an omnibus federal spending bill, similar in concept to the OSTP Directive, was signed into law by President Obama; it includes an OA mandate (Section 527 of the Consolidated Appropriations Act, 2014 [H.R.3547]).
- Spain passed the national Law on Science, Technology and Innovation (2011) (Ley de la Ciencia). Article 37 mandates that a digital version of the final copy of research accepted for publication and funded under the national public R&D funding scheme be deposited within 12 months of publication in an OA repository.
- In Germany, legislation (BGB1. I S. 3714) enacted on October 1, 2013, allows authors to make any of their articles stemming from publicly funded research openly accessible and available for non-commercial purposes without the consent of the publishers 12 months after first publication.
- Italy's Law of 7 October 2013 (No. 112) includes a regulation for OA to scientific publications. Researchers whose research has been publicly funded (at least 50%) are required to either publish their work in an OA journal or deposit their work in OA archives within 18 to 24 months after publication.
- In Lithuania, national legislation mandating that all state-funded research be made publically available took effect on May 12, 2009.

A number of countries in the ERA have instituted national policies, programmes, and principles related to OA.

- The UK is a leader in the development of OA to peer-reviewed publications, with the Higher Education Funding Council for England (HEFCE) and the Research Councils UK (RCUK) pushing for greater public access to publicly supported research and the 2012 'Finch Report' raising awareness of and fostering discussion on OA in the country. Jisc, a UK registered charity that

champions the use of digital technologies in UK education and research, has also had a considerable influence. The 2013 Policy on Open Access, drafted by the Working Group on Expanding Access to Published Research Findings, chaired by Dame Janet Finch, will make all government-funded research OA within five years, with a target of 45% in the first year. The UK is a firm supporter of a model that favours Gold OA.

- In Ireland, the National Principles for Open Access Policy Statement (2012) mandates the deposit of outputs of funded research in OA repositories.
- Since 2006, Sweden has had a national OA programme, OpenAccess.se, which has played a role in the creation of a national search portal for scholarly publications (SwePub), the Directory of Open Access Journals (DOAJ), and a number of institutional and funder policies.
- France's HAL multi-disciplinary open archive was launched by the Centre National de la Recherche Scientifique (CNRS) in 2001.

At the pan-European level, the Open Access Pilot was launched by the European Commission as part of its Seventh Framework Programme (FP7) in August 2008. Within several thematic areas of the framework programme, FP7 projects are required to deposit peer-reviewed research articles or final manuscripts resulting from projects into an online repository. Other Europe-wide initiatives include the Digital Repository Infrastructure Vision for European Research (DRIVER), established to build a cohesive network of repositories for research and education, and the Open Access Infrastructure for Research in Europe (OpenAIRE), a complementary project offering organisational and technological infrastructure for the identification, deposition, access and monitoring of FP7 and European Research Council (ERC) funded publications. Launched in February 2014, a new 30-month project titled PASTEUR4OA (Open Access Policy Alignment Strategies for European Union Research) aims to help Member States to develop and/or reinforce OA strategies and policies at the national level and facilitate coordination among the Member States.

At the international level, research performing organisations also contribute to the global spread of OA. Since 2010, much of the World Bank's research has been made available to the public through its website and with the Open Data Initiative and Access to Information Policy. Furthermore, its new OA policy, effective since July 1, 2012, adopts the Creative Commons Attribution (CC-BY) copyright licence for all of its outputs and other knowledge products, solidifying the World Bank's position as a forerunner in OA.

Funding Bodies' Policies and Mandates

An analysis of funding bodies' OA policies was performed to assess the extensiveness of OA policies as well as to examine OA rules for grant recipients, across ERA countries and in Brazil, Canada, Japan, and the US. The country with the highest number of OA policies is the UK (with 34 mandates), followed by Canada (14), the US (9), Denmark (6), Ireland (5), and France (5). No funder mandates could be found for Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, Greece, Latvia, Lithuania, Luxembourg, Malta, Poland, Romania, Slovakia, Slovenia, Liechtenstein, Turkey, or the Former Yugoslav Republic of Macedonia. All in all, the number of policies alone is a weak indicator of commitment to OA in a given country.

An analysis of 48 implemented funder policies in the countries was conducted, and startling inequalities were found in the level of detail provided. Funding agencies that are building a new OA policy or renewing a pre-existing policy should consider a number of key points for transparency. These include the following:

- Coverage of article processing charges (APCs): 46% of funders indicated that they would cover the APCs, and 12% indicated that they would not. The remaining 42% of policies did not specify whether they would pay the fees.
- Preference for Green or Gold OA: One of the funder policies favoured Gold OA, 40% favoured Green, 2% mandated both Green OA and Gold OA, and 58% expressed no preference. If Green OA is allowed, specific repositories may be identified.
- Acceptable types of documents and metadata: 79% of policies specified that articles should be deposited in their final accepted version or post-print.
- Project scope: Guidelines must clarify at what point the policy applies with respect to a certain percentage of funding provided or the number of authors who are grantees.
- Embargoes: If the policy supports Green OA, embargoes may be accepted to give publishers exclusivity for a limited time. Among the 48 funder policies reviewed, 77% accepted embargoes between 6 and 12 months.
- Compliance with policy is seldom tracked or reported.
- Other items that may be listed in the policy include the prescribed timing of deposits, exceptions in types of outputs, the transfer of rights, and sanctions.

Research Institutions' OA Strategies

Brazil, Canada, Japan, the US and ERA countries collectively have 293 institutional, multi-institutional, sub-institutional, and thesis OA mandates presently in place. Brazil, Canada, Japan, the US, and the ERA countries collectively have 70 proposed institutional, multi-institutional, and sub-institutional OA mandates and non-mandates. The largest number of mandates is in the US, followed by the UK, Italy, Finland, and Portugal.

Some universities have set aside earmarked funds for the purpose of OA provision, and publishers may accept author requests to waive these fees. Many publishers some form of publication charge discount to authors from institutions that subscribe to a relevant Hybrid OA journal. Other journals offer discounts to society members or institutions that have purchased institutional memberships. Universities are also pioneering software and application development for OA repositories.

A survey of head librarians at universities and higher-learning institutions was conducted for this study. The survey found that 73% of respondents agreed or strongly agreed with the statement 'Providing open access to scholarly publications is a priority in [their] organisation'. A similar proportion agreed or strongly agreed with the statement 'Providing open access to scholarly publications is a priority in [their] country'. However, only 42% of these respondents stated that their organisation has an open access policy regarding peer-reviewed scholarly publications. Among these respondents, 22% declared that their organisation's policy is not publicly available.

Within the ERA, Brazil, Canada, Japan, and the US, nearly 40 million records are spread across 1,450 institutional repositories as of April 2014 in *Open*DOAR alone. Institutional repositories account for 28% of records in OA repositories (disciplinary repositories account for 38%, governmental repositories for 25%, and aggregating repositories for 9%) (as of April 2013). Importantly, these records are highly heterogeneous. OA institutional repositories contain digital images, music, and text. Only a portion of the text files is made up of peer-reviewed scholarly papers. Hence, the presence of records in repositories is not a robust proxy for the availability of scientific papers, and will not be so until repositories are characterised with all due care.

Repository development and implementation faces numerous challenges related to intellectual property rights, data curation, long-term preservation, infrastructure development and interoperability. Universities also struggle with promoting OA within the academic community. Incentives are essential for reaching researchers who are reticent about OA or are deterred by the trade-off between the costs and benefits of making their work OA. Survey results suggest that direct advantages for researchers who make their work available in OA form remain rare at the level of institutions. Of survey respondents, 49% indicated that researchers in their organisation were encouraged to archive their scholarly work but without any formal reward, and 36% indicated that their institution had no policy in this regard. Meanwhile, only 15% of respondents indicated that self-archiving was mandatory, and 14% indicated that financial support was available for researchers who published in OA journals.

Effects on, and Responses of, Publishers of Scientific Journals

In response to the changing landscape of scholarly communication, publishers developed new products known as 'big deals'. Contracts are established between libraries and publishers whereby libraries secure access to a large set of journals distributed by the publisher, mostly in electronic format, for all faculty and students at the subscribing university, for a set price and for a period of three to five years. Mergers and acquisitions in the scholarly communication sector have increased the concentration of journals in the hands of a limited number of publishers. As a result, librarians have little power to opt out of big deals or negotiate the terms of subscriptions contracts. As the price of serials has continued to rise faster than inflation, library budgets have increased moderately, stagnated or even decreased, a situation referred to as the 'serials crisis'.

Although it is commonly assumed that there are many vested interests to preserve the status quo of the current subscription market, many publishers have recognised that OA can lead to wider dissemination, maximised market reach, greater visibility and higher journal citation impact factors for their articles. However, OA journals have been challenged with adopting a funding model that is consistent with their survival. Several models for OA publishing that differ with respect to type of content access, retention of author's rights and type of financing have emerged. These models include OA journals that are free for authors and readers; OA journals that are free for authors and readers of the online version, with subscription payment for the paper version; 'author pays' OA journals; hybrid systems; journals with free access to certain content; and journals with free access to contents after a period of embargo.

In recent years, many traditional commercial publishers—including the Nature Publishing Group, Springer, and Elsevier—have established sizable OA journal operations or have extended their Hybrid OA operations. Successful 'Mega-OA' journals have also been established, most notably PLoS ONE (Public Library of Science) and Scientific Reports (Nature Publishing Group), and these have had a positive impact on the credibility of OA peer-reviewed publications.

Journal publishers are also increasingly allowing article archiving. As compiled in SHERPA/RoMEO, from January 2004 to April 2014, the number of publishers' OA policies that allow some form of archiving grew steadily, from 80 to close to 1,700. Of these, 31% allow post-print archiving, 33% allow pre-print and post-print archiving, and 9% allow pre-print archiving only. The remaining 27% of publishers do not formally allow any form of archiving but may agree to special arrangements with authors, particularly in the context of a funder mandate.

Facilitating Factors and Barriers

It has been suggested that OA improves the speed, efficiency and efficacy of research by allowing researchers faster access to the information they need. It increases the visibility and usage of research, with studies reporting an additional increase in usage of around 7–8%; authors thereby gain a larger potential audience than any subscriber-restricted journal can give them. It may also result in greater research impact due to increased citations. The model may help to relieve the 'serials crisis' and save the direct costs of print publication and dissemination. For authors, it can shorten the delay between acceptance and publication in a journal.

The main bottlenecks that have prevented OA from gaining greater acceptance among stakeholders include a lack of awareness among researchers, concerns about the quality and prestige of OA journals, concerns and confusion regarding copyright, the dissuasive influence of author-side fees, difficulties moving beyond the current system of subscription-based journals, the lack of useful data on OA's evolution, a perceived lack of profitability surrounding OA business models, and a lack of infrastructure to support OA in developing countries.

Despite these barriers, this investigation concludes that OA has become the dominant form of dissemination of peer-reviewed scholarly articles in the ERA, Brazil, Canada, Japan, and US.

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1 Introduction

Borne on the back of the digital revolution, the movement towards open access (OA) to scholarly publications is transforming the global research communication and dissemination system. Since the pioneering years of OA in the early nineties, OA literature has come to occupy an increasing share of scholarly research across geographical regions and scientific disciplines.

The ineffectual situation whereby publicly-funded research results published in peer-reviewed journals continue to sit behind a 'pay wall', a situation made worse by consistent increases in the price of scholarly journal subscriptions, has fuelled the popularity of OA. In response to what many perceive to be a dysfunctional system, individual researchers, libraries, universities, research funders, and governments have become incentivised to join the campaign for OA. Often characterised as a disruptive movement, OA continues to transform everything from publication processes to business models.

The two main routes to OA—'Green' (via OA self-archiving in repositories) and 'Gold' (via OA journals and article processing charges)—were originally envisioned as complementary strategies that would interact and gradually form a coherent OA scholarly communication system. However, in practice, repositories and journals have appeared to progress on parallel tracks. This has created tension among the different players, with fracture lines most apparent between academia and publishers. While it may be a long time before a balance is struck among the various competing modes of scholarly publishing and communication, the interests of the different parties are not necessarily mutually exclusive (for example, journals and repositories can and increasingly do work effectively together), and all groups have shown some willingness to innovate.

This report, updated as of April 2014, presents an analysis of OA strategies in the European Research Area (ERA),[1] Brazil, Canada, Japan and the US from 2000 onwards. It examines policy strategies that aim to foster OA, as well as how these policies are monitored and enforced. The analysis is supported by findings from the literature on the global progression of OA since 2000—particularly its growth as a segment of scholarly publishing—as well as some of the broader trends, themes and debates that have emerged from the movement.

The report is organised as follows. Section 2 on national OA strategies first outlines existing strategies involving national and regional legislation on OA (Section 2.1), followed by an analysis of funding bodies' policies and mandates, including OA rules for grant recipients (Section 2.2). Section 3 discusses research institutions' strategies (in practice, this relates mostly to universities). Section 4 examines the effects of these policies, including the uptake of OA by country (shares of Green OA, papers in Gold OA journals, Other OA and Total OA) (Section 4.1), institutional response (e.g., the presence of repositories) (Section 4.2) and effects on publishers of scientific journals, including 'big deals' (Section 4.3). Finally, Section 5 discusses the strengths and weaknesses (including barriers to acceptance) of OA and existing OA strategies.

[1] The ERA countries covered in this particular report are those in the initial invitation to tender for this work: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, The former Yugoslav Republic of Macedonia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Turkey, UK.

2 National open access strategies

2.1 National and regional legislation and policies

In the last decade, governments have demonstrated their growing awareness of the benefits of OA and have taken concrete steps to support greater access to the published results of research, particularly research funded by taxpayer dollars. Indeed, the potential impacts of implementing OA strategies are great—OA accelerates and broadens opportunities for the adoption and commercialisation of research findings, leading to increased returns on public investment in research and development (R&D) and on private investment. This, in turn, may lead to greater productivity in certain sectors of the economy and the potential for the emergence of new industries based upon OA content (e.g., new industries that are built on publicly accessible data). OA may also have positive impacts on policy development through better informed debate and enhanced access to the information underpinning policy decisions (Houghton & Sheehan, 2009).

2.1.1 Enacted open access legislation

A number of countries have shown unequivocal support of OA, both in principle and in practice, by creating legislation mandating OA to scientific publications. At the time of writing (April 2014), legislation directly addressing OA has been implemented in the US, Spain, and Germany. Italy and Lithuania have also recently passed laws that have direct implications for OA in those countries. Additionally, a number of countries outside of those included in this study—namely Argentina and Peru—have enacted legislation requiring that government-funded research results be available in OA digital repositories.

United States: The Consolidated Appropriations Act, 2008 (H.R.2764), is the legislative basis for the OA policy of the National Institutes of Health (NIH). With this legislation, the US became the first country to adopt a national OA mandate. The groundbreaking policy states that all NIH-funded researchers must submit an electronic version of their final, peer-reviewed manuscripts to the National Library of Medicine's PubMed Central no later than 12 months after the official date of publication. Although the Act applied only to NIH-funded research, the Institutes' annual budget of more than US$30 billion accounts for a substantial number of papers published annually (NIH, 2013).

Proposed in 2006, 2010, and again in 2012, the Federal Research Public Access Act (FRPAA) would have required that the 11 federal agencies with research expenditures over US$100 million create online repositories of journal articles of their research and make them publicly available. However, FRPAA was never voted on and instead was succeeded by the Fair Access to Science and Technology Research Act (FASTR), which was introduced in Congress and in the House in February 2013. If passed, it will require all federal agencies with extramural research expenditures of over US$100 million to develop a 'specified federal research public access policy that is consistent with, and that advances, the purposes of the agency.' It will also make 'each federal research public access policy applicable to: (1) researchers employed by the federal agency whose works remain in the public domain and (2) researchers funded by the agency,' with some exclusions, and will require each federal agency to submit annual reports on its federal research public access policy. At the time of writing, FASTR has not been passed but has been referred to the Senate Committee on Homeland Security and Governmental Affairs (S.350) and to the House Committee on Oversight and Government Reform (H.R.708).

Also in February 2013, the White House's Office of Science and Technology Policy (OSTP) issued a policy memorandum directing all federal agencies with R&D expenditures of over US$100 million

to develop plans to 'ensure that the public can read, download, and analyse in digital form final peer-reviewed manuscripts or final published documents within a timeframe that is appropriate for each type of research conducted or sponsored by the agency.' The OSTP Directive was issued in response to a *We the People* petition asking for expanded public access to the results of taxpayer-funded research. It was also based on the results of extensive conversations with stakeholder groups and feedback from an Open Access Interagency Working Group.[2] While similar to FASTR, the OSTP Directive was criticised by OA advocates for allowing too many restrictions and exceptions. However, its potential impact was considered significant, as it would involve 24 federal agencies. At the time of writing, no agency plans have been issued from the OSTP or the Office of Management and Budget (OMB) in relation to the Directive, nor have any draft plans from federal agencies and departments been publically released.[3]

In September 2013, new public access legislation was introduced in the US House of Representatives—the Public Access to Public Science Act (PAPS)—which intends to build on the OSTP Directive on Public Access. It covers four agencies: the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), and the National Weather Service (NWS). However, the Act was criticised for not being as strong a piece of legislation as FASTR.[4] At the time of writing, it has not been introduced in the Senate.

On January 17, 2014, a federal omnibus spending bill, similar in concept to the OSTP Directive, was signed into law by President Obama that includes an OA mandate. Section 527 of the Consolidated Appropriations Act, 2014 (H.R.3547) states that agencies that have research budgets of US$100 million or more operating under the portion of the bill covering Labor, Health and Human Services, and Education are required to provide online access to peer-reviewed articles that report on federally funded research within 12 months of publication.

Legislation is also being enacted at the state level. For example, in May 2013, the Illinois House passed Senate Bill 1900 (Open Access to Research Articles Act), which would require each public university to develop an OA to research articles policy that would mandate all faculty to submit electronic versions of their final manuscripts upon acceptance by a scholarly research journal.[5] Other policies currently in play are the New York State Taxpayer Access to Publicly Funded Research Act (A 180/S 4050) and the California Taxpayer Access to Publicly Funded Research Act (AB 609).

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[2] Joseph, H. (2014, February 22). *The White House Directive: One year in, time for further action* [article]. http://www.sparc.arl.org/blog/white-house-directive-one-year-time-further-action.

[3] Ibid.

[4] Wesolek, A. (2013, September). *New public access legislation* [article]. http://oanow.org/2013/09/new-public-access-legislation/.

[5] Illinois General Assembly. (2013). *Bill status of SB1900* [article]. http://www.ilga.gov/legislation/BillStatus.asp?DocNum=1900&GAID=12&DocTypeID=SB&SessionID=85&GA=98.

Spain: In 2011, Spain passed the national Law on Science, Technology and Innovation (2011) (*Ley de la Ciencia*), which had been introduced as a draft law in 2009. Under Article 37, titled 'Open Access Dissemination', the law mandates that a digital version of the final copy of research accepted for publication and funded under the national public R&D funding scheme be deposited within 12 months of publication in an OA repository. Also in Spain, two autonomous regional governments—the Autonomous Community of Madrid (2008) and the Principality of Asturias (2009)—have established OA mandates promoting the population of open repositories with peer-reviewed scientific articles (European Commission, 2011a).

Germany: A new German law (BGB1. I S. 3714), modifying Section 38 of the German Copyright Act, was enacted on October 1, 2013. The copyright reform directly targets OA to scientific publications; more specifically, it is meant to hold up a 'second publication right' for authors, allowing them to make any of their articles stemming from publicly funded research openly accessible and available for non-commercial purposes without the consent of the publishers 12 months after the first publication.[6]

Italy: OA legislation at the national level has existed in Italy for theses, but not for scientific publications until recently.[7] In October 2013, the Italian Parliament approved a new law (Law of 7 October 2013, no 112) that includes a regulation for OA to scientific publications. Researchers whose research has been publicly funded (at least 50%) are required to either publish their work in an OA journal or deposit their work in OA archives no later than 18 months from first publication for scientific, technical and medical disciplines or 24 months for the humanities and social sciences.[8]

Lithuania: National legislation took effect on May 12, 2009, mandating that the results of scientific activity be made publicly available. Article 45 of the 2009 Law on Science and Studies of the Republic of Lithuania[9] states that all results of the scientific activity carried out in the state science and study institutions as well as at non-governmental institutions of science using state funds 'must be made public (via the internet and other means) if this is in agreement with laws regulating intellectual property and protection of the commercial, state or work related secrets.'[10] As Suber[11] pointed out, the law only requires that publicly-funded research be made available online, not that it be made *free* online (though in most cases it is presumed to be free). However, most agree that it is a welcome step towards OA in the country, one that is progressively being implemented.

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[6] Buch Report. (2013, June). *Green light for green way* [article]. http://www.buchreport.de/nachrichten/verlage/verlage_nachricht/datum/2013/06/28/gruenes-licht-fuer-gruenen-weg.htm?utm_source=twitterfeed&utm_medium=twitter.

[7] Ibid.

[8] Moscon, V. (2013). *Italy: Open access in Italy* [article]. http://merlin.obs.coe.int/iris/2014/1/article32.en.html.

[9] Republic of Lithuania. (2009, April). *Republic of Lithuania Law on Higher Education and Research* [Web document]. http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=366717.

[10] Suber, P. (2009, June). *Mandatory online access for publicly-funded research in Lithuania* [article]. http://legacy.earlham.edu/~peters/fos/2009/06/mandatory-online-access-for-publicly.html.

[11] Ibid.

2.1.2 Proposed open access legislation

OA legislation has been proposed in Brazil, Poland, and Denmark.

Brazil: Introduced in May 2007, a bill (PL 1120/2007) proposed that all public institutions of higher education and research units be required to establish institutional repositories, where all technical and scientific research outputs would be deposited and made freely available online.[12] The bill was amended and approved by the Committee on Science and Technology, Communication and Computing in 2008; by the Committee on Education and Culture in 2009; and by the Committee on Constitution, Justice, and Citizenship in 2010. However, in January 2012, the bill was archived. No evidence could be found of legislation stemming from the bill.

Poland: The government of Poland (specifically, the Chancellery of the Prime Minister and the Ministry of Science and Higher Education) has been working on legislation to make the results of publicly funded research OA. A campaign was launched in support of a national OA mandate (Schmidt & Kuchma, 2012). In January of 2013, the Polish Ministry of Administration and Digitisation published Draft Guidelines for the Proposal of the Act on Open Public Resources.[13] The aim of the draft bill is to ensure that as much material as possible, particularly that resulting from public subsidies, is made openly accessible on the internet. The law would apply to all publicly-funded scientific, educational and cultural resources.

Denmark: In March 2011, Denmark's Open Access Committee issued a series of OA policy recommendations (Danish Agency for Libraries and Media, 2011). The paper includes 16 recommendations in total, the first being that 'a national Open Access policy be phrased on the basis of Green Open Access with continual quality assurance by the scientific journals' and that 'that there should be Open Access to the results of publicly funded research to as great an extent as possible.' A series of meetings have since been launched with stakeholders in order to develop a Danish OA strategy.

2.1.3 Notable open access policies and initiatives

The majority of national governments examined for this report currently address OA (if they address it at all) through less formal instruments, such as guidelines for their research funding agencies. In the absence of specific legislation on OA, relevant laws include copyright and licensing laws. With the exception of Cyprus, all countries covered in this study have copyright legislation that may apply to peer-reviewed publications but that does not directly address OA. While the following countries have not proposed or enacted legislation, many are seeing swift progress towards OA.

United Kingdom: The UK is a leader in the development of OA to peer-reviewed publications. The UK Government stated its commitment to OA in its Innovation & Research Strategy for Growth in December 2011 (BIS UK, 2014). Major stakeholders in the allocation of public research funds have pushed for greater public access to publicly supported research, such as the Higher Education Funding Council for England (HEFCE). In July 2013, the HEFCE, on behalf of all four UK higher

[12] Brazil House of Representatives. (2007). *PL 1120/2007, Projeto de Lei* [Web document]. http://www.camara.gov.br/proposicoesWeb/fichadetramitacao?idProposicao=352237.

[13] Polish Ministry of Administration and Digitization. (2012, December). *Draft guidelines for the proposal of the act on open public resources* [Web document]. http://mac.bip.gov.pl/prawo-i-prace-legislacyjne/projekt-zalozen-projektu-ustawy-o-otwartych-zasobach-publicznych.html.

education funding bodies, issued a consultation on OA in the next Research Excellence Framework (REF). The HEFCE is currently exploring how to make OA a requirement so that research outputs submitted to any research assessment exercise after 2014 are as widely accessible as possible.[14] The development of OA in the UK has greatly benefited from the work of Jisc. The organisation receives its funding from higher education and further education funding bodies. In turn, it provides initiatives, strategy, and support in the development of information and communication technologies in research and education (Jisc, 2009). Jisc has funded major OA projects that encompass content, infrastructure, management and training, including SHERPA, ROAR, *Open*DOAR, the Repository Support Project, the Open Repository Junction and ePrints UK (Jisc, 2013). The involvement of these stakeholders in the development of OA is likely to have contributed to the government's proactive stance on OA.

The Working Group on Expanding Access to Published Research Findings, chaired by Dame Janet Finch, was formed in 2011 with the goal of proposing a programme of action to broaden access to research findings and outcomes (Research Information Network, 2011). The Working Group, supported by the Department of Business, Innovation and Skills (BIS), the Publishers Association, Research Councils UK (RCUK), and the HEFCE, presented its findings and recommendations in June 2012; most of these were formally accepted by David Willetts, minister for Universities and Science, in July 2012 (BIS, 2012). Notably, the Working Group strongly advocated Gold OA based on APCs (though Green OA was also allowed, with embargos).

While the report was controversial, the UK government accepted the report's recommendations, resulting in rapid institutional uptake. In July 2012, the UK government announced that it will make publicly funded scientific research available for anyone to read for free.[15] Later that year, the RCUK announced that it would modify its policy to require Gold OA, and Mark Thorley[16] stated that the Councils would provide block grants to universities for paying APCs, which they will 'manage through the establishment of publication funds, and universities will decide how to spend the money to best deliver the RCUK policy' (Suber, 2012). In other words, universities are eventually expected to establish and manage their own publication funds.

The announcement was met with much criticism. The House of Lords Science and Technology Select Committee launched a short inquiry into the implementation of the Government OA policy, with a report issued in February 2013 describing concerns from the academic and publishing communities.[17] In March 2013, the policy was revised, and the RCUK adopted a softer stance on Gold versus Green OA (House of Lords, 2013; RCUK, 2013). The Policy on Open Access, which came into force on April 1, 2013, expresses the Councils' preference for immediate OA with the

[14] HEFCE. (2014). *Open access and research assessment* [Web document]. https://www.hefce.ac.uk/whatwedo/rsrch/rinfrastruct/oa/.

[15] House of Commons Business, Innovation and Skills Committee (BIS). (2012, July 16). *Government to open up publicly funded research* [article]. https://www.gov.uk/government/news/government-to-open-up-publicly-funded-research.

[16] Head of Science Information and Data Management Coordinator for the UK's Natural Environment Research Council (NERC) and Chair of the RCUK Research Outputs Network.

[17] UK Parliament. (2013). *Government response to the House of Lords Science and Technology Committee Report: 'Implementation of open access'* [Web document]. http://www.parliament.uk/business/committees/committees-a-z/lords-select/science-and-technology-committee/inquiries/parliament-2010/open-access/.

maximum opportunity for reuse. It will make all UK government-funded research OA within 5 years, with a target of 45% in the first year.

In September 2013, a report from the BIS Committee was released (BIS, 2013). The report asked that the UK government and the RCUK reconsider their preference for Gold OA, stating that while the Gold OA model is 'a desirable ultimate goal, focusing on it during the transition to a fully open access world is a mistake.' It also requested that due regard be given to the 'evidence of the vital role that Green Open Access and repositories have to play as the UK moves forward.' The report's sentiments echoed widespread concerns that the preference for Gold OA did not reflect policy being adopted in other nations and that the UK OA initiatives would lead to significant cost increases for the UK.[18]

The Finch Group published a review in October 2013 of the progress that had been made to date in implementing the recommendations of the Finch Report (Working Group on Expanding Access to Published Research Findings, 2013). The report stated that progress 'has been mixed, and has given rise to issues and problems that have not as yet been fully resolved.' The Finch Group reaffirmed its support for a mixed economy (both Gold and Green OA) and noted policy similarities across countries. Fourteen additional recommendations were made, including renewed emphasis on improved access within the UK to the global outputs of research through licence extensions and similar initiatives. In January 2014, the UK government published a response to the Finch Group's review on OA implementation, upholding its commitment to an OA policy with a 'strong preference for Gold OA and an acceptance of Green OA' (Willets, 2014).

In response to one of the key recommendations of the Finch Group, the new 'Access to Research' plan was announced in February 2014. As part of a two-year pilot, thousands of research journal articles are to be made available for free at libraries across the UK, but only on computers located physically within a public library (walk-in access).[19] The initiative will provide users with access to 8,400 journals published by many of the major academic publishers, including Elsevier, Wiley-Blackwell, Springer, Taylor and Francis and Nature Publishing Group.[20]

Ireland: Ireland's National Principles for Open Access Policy Statement was released on October 23, 2012 (Irish Universities Association, 2012). The outputs of all research fully or partially funded by the Irish government, including peer-reviewed publications, research data and other research artefacts, are to be deposited in OA repositories. Although embargoes and restrictions may apply, the full text is recommended to be released no later than the publication date and the metadata is to be released immediately after deposit. Publication in OA journals is encouraged but is neither mandatory nor a substitute for deposit in a suitable repository. Ireland's universities benefit from a pre-existing network of interoperable institutional repositories with a national portal established as a separate project from 2007 to 2010 (Rian, 2012).

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[18] Brienza, C. (2014, January 30). *Paying twice or paying thrice? Open access publishing in a global system of scholarly knowledge production and consumption* [article]. http://blogs.lse.ac.uk/impactofsocialsciences/2014/01/30/paying-twice-or-paying-thrice-brienza/.

[19] Clark, I. (2014, February 20). *U.K. libraries offer free article access to walk-ins* [article]. http://lj.libraryjournal.com/2014/02/oa/u-k-libraries-offer-free-article-access-to-walk-ins/.

[20] Jump, P. (2014, February 3). Publishers launch free journal access for libraries [Article]. *Times Higher Education*. http://www.timeshighereducation.co.uk/news/publishers-launch-free-journal-access-for-libraries/2010999.article.

Sweden: Sweden's national OA programme, OpenAccess.se, has been active since 2006. The programme is led by the National Library of Sweden, in partnership with the Association of Swedish Higher Education, the Swedish Research Council, the Royal Swedish Academy of the Sciences, the Swedish Knowledge Foundation and the Riksbankens Jubileumsfond. The programme had a role in the creation of a national search portal for scholarly publications (SwePub), the Directory of Open Access Journals (DOAJ), and a number of institutional and funder policies. The programme's steering committee called on the Ministry of Education to develop a national OA policy in 2011. In the Swedish Research and Innovation Bill for 2013–2016, the government commissioned the Swedish Research Council to develop national OA guidelines. The first version of the guidelines is expected to be in place by the end of 2014 (Kronman, 2012).

France: In France, the Centre national de la recherche scientifique (CNRS) launched the HAL open archive in 2001, a multi-disciplinary archive of research papers and theses primarily directed at French academics but open to submissions from other countries or sectors. In 2006, the CNRS, along with five other governmental research centres, the Conférence des présidents d'universités, the Institut Pasteur, and the Conférence des grandes écoles agreed to coordinate a national strategy for OA archiving of scientific production using HAL.[21] HAL's features that facilitate deposits include interconnectivity with Arxiv and PubMed Central. In contrast to this strong OA infrastructure, no OA mandate emanating from national research funding organisations exists in France, with the exception of the social sciences and humanities branch of the Agence nationale de la recherche; thus, compliance with existing policies is still voluntary.

Croatia: Croatia does not currently have a national OA mandate. However, the Ministry of Science Education and Sports supports Hrcak, the portal of scientific journals of Croatia. Hrcak is a gateway to 327 OA journals and over 90,000 full text articles (Hebrang Grgic, 2011).

Estonia: Estonia currently has no specific OA mandate or infrastructure at the national level, but the country is quite advanced in terms of electronic governance. The country's government has invested heavily in IT infrastructure and training since the mid-1990s. It introduced e-cabinet meetings, digital contract signature, and e-tax filing in 2000, followed by electronic ID cards in 2002, and internet voting with binding results in 2005.[22] These measures have been largely adopted by Estonians, who used online banking in a proportion of 87% in 2012 (EU average: 54%) and voted online in a proportion of 24% of participating voters in the 2011 election (Estonian National Electoral Committee, 2013; Narusk, 2013). Computer and internet literacy may contribute to the development of an OA culture among researchers in the absence of a national mandate.

Europe: In August 2008, the European Commission (EC) launched the Open Access Pilot under its Seventh Framework Programme (FP7), mandating all new projects in seven FP7 areas to deposit peer-reviewed research articles or final manuscripts resulting from their projects into an online repository and make them OA (European Commission, 2012b). In July 2012, the EC issued a Communication and a Recommendation to member states proposing to define clear policies to make all publicly funded research conducted within the EU available in OA form within Horizon 2020 (European Commission, 2012a, 2012b). In a recent speech, the EC's Vice-President responsible for the Digital Agenda, Neelie Kroes, declared that the EC will 'require open access to

[21] CNRS. (2008). Protocole d'accord en vue d'une approche coordonnée, au niveau national, pour l'archivage ouvert de la production scientifique [Web document]. http://openaccess.inist.fr/?PROTOCOLE-D-ACCORD-en-vue-d-une.

[22] Estonia.eu. (2013). *Economy & IT* [Web document]. estonia.eu/about-estonia/economy-a-it/e-estonia.html.

all publications stemming from EU-funded research' (Kroes, 2013). The speech focused on the launch of the Research Data Alliance, and no further details were given concerning an OA mandate. On December 11, 2013, the Commission published Version 1 of the *Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020.* The guidelines 'provide context and explanation for the rules on open access applicable to beneficiaries in projects funded or co-funded under Horizon 2020.'[23]

The Digital Repository Infrastructure Vision for European Research (DRIVER) was established to build a cohesive pan-European network of repositories for research and education (European Commission, 2007). Now in its second phase, DRIVER is a unique network in terms of scope and interoperability within the group of countries covered in this study. The Open Access Infrastructure for Research in Europe (OpenAIRE) is a complementary project offering organisational and technological infrastructure for the identification, deposition, access and monitoring of FP7 and European Research Council (ERC) funded publications (Manghi et al., 2010). OpenAIRE adds value to the pre-existing DRIVER network in several ways: it provides support for researchers that deposit into compliant repositories in all member states; it enables researchers who do not have access to compliant repositories to deposit their work into the OpenAIRE Orphan Record Repository; it adds a layer of user-level services to the repository infrastructure; and, perhaps most importantly, it introduced a set of three fields to enhance an item's Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH metadata), specifying the item's relation to an FP7/ERC project ID, the type of access allowed for the item, and the end date of the embargo period where applicable (OpenAIRE, 2012). Together, the infrastructure and services developed through DRIVER and OpenAIRE form a model that could facilitate the uptake and development of OA on a large scale.

Launched in February 2014, a new 30-month project titled PASTEUR4OA (Open Access Policy Alignment Strategies for European Union Research) aims to help Member States to develop and/or reinforce OA strategies and policies at the national level and facilitate coordination among the Member States. More specifically, it will attempt to address known shortcomings and barriers to OA policy development in Europe by developing a programme of network-building activities, creating expertise in Member States, engaging policymakers, and providing evidence-based advocacy to policymakers and the research community.[24] The project builds on the existing Mediterranean Open Access Network (MedOANet) project and leverages the networks of organisations such as EOS (Enabling Open Scholarship), Jisc, SparcEUROPE, LIBER (Association of European Research Libraries), and EIFL.

2.2 Public funding bodies' open access policies and incentives

As most research is funded through taxpayers, research funding bodies seek maximum impact from the research they support, which can best be achieved by ensuring the widespread accessibility of publications arising from that research. Many research funders have implemented policies mandating the deposit of their funded research outputs in open online archives so that it is made freely available on the internet. Indeed, research shows that by mandating OA archiving,

[23] European Commission. (2013). *Guidelines on open access to scientific publications and research data in Horizon 2020.* http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-pilot-guide_en.pdf.

[24] http://www.pasteur4oa.eu/.

research funders could set in motion a significant 'ripple effect'. An American study by Houghton, Rasmussen and Sheehan (2010) estimated that the potential incremental benefits of an OA archiving mandate for all US FRPAA agencies' funded R&D would be worth around US$1.6 billion, with $1 billion of these benefits accruing within the US and the remainder spilling over to other countries. Additionally, the study projected that openly archiving all FRPAA agencies' funded R&D article outputs would result in US national benefits equalling around eight times the cost.

A prominent example of a funder's mandate is that of the Wellcome Trust. This UK-based charitable foundation established its policy—the first of its kind in the world—in October 2006. The policy requires electronic copies of any Wellcome Trust-funded research papers that have been accepted for publication in a peer-reviewed journal to be made available through PubMed Central (PMC) and Europe PubMed Central (Europe PMC) as soon as possible within six months of the journal publisher's official date of final publication.[25] In May 2013, the Trust announced that it would expand its OA policy to include scholarly monographs and book chapters, effective for holders of grants awarded after October 1, 2013, and existing grant holders from October 2014.[26]

Another well-cited example is the US-based NIH, whose policy requires grant recipients to make articles resulting from their grant funding freely available within 12 months of publication in a peer-reviewed journal. The NIH has long been a model for funding agencies in other countries, such as the Canadian Institutes of Health Research (CIHR), which has had a mandate in place since January 2013. Canada's two major federal funding agencies, the Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC) have also proposed a mandatory OA policy for peer-reviewed journal articles. The 'tri-council' policy would make journal articles freely available within a year of publication.[27]

Across Europe, funding bodies have implemented policies requiring their funded researchers to deposit results of research into an appropriate repository or publish in an OA journal. A survey of the European Heads of Research Councils (EUROHORCs) member organisations in December 2007 revealed that two-thirds of these organisations signed the Berlin Declaration on OA and introduced a special OA policy, though existing OA regulations were highly variable. In April 2008, the General Assembly of EUROHORCs agreed to recommend a minimal standard regarding OA to its member organisations (EUROHORCs, 2008).

In April 2013, Science Europe, the successor to EUROHORCs, put out a position statement on the *Principles for the Transition to Open Access to Research Publications* outlining a set of common principles that had been agreed upon by Member Organisations. These included the recommendation that 'research publications should either be published in an Open Access journal or be deposited as soon as possible in a repository, and made available in Open Access in all cases

[25] Wellcome Trust. (2012). *Open access policy* [Web document]. http://www.wellcome.ac.uk/About-us/Policy/Policy-and-position-statements/WTD002766.htm.

[26] Wellcome Trust. (2013, May). *Wellcome Trust extends open access policy to include scholarly monographs and book chapters* [article]. http://www.wellcome.ac.uk/News/Media-office/Press-releases/2013/WTP052746.htm.

[27] NSERC. (2014, January). *Open access: Consultation on the draft Tri-Agency Open Access Policy*. http://www.nserc-crsng.gc.ca/NSERC-CRSNG/policies-politiques/OpenAccess-LibreAcces_eng.asp.

no later than six months following first publication. In Arts, Humanities and Social Sciences, the delay may need to be longer than six months but must be no more than 12 months.'[28]

International research funding and performing organisations are also playing a major role in the spread of OA by implementing their own policies.

- The World Bank's OA policy, effective since July 1, 2012, was built on its existing policy. Since 2010, much of the World Bank's research has been made available to the public through its website, with the Open Data Initiative and Access to Information Policy. The new policy goes further by adopting the Creative Commons Attribution (CC-BY) copyright licence for all of its research outputs and other knowledge products, including works produced prior to the policy, which will be added progressively to the database.[29] CC-BY is the most open license offered by Creative Commons and allows distribution, reuse, and adaptation of the copyrighted material, even for commercial purposes.[30] Its 4.0 licenses were released in November 2013, the 'most global, legally robust licenses produced by CC to date.'[31] The research outputs and knowledge products will be hosted on the World Bank's Open Knowledge Repository, which is compliant with the Dublin Core Metadata Initiative standards and OAI-PMH.[32] This policy goes further than mere public access and makes the World Bank a forerunner in OA, as defined by the Berlin, Budapest and Bethesda declarations.[33]
- The United Nations Organization for Education, Science and Culture (UNESCO) announced in April 2013, following a decision by its Executive Board, that it would make its digital publications available free of charge with an open license. With this, UNESCO became the first member of the United Nations to adopt such an OA policy for its publications.[34] In

[28] Science Europe. (2013). *Science Europe position statement: Principles for the transition to open access to research publications*.
http://www.scienceeurope.org/uploads/PublicDocumentsAndSpeeches/SE_OA_Pos_Statement.pdf.

[29] World Bank. (2012). *World Bank Announces Open Access Policy for Research and Knowledge, Launches Open Knowledge Repository* [press release].
http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:23164491~pagePK:64257043~piPK:437376~theSitePK:4607,00.html.

[30] Creative Commons Corporation. (nd). *Attribution 3.0 Unported* [Web document].
http://creativecommons.org/licenses/by/3.0/legalcode.

[31] Creative Commons Corporation. (2013, November). *CC's Next Generation Licenses—Welcome Version 4.0!* [article] http://creativecommons.org/weblog/entry/40768.

[32] World Bank. (2013). *About the World Bank Open Knowledge Repository*.
https://openknowledge.worldbank.org/about.

[33] Highly regarded and well-established definitions of OA are those provided by the three Bs: the Budapest Open Access Initiative (BOAI, 2002), the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003) and the Bethesda Statement on Open Access Publishing (2003). The Berlin Declaration and Bethesda Statement build on the definition developed in Budapest, which remains authoritative. BOAI defines Open Access as 'free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited.'
(http://www.budapestopenaccessinitiative.org/read).

[34] UNESCO. (2013, May 14). *UNESCO to make its publications available free of charge as part of a new Open Access policy* [article]. http://www.unesco.org/new/en/media-services/single-

December 2013, UNESCO introduced its new Open Access Repository, containing over 300 digital reports, books and articles available under the Creative Commons IGO licenses.[35]

- The European Research Council (ERC) implemented its new OA policy on July 13, 2012. All papers resulting from ERC grants from 2014 must be OA within six months of publication. Furthermore, the organisation 'strongly encourages the use of discipline-specific repositories,' such as arXiv and Europe PubMed Central.[36]
- The World Health Organization (WHO) announced in January 2014 that a new OA policy would soon be announced and come into force in July 2014. WHO-published research has always been freely available through the WHO website, but the new policy will apply to all WHO-authored or WHO-funded research published in non-WHO publications (journals and books). Additionally, it was announced in January 2014 that more information products would become available on the Institutional Repository for Information Sharing (IRIS), the multilingual digital library of WHO created in 2012. This would include scientific and technical reports, governing bodies' documents, and many other publications that were previously inaccessible.[37]

2.2.1 Analysis of funders' open access policies across countries

The SHERPA-maintained JULIET, a database of research funders' OA policies related to self-archiving, OA publishing and data archiving, outlines the policy conditions and stipulations for about 132 funders (at the time of writing). Careful analysis of the data available in JULIET, as well as in BioMed Central (Funder Policies), ROARMAP and MELIBEA, has been conducted to assess the spread of OA policies across ERA countries and in Brazil, Canada, Japan, and the US. The results are shown in Figure 1. About 100 mandates can be found across the ERA, Brazil, Canada, Japan and the US.

The OA policies reviewed below encompass any publicly available official statement inciting researchers to make their research publicly available, regardless of reuse permissions, restrictions or embargoes. As copyright and licensing restrictions may apply, a number of the policies reviewed here do not meet the requirements of the Berlin, Budapest and Bethesda statements on OA. For example, the NIH's Public Access Policy ensures that the public has free access to the peer-reviewed and published results of all NIH-funded research through PubMed Central, where material is protected by copyright law under the principles of Fair Use (NIH, 2008). As such, '[t]he respective copyright holders retain rights for reproduction, redistribution and reuse.'[38]

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view/news/unesco_to_make_its_publications_available_free_of_charge_as_part_of_a_new_open_access_policy/#.UxJxvPk7ssA AND http://unesdoc.unesco.org/images/0022/002208/220872E.pdf.

[35] UNESCO. (2013, December 10). *UNESCO publications now freely available through a new Open Access Repository* [article]. http://www.unesco.org/new/en/media-services/single-view/news/unesco_makes_its_publications_available_free_of_charge_through_a_new_open_access_repository/#.UxN2Ofk7ssB.

[36] European Research Council. (2013, September 16). *European Research Council takes a further step forward towards open access by joining arXiv* [article]. http://blogs.nature.com/news/2013/09/european-research-council-funds-arxiv-a-taste-of-changes-to-come.html.

[37] World Health Organization (WHO). (2014, January). *WHO's vision for information sharing* [Web document]. http://www.who.int/about/who_reform/change_at_who/issue4/information-sharing/en/#.UxKQc_k7ssA.

[38] PubMed Central. (2012). *Copyright notice [Web document].* http://www.ncbi.nlm.nih.gov/pmc/about/copyright/.

For the following countries, no funder OA mandates appear in the databases used in this study: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, Greece, Latvia, Lithuania, Luxembourg, Malta, Poland, Romania, Slovakia, Slovenia, Liechtenstein, Turkey, or the Former Yugoslav Republic of Macedonia. Even though there is no official OA mandate or proposed policy in Israel, BioMed Central's list of policies states that the Israel Science Foundation's grant funds may be used to cover APCs.[39] However, no evidence of this could be found in other databases or on the Foundation's translated website.[40] It should be noted that BioMed Central's list is not as up to date and complete as ROARMAP. At the time of writing, it was not possible to confirm this information.

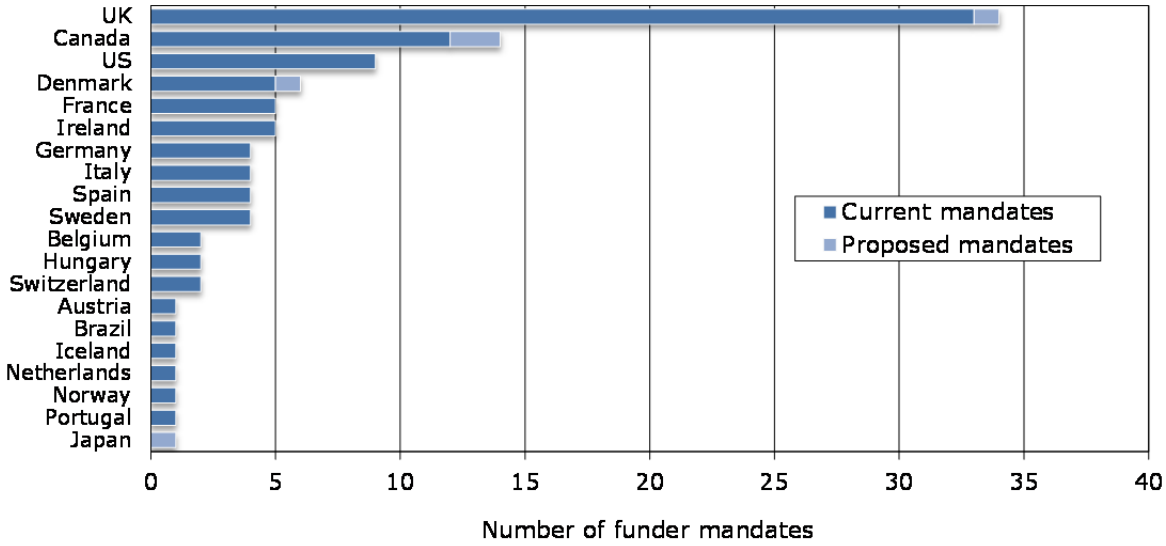

Figure 1 Currently implemented and proposed funder mandates within the ERA and in selected countries, April 2014

Source: Compiled by Science-Metrix using SHERPA/JULIET, BioMed Central (Funder Policies), ROARMAP and MELIBEA

Caution should be taken in interpreting the number of OA policies across countries. The number of policies alone is a weak indicator of commitment to OA in a given country. A number of factors must be considered in comparing policies, or sets of policies, relative to one another in terms of their impact on OA publication. A policy's scope, or its potential to directly influence a large number of researchers, is a crucial factor that can reasonably be determined by the size of the institution or the number of grants awarded by the funder. Currently implemented policies can be assumed to have more impact than proposed policies. Careful and methodical analysis of policies' text should also be conducted in order to assess critical characteristics, limitations and exceptions. Ultimately, the ratio of compliant papers over eligible papers published would substantiate the policy's efficiency. All of this information should be considered in the context of the country's population, research output and investment in research.

With the exception of policies' proposed or implemented status, the data necessary to conduct such an assessment at the scale of the ERA, Brazil, Canada, Japan, and the US are not readily available so that gathering such data would require a substantial investment. Still, a tentative analysis of the 48 funder policies currently implemented in the countries covered (registered as of

[39] http://www.biomedcentral.com/funding/funderpolicies.

[40] http://www.isf.org.il/english/default.asp.

December 2012) revealed startling inequalities in the level of detail provided, ranging from the Wellcome Trust, which offered seven guides and three reports on the subject, to the Fonds Wetenschappelijk Onderzoek–Vlaanderen (*FWO*), which offered one short paragraph. As a result, comparisons may be skewed by the missing data. For example, when trying to determine whether funders would pay APCs (as part of the grants or separately), Science-Metrix found that over 40% of policies made no mention of them. As for compliance, few organisations keep track of it, and fewer still make this information publicly available.

Suber (2009) has suggested that funding agencies that are building a new OA policy or renewing a pre-existing policy should consider a number of key elements, which should be addressed in the policy's text. To avoid confusion, the intended definition of OA should be clearly delineated in terms of access, reuse, and licensing. While the NIH still mandates public access subject to fair use restrictions, the Wellcome Trust requires the use of the CC-BY license whenever the Trust's funds are used to pay an OA fee. The definition of OA will have an impact on the ability of users to create derivative works, find commercial uses, or engage in text mining.

The decision to request or require OA is likely to have a major impact on compliance. When the NIH's Public Access policy was first implemented on a voluntary basis (May 2005 to March 2008), less than 800 articles per month were submitted (NIH, 2005; NIH, 2008). When the policy was revised and PubMed Central archiving became mandatory for all NIH-supported research, submissions rose sharply, reaching 5,000 articles per month (NIH Manuscript Submission System, 2013). Compliance levels are difficult to ascertain given that the overall number of articles published as a result of NIH-supported research for this period is unavailable. However, considering that the NIH's total budget has increased by less than 4% over the same period (amounts not indexed for inflation), it is reasonable to conclude that the sharp rise in articles submitted to PubMed Central is the result of increased compliance (Figure 2).

Funders may express a preference for Green or Gold OA (including Delayed OA), or they may leave that decision to the author. Except for the UK, none of the 48 funder policies reviewed favoured Gold OA, 40% favoured Green, 2% mandated both Green and Gold, and 58% expressed no preference (ROARMAP data).

If Green OA is allowed, a specific repository may be identified. For example, all research supported by the Wellcome Trust, the NIH, Arthritis Research UK, the British Heart Foundation, Cancer Research UK, the Chief Scientist Office of the Scottish Government Health and Social Care Directorate, the UK Department of Health, and Telethon Italy must be available through PubMed Central (PMC, UKPMC or Europe PMC). Central storage of publications in a specific repository facilitates compliance monitoring and the compilation of statistics.

As most repositories are not yet fully interoperable and searchable by machines (crawlers), large disciplinary repositories such as PMC and ArXiv appeal to authors because they attract more readers than small institutional repositories. As interoperability develops, this question is expected to become less relevant as readers find more publications through search engines, even those that are hosted on small repositories. Requesting deposit in institutional repositories also has its advantages: it allows institutions to showcase, share, measure, and analyse their research output. Suber (2009) also believes that it may spread the OA culture to researchers within the institution who were not supported by a funder requesting OA.

Although it may be practical to mandate deposit in a central or institutional repository, there is no need to mandate exclusivity in this respect. With consistent metadata, multiple deposit locations are acceptable. The most important characteristic of a repository is its compatibility with other repositories and search engines. Neglecting interoperability could lead to the isolation of the

repository's contents from readers and harvesters. At present, the Simple Web-service Offering Repository Deposit (SWORD) protocol is the most used standardised deposit interface for digital repositories (Lewis, de Castro, & Jones, 2012).

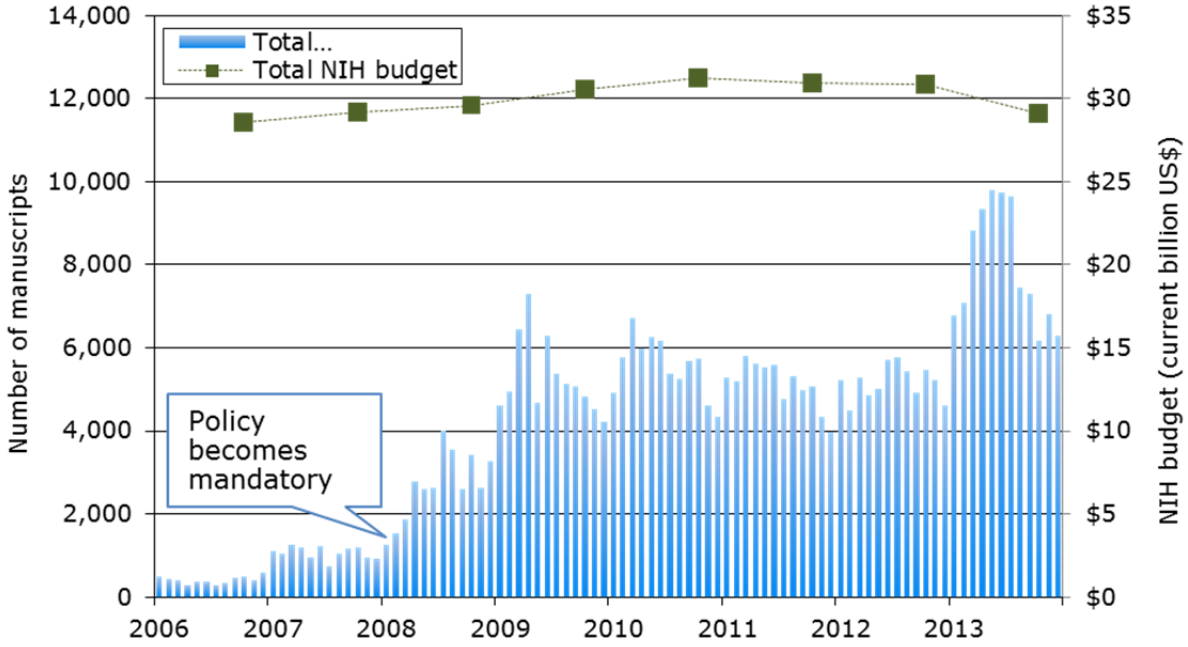

Figure 2 Manuscripts submitted for inclusion in PubMed Central and NIH budget, 2006–2013

Note: Budget in current US dollars.
Source: Compiled by Science-Metrix: NIH Manuscript Submission System (NIHMS, 2014) and NIH Office of Budget (2014).

Acceptable types of documents and metadata must be specified. Because the peer review process is a defining aspect of scholarly literature, accepting documents that have not been peer-reviewed would undermine the repository's credibility. The post-print, or the final version of the peer-reviewed manuscript, is generally required. The deposit of the published version of the article, containing the publisher's final formatting, may be preferred by the publishers themselves but should not be a requirement. Policies commonly refer to the post-print version, although this expression may be interpreted as the final peer-reviewed manuscript or as the publisher's version. Of the 48 funder policies reviewed, 79% specified that the final accepted version or post-prints of articles should be deposited.

The scope of projects covered by a policy can be defined as 'all research funded in whole or in part by [the funder],' as is the case with the Wellcome Trust's policy. Otherwise, guidelines must clarify at what point the policy applies with respect to a certain percentage of funding provided or the number of authors who are grantees. This may prove complicated, considering that projects may span many years, while funding and team composition fluctuate.

Policy sometimes accepts embargoes to give publishers exclusivity for a limited time. Embargoes are characteristic of current publication contracts and not a sought after characteristics of OA. Typically, 6 months is the maximum embargo allowed for articles in science, technology and medicine, while 12 months is accepted for articles in social sciences and humanities, but double these figures can sometimes be encountered. Among the 48 funder policies reviewed, 77% accepted embargoes between 6 and 12 months. Failure to address this point clearly, whether by omission or by vague language, may render the policy ineffective and compromise accountability.

The prescribed timing of deposits may be different from the timing of release at the end of the embargo period. Most repositories allow for closed deposit, which enables the full text of the article to remain private until the end of the embargo period. This is known as immediate-deposit/optional-access (ID/OA) and prevents further delays at the end of the embargo period as the article and metadata are processed ahead (Harnad, 2006; Suber, 2009).

OA policies may not apply to all grantees; such exceptions are preferably listed within the policy. Frequent exceptions are books and other royalty-producing outputs, patentable discoveries, any data which may personally identify subjects, and classified research.

The transfer of rights is seldom mentioned in funders' OA policies, yet it has far-reaching copyright implications. Authors are the original holders of the rights, unless the employer retains the rights, which they typically transferred to the publishers under the subscription access model. Permission must then be granted by the publishers to give OA. Alternatively, funders can require authors to reserve the rights to authorise OA. In this case, the policy can require researchers to publish only where publishers will accept OA. This type of requirement was first adopted by the Wellcome Trust in 2004 and is a common feature in recent policies. Funders can facilitate negotiations with publishers by providing forms to amend copyright transfer agreements.

Article Processing Charges (APCs) may or may not be covered by the funder. If they are covered, the funds may come from the grant itself, may need to be requested separately, or they may be covered by block grants to institutions, as is the case with the new RCUK policy. Of the 48 funder policies analysed by Science-Metrix, 46% covered APCs, 12.5% did not, and 42% did not specify.

Sanctions may be necessary to enforce OA mandates. Most of the policies reviewed do not mention any type of sanction or monitoring. The few policies that do mention sanctions chiefly delay or withhold part of the funds granted, or suspend eligibility for future grants.

3 Research institutions' open access strategies

OA initiatives are often led by universities and research institutes, and many have signed international agreements and declarations that promote OA. For instance, influential universities formed the Coalition of Open Access Policy Institutions (COAPI) and the Compact for Open Access Publishing Equity (COAPE); and the European Universities Association issued an endorsement of OA models for dissemination in 2008. Faculty groups have also increasingly passed resolutions in support of OA.

Universities are chiefly concerned with managing their intellectual assets (not only articles, but also datasets, course materials and research papers), enhancing their competitive profile by showcasing their research output and maximising and attracting research income and performance (Van der Graaf, 2008). As such, they are setting up institutional digital repositories to preserve and distribute faculty scholarly articles and other research outputs, and they are requesting or requiring that researchers deposit their research in institutional repositories or participate in a shared repository. These mandates have an impact on levels of Green posting: one study (Gargouri et al., 2010) found that the level of uptake in universities that instituted mandates a few years ago is around 60%, compared to an uptake of around 15% in universities without a mandate. Universities are also pioneering software development for OA repositories.

In the US, Harvard's model Open Access Policy (2010) for the deposit of scholarly articles in OA repositories is one prominent example. The University of California (UC), the largest public research university in the world, also adopted an OA mandate in August 2013, committing all 10 of its campuses to OA. All research articles authored by Harvard faculty are to be made available to the public at no charge through the eScholarship repository. Notably, the policy comes with an opt-out feature that allows individual faculty members to waive OA, a situation that has left some OA advocates doubting its full effectiveness.[41] OA mandates have also recently been passed at other California universities: the Stanford Graduate School of Education (July 2013) and the California Institute of Technology (Caltech) (January 2014).[42]

Some universities have set aside earmarked funds for the purposes of OA provision (for example, to help authors pay for APCs), and some publishers may accept author requests to waive these fees. Approximately 18% of publishers surveyed in an Association of Learned and Professional Society Publishers (ALPSP) Scholarly Publishing Practice survey offered some form of publication charge discount to authors based at institutions that subscribe to a relevant Hybrid OA journal, while other journals offer discounts to society members or institutions that have purchased institutional memberships (Bird, 2010).

In a survey of head librarians at universities and higher learning institutions conducted by Science-Metrix in 2013, 73% of respondents agreed or strongly agreed with the statement that 'Providing open access to scholarly publications is a priority in [their] organisation' (Table I).

[41] Quint, B. (2013, August 20). *OA rules at the University of California* [article]. Info Today. http://newsbreaks.infotoday.com/NewsBreaks/OA-Rules-at-the-University-of-California-91445.asp.

[42] Caltech. (2013, December 11). *Caltech announces open-access policy* [article]. http://www.caltech.edu/content/caltech-announces-open-access-policy.

Table I Perceived priority given to open access scholarly publications at the national and organisational levels

Do you agree or disagree with the following statements:	Agree	Disagree
Providing scholarly publications in open access form is a priority in my country.	70%	27%
Providing scholarly publications in open access form is a priority in my organisation.	73%	25%

Notes: Ratings of 'agree' and 'strongly agree' were combined, as were ratings of 'disagree' and 'strongly disagree'. The percentages include all respondents, including those who did not provide a rating. (n=162).
Source: Science-Metrix survey of head librarians at universities and higher learning institutions.

A similar proportion agreed or strongly agreed with the statement that 'Providing open access to scholarly publications is a priority in [their] country.' However, only 42% of these respondents stated that their organisation has an OA policy regarding peer-reviewed scholarly publications (Table II). This discrepancy could be attributed to a number of factors, including delays in the development and adoption of an OA policy, the decision to adopt a voluntary approach to OA, or the existence of OA policies aimed at other types of research outputs (e.g. theses or data). Among the respondents whose institutions have an OA policy, 22% declared that it is not publicly available. This suggests there may be relatively large gaps in institutional OA policy databases.

Table II Prevalence of open access policies for scholarly publications in universities and higher learning institutions

	Yes	No
Does your organisation have an open access policy regarding peer-reviewed scholarly publications (e.g., self-archiving policy; publications in open access journals)?(n=162)	42%	52%
Is this policy publicly available? (n=68)	69%	22%

Notes: The percentages include all respondents, including those who did not provide an answer. Only respondents who declared that their organisation has a policy were asked whether it was publicly available.
Source: Science-Metrix survey of head librarians at universities and higher learning institutions.

Fewer databases exist for institutions' OA policies than for funders' OA policies. Only ROARMAP and MELIBEA maintain extensive lists. Data from ROARMAP suggests that Brazil, Canada, Japan, the US, and ERA countries collectively have 293 institutional, sub-institutional, multi-institutional, and thesis OA mandates, a substantial increase from the 231 in ROARMAP one year ago (Figure 3). The OA policies reviewed encompass any official statement inciting researchers to make their research publicly available, regardless of reuse permissions, restrictions or embargoes. Since copyright and licensing restrictions may apply, a number of the policies reviewed here do not meet the requirements of the Berlin, Budapest and Bethesda statements on OA. No such mandates appear in the databases used in this study for Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Israel, Latvia, Liechtenstein, Macedonia, Malta, Romania, and Slovakia.

Brazil, Canada, Japan, the US, and the ERA countries collectively have 70 proposed institutional, multi-institutional, and sub-institutional OA mandates and non-mandates (Figure 4). No such policies appear in the databases used in this study for Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Ireland, Israel, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Romania, Slovakia, Slovenia, Switzerland, and Turkey.

As with funder policies, the number of institutional policies in any given country should be interpreted with care. Alone, it is a weak indicator of commitment to OA. A strong assessment would require careful and methodical analysis of the policies' characteristics, limitations and exceptions, as well as a consistent measurement of compliance. It should also take into account the relative weight of institutions within their respective country. All of this information should be

considered in the context of the country's population, research output or investment in research. However, the data necessary to conduct such an assessment at the scale of the ERA, Brazil, Canada, Japan, and the US are not readily available.

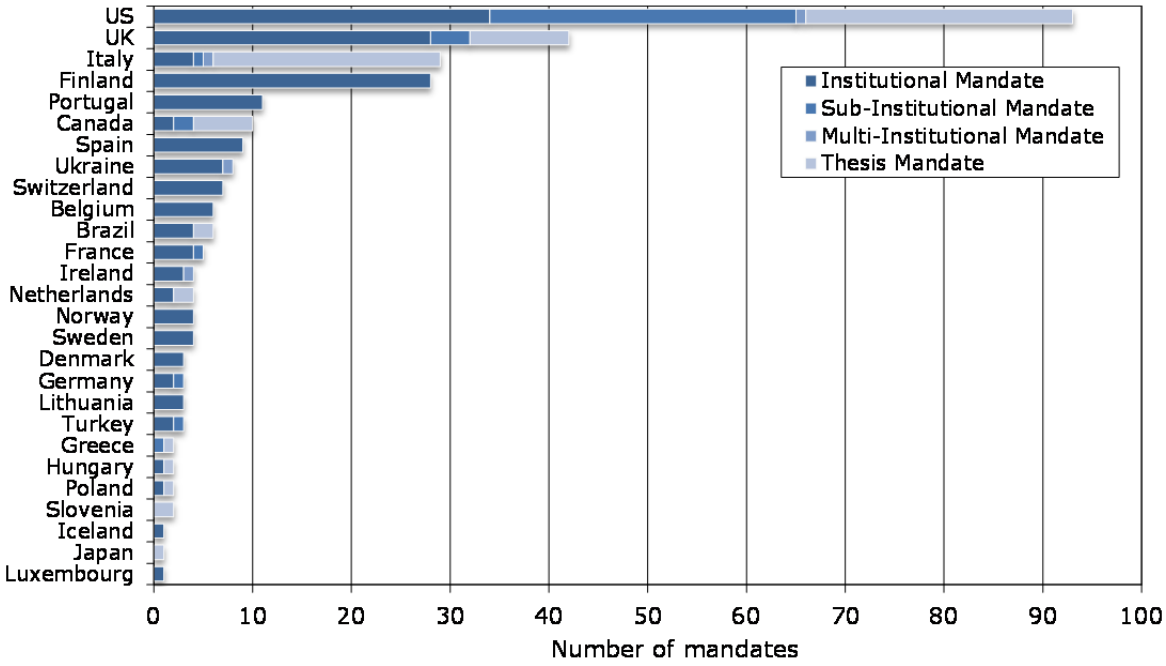

Figure 3 **Institutional, multi-institutional, sub-institutional, and thesis mandates within the ERA and in selected countries, April 2014.**

Source: Compiled by Science-Metrix using ROARMAP data.

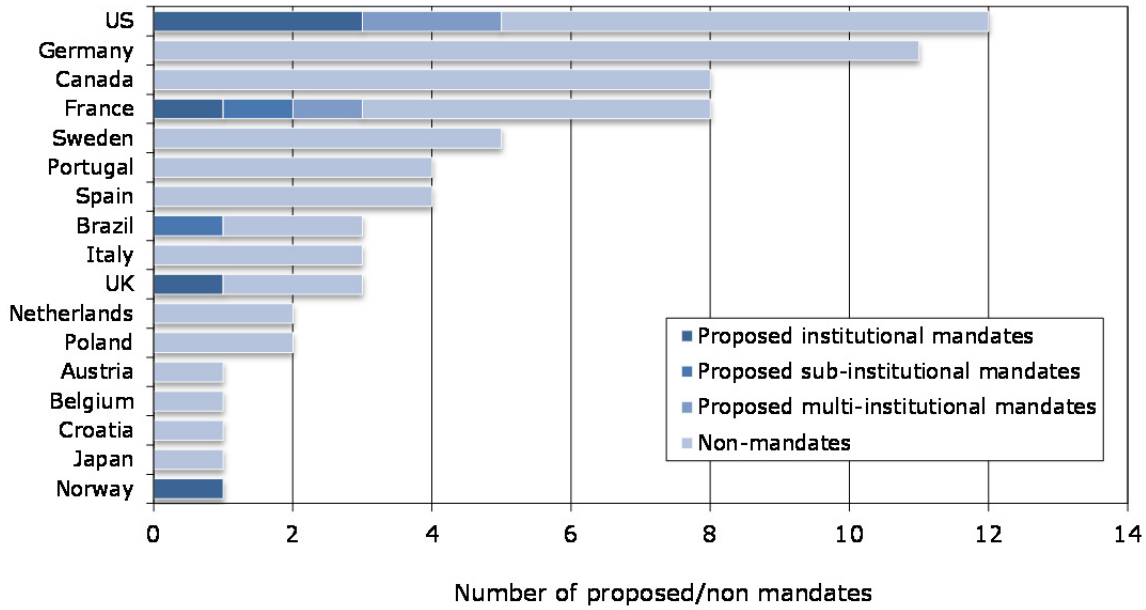

Figure 4 **Proposed institutional, multi-institutional, sub-institutional mandates and non-mandates within the ERA and in selected countries, April 2014.**

Source: Compiled by Science-Metrix using ROARMAP data.

4 Effects of open access strategies

4.1 National uptake of open access

Within the ERA, Brazil, Canada, Japan, and the US, 118 million records are spread across 1,770 repositories (as registered in *Open*DOAR in April 2014). Their distribution per country is shown in Figure 5. Countries above the regression line, such as Lithuania, Switzerland, and the UK, have proportionately more records given the number of repositories they have, while those below the line, such as Israel, Norway, Bulgaria, Romania, and Austria, have comparatively smaller repositories in comparison to other countries. Liechtenstein, Malta, and Slovakia did not have any repositories listed in *Open*DOAR at the time of writing. Nine countries— Israel, Romania, Bulgaria, Macedonia, Luxembourg, Cyprus, Latvia, Iceland, and Austria—have less than 30,000 records in their respective repositories.

All ERA countries have tipped towards having a majority of papers in OA, though in the case of the Republic of Moldova the margin of error is quite high and it is quite possible that the country has not tipped to OA yet. The EU28 and ERA have slightly more than the level of OA observed at the world level (around 58% for the 2008–2013 period for the EU and ERA versus 54% at the world level, although there are notable differences among countries (Table III)). Looking at OA score adjusted for retrieval precision and recall, four countries have even reached an aggregate availability score above 70%—the Netherlands, Croatia, Estonia, and Portugal. It is interesting to note that the Netherlands, which is also scientific publishers' land of predilection, is the EU country with the largest share of papers available in OA form (74%) as a whole for papers published in the 2008–2013 period and available for free downloading as of April 2014.

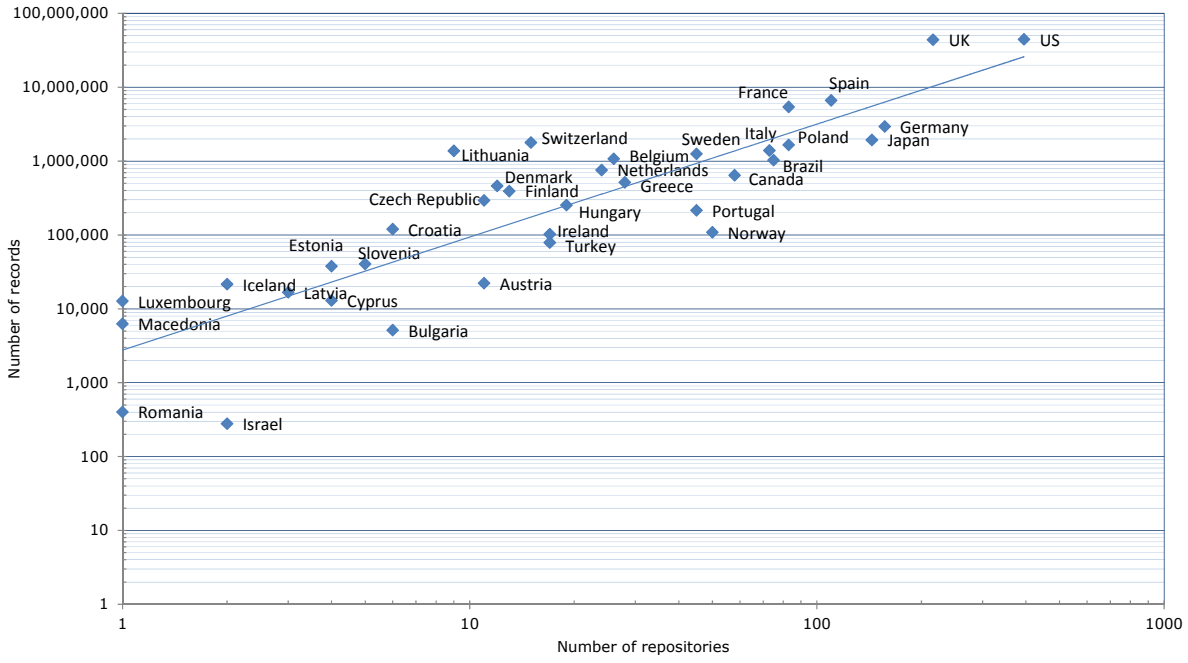

Figure 5 Uptake of open access by country as illustrated by the number of repositories and number of records, April 2014

Source: Compiled by Science-Metrix using *Open*DOAR data.

In countries outside the ERA, it is noteworthy that the US has passed the tipping point by a fair margin (Adjusted OA = 67.9%), as is also the case for Canada (64.4%). Even more salient is the

proportion of 76% observed in Brazil. This is no doubt due to the important contribution of Scielo, which plays a key role in the Southern hemisphere in making scientific knowledge more widely available. Japan is just a hair over 50% and given the margin of error of Adjusted OA may or may not have tipped to having a majority of papers in OA form.

Within the European Union, Green OA is more widely used in Portugal (16.3%), Ireland (15.8 %), France (14.0%) and Belgium (13.8%), and least used in Lithuania (4.5%), Malta (5.0%), Croatia (5.2%), and Romania (5.3%).

Publishing in Gold journals is much more frequently encountered in Eastern Europe, as it is much higher in Croatia, Slovenia, Latvia, Poland, Estonia, and Lithuania (in addition to Malta). One interesting hypothesis is that researchers in these countries may use Gold journals because they more frequently allow publishing in languages other than English. Should that be the case, this may also contribute to explaining the lower citation scores received by papers in Gold journals as the readership for 'vernacular languages', as Eugene Garfield (1998) would put it, is lower and the size of the potential reference pool is consequently also smaller. There is therefore potentially fertile ground for studying the social and linguistic aspects of science by examining where and why Gold open access journals are appearing and who actually makes use of them. The countries that least use Gold OA journals are France (6.6%), the United Kingdom (7.2%), and Belgium (7.4%).

Table III Proportion of OA per country, 2008–2013

Group	Country	Sample size	Green OA		Gold OA journals		Other OA		Total OA		Adjusted OA
			Found	%	Found	%	Found	%	Found	%	%
	Austria	8,764	821	9.4 ± 0.6	775	8.8 ± 0.6	3,450	39.4 ± 1.0	4,855	55.4 ± 1.0	63.5 ± 4.6
	Belgium	13,147	1,813	13.8 ± 0.6	968	7.4 ± 0.4	5,210	39.6 ± 0.8	7,841	59.6 ± 0.8	68.4 ± 4.6
	Bulgaria	1,707	161	9.4 ± 1.3	126	7.4 ± 1.2	558	33 ± 2	829	49 ± 2	56 ± 5
	Croatia	2,954	153	5.2 ± 0.8	687	23 ± 1.5	1,149	38.9 ± 1.7	1,876	63.5 ± 1.7	72.8 ± 4.8
	Cyprus	584	72	12 ± 3	43	7 ± 2	223	38 ± 4	329	56 ± 4	65 ± 6
	Czech Republic	7,637	521	6.8 ± 0.5	736	9.6 ± 0.6	2,598	34.0 ± 1.0	3,718	48.7 ± 1.1	55.8 ± 4.6
	Denmark	9,097	871	9.6 ± 0.6	819	9.0 ± 0.6	3,539	38.9 ± 1.0	5,127	56.4 ± 1.0	64.6 ± 4.6
	Estonia	932	81	8.7 ± 1.8	123	13 ± 2	390	42 ± 3	577	62 ± 3	71 ± 5
	Finland	7,414	659	8.9 ± 0.6	690	9.3 ± 0.6	2,838	38.3 ± 1.0	4,102	55.3 ± 1.1	63.4 ± 4.6
	France	48,991	6,881	14.0 ± 0.3	3,255	6.6 ± 0.2	16,560	33.8 ± 0.4	25,915	52.9 ± 0.4	60.6 ± 4.5
	Germany	66,268	7,575	11.4 ± 0.2	5,065	7.6 ± 0.2	21,993	33.2 ± 0.3	33,735	50.9 ± 0.4	58.4 ± 4.5
	Greece	8,043	525	6.5 ± 0.5	773	9.6 ± 0.6	3,067	38.1 ± 1.0	4,246	52.8 ± 1.0	60.5 ± 4.6
	Hungary	4,559	454	10.0 ± 0.8	356	7.8 ± 0.7	2,023	44 ± 1.4	2,782	61.0 ± 1.3	69.9 ± 4.7
	Ireland	5,150	815	15.8 ± 0.9	472	9.2 ± 0.8	1,839	36 ± 1.2	3,018	58.6 ± 1.3	67.2 ± 4.7
EU28	Italy	39,117	3,691	9.4 ± 0.3	3,112	8.0 ± 0.3	14,594	37.3 ± 0.5	21,021	53.7 ± 0.5	61.6 ± 4.5
&	Latvia	387	21	5.4 ± 2.3	57	15 ± 3	156	40 ± 5	232	60 ± 5	69 ± 7
ERA	Lithuania	1,434	65	4.5 ± 1.0	183	12.8 ± 1.7	593	41 ± 2	811	57 ± 2	65 ± 5
	Luxembourg	417	46	11.0 ± 3.0	36	9 ± 3	174	42 ± 5	253	61 ± 5	70 ± 6
	Malta	140	7	5.0 ± 3.8	30	21 ± 7	41	29 ± 7	75	54 ± 8	61 ± 9
	Netherlands	23,564	2,863	12.1 ± 0.4	1,883	8.0 ± 0.3	10,707	45.4 ± 0.6	15,177	64.4 ± 0.6	73.8 ± 4.5
	Poland	15,628	1,112	7.1 ± 0.4	2,099	13.4 ± 0.5	4,695	30.0 ± 0.7	7,416	47.5 ± 0.7	54.4 ± 4.5
	Portugal	7,190	1,169	16.3 ± 0.8	747	10.4 ± 0.7	2,636	36.7 ± 1.1	4,422	61.5 ± 1.1	70.5 ± 4.6
	Romania	5,105	271	5.3 ± 0.6	487	9.5 ± 0.8	1,994	39.1 ± 1.3	2,647	51.9 ± 1.3	59.4 ± 4.7
	Slovakia	2,372	156	6.6 ± 1.0	240	10.1 ± 1.2	798	33.6 ± 1.8	1,155	48.7 ± 1.9	55.8 ± 4.9
	Slovenia	2,586	181	7.0 ± 0.9	425	16.4 ± 1.4	871	33.7 ± 1.7	1,369	52.9 ± 1.8	60.7 ± 4.8
	Spain	35,557	3,517	9.9 ± 0.3	4,074	11.5 ± 0.3	12,119	34.1 ± 0.5	18,341	51.6 ± 0.5	59.1 ± 4.5
	Sweden	14,872	1,527	10.3 ± 0.5	1,460	9.8 ± 0.5	5,767	38.8 ± 0.7	8,587	57.7 ± 0.8	66.2 ± 4.5
	United Kingdom	73,621	8,506	11.6 ± 0.2	5,265	7.2 ± 0.2	28,173	38.3 ± 0.3	41,133	55.9 ± 0.3	64.0 ± 4.5
Total EU28		**337,231**	**31,635**	**9.4 ± 0.1**	**29,165**	**8.6 ± 0.1**	**117,793**	**34.9 ± 0.2**	**172,956**	**51.3 ± 0.2**	**58.8 ± 4.5**
	Albania	87	4	5 ± 5	16	18 ± 8	25	29 ± 10	43	49 ± 11	57 ± 11
	Bosnia and Herzegovina	362	3	0.8 ± 1.0	92	25 ± 4	139	38 ± 5	226	62 ± 5	72 ± 7
	Iceland	554	57	10.3 ± 2.5	37	7 ± 2	269	49 ± 4	354	64 ± 4	73 ± 6
	Israel	8,450	894	10.6 ± 0.6	502	5.9 ± 0.5	3,552	42.0 ± 1.0	4,882	57.8 ± 1.0	66.2 ± 4.6
ERA	Liechtenstein	40	5	13 ± 11			20	50 ± 16	25	63 ± 15	72 ± 16
Associated	FYR Macedonia	255	18	7 ± 3	75	29 ± 5	87	34 ± 6	173	68 ± 6	78 ± 7
Countries	Montenegro	104	6	6 ± 5	30	29 ± 9	38	37 ± 9	71	68 ± 9	78 ± 10
	Norway	7,280	629	8.6 ± 0.6	705	9.7 ± 0.6	2,907	39.9 ± 1.1	4,145	56.9 ± 1.1	65.3 ± 4.6
	Rep. of Moldova	160	14	9 ± 4	5	3 ± 3	52	33 ± 7	71	44 ± 8	51 ± 9
	Serbia	2,997	135	4.5 ± 0.7	906	30.2 ± 1.6	803	26.8 ± 1.5	1,786	59.6 ± 1.7	68.3 ± 4.8
	Switzerland	16,896	2,497	14.8 ± 0.5	1,547	9.2 ± 0.4	6,630	39.2 ± 0.7	10,369	61.4 ± 0.7	70.3 ± 4.5
	Turkey	17,420	475	2.7 ± 0.2	3,458	19.9 ± 0.6	4,853	27.9 ± 0.6	7,962	45.7 ± 0.7	52.4 ± 4.5
Total ERA		**375,820**	**33,766**	**9.0 0.1**	**34,932**	**9.3 0.1**	**130,244**	**34.7 0.1**	**192,202**	**51.1 0.2**	**58.6 4.5**
Others	Brazil	26,158	1,626	6.2 ± 0.3	10,482	40.1 ± 0.6	6,515	24.9 ± 0.5	17,322	66.2 ± 0.5	75.9 ± 4.5
	Canada	41,114	2,895	7.0 ± 0.2	3,098	7.5 ± 0.2	17,438	42.4 ± 0.5	23,096	56.2 ± 0.5	64.4 ± 4.5
	Japan	58,527	4,170	7.1 ± 0.2	5,382	9.2 ± 0.2	16,883	28.8 ± 0.3	25,846	44.2 ± 0.4	50.6 ± 4.5
	United States	258,815	17,865	6.9 ± 0.1	17,709	6.8 ± 0.1	119,943	46.3 ± 0.2	153,416	59.3 ± 0.2	67.9 ± 4.5
World		**1,000,000**	**60,271**	**6.0 ± 0.04**	**104,050**	**10.4 ± 0.1**	**324,637**	**32.5 ± 0.1**	**470,530**	**47.1 ± 0.1**	**53.9 ± 4.5**

Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

4.2 Institutions' responses to open access

The response of universities and other research performing organisations to OA has been shaped by the perceptions and expectations of the heterogeneous community of faculty and student researchers, librarians and managers. The pressures of budget constraints, visibility and prestige, coupled with an increasing reliance on digital information in scholarly communication, have led to a broad variety of strategies to address OA. The prevalence of OA policies has been addressed in Section 3, while the choice of repository and incentives used to promote OA will be presented here, followed by a few examples of institutions whose OA strategies go above and beyond the most common approaches.

In the survey of head librarians conducted by Science-Metrix, respondents were asked to identify every type of repository maintained by their institution for OA scholarly publications. Central repositories proved to be the most frequent choice by far; this option was selected by 72% of respondents. Only 15% of respondents indicated that their institution has no institutional repository or systematic archiving. Thus, many institutions appear to have at least one OA repository but no OA policy.

The quality of the IT infrastructure is less variable now than it was a decade ago. While there were few institutional repositories in existence a decade ago, their numbers have grown substantially, most having been built using open source solutions. Nearly all mid-sized and small subject repositories are currently run using openly available repository software such as Eprints, DSpace and Opus (Björk, 2013).

Table IV Types of repositories used to archive open access scholarly publications

Does your university maintain one or more institutional repositories for open access scholarly publications (including pre-print, post prints, etc.)? Check all that apply.	**Frequency**	**%**
Central repository	116	72%
Faculty/departmental repository(ies)	16	10%
Systematic researcher-level archiving (with a content management system and/or based on web-posted c.v.)	12	7%
My organisation has no institutional repository or systematic researcher-level self-archiving on the organisation web-servers	24	15%
Don't know/Not applicable	7	4%
Other (please specify)	9	6%

Notes: Respondents could select more than one answer (n=162).
Source: Science-Metrix survey of head librarians at universities and higher learning institutions.

Nevertheless, some longer-term technical challenges remain for digital repositories, in particular the non-uniformity of manuscript files and metadata formats (Pinfield, 2009; Wallace, 2011). Indeed, repository contents are in many ways heterogeneous. A single repository may contain items that are OA and items that are not. It may contain peer-reviewed articles, theses, books, copies of ancient documents, images, or audio and video files.

Most repositories now adhere to a set of internationally agreed upon technical standards to standardise the metadata used to identify each item they contain (Swan & Chan, 2009). This allows their contents to be indexed and harvested through the OAI-PMH. However, the internationally agreed upon Dublin Core metadata format, which identifies individual items within OAI-PMH compliant repositories, is fairly limited. It contains no information about the public accessibility or specific nature of items; it merely separates types of objects (images, audio, video, text). Some items contain only metadata, without any associated file. It is therefore frequently

impossible to determine whether a text item is a peer-reviewed publication, a book chapter, an editorial or any other type of text file and whether or not the item is publicly accessible without manually examining each item.

The interoperability of repositories—allowing all types of repositories to communicate and connect with and transfer information, metadata, and digital objects between each other—is another technical challenge. Repository development is undergoing rapid change, contributing to an 'evolving interoperability landscape that at first sight may appear chaotic, confusing, and complex' (Confederation of Open Access Repositories [COAR], 2012). The European Commission, for example, reports that many European national repository infrastructures have been created but are at risk of remaining 'islands' that are not sufficiently interconnected (European Commission, 2011a). To enable greater interoperability, guidelines, protocols and standards are currently being written.

Another noted challenge, this one impacting the implementation of institutional policies, is the promotion of OA within the academic community. Most researchers agree on the validity of OA as a principle but an array of other factors can influence their decision to publish in Gold or Green OA or in a traditional subscription-based journal (Dallmeier-Tiessen et al., 2011). Even in institutions in which an OA policy is in place, compliance is not absolute. As previously noted, studies have suggested that compliance is higher if OA is mandated or if it is linked to a direct advantage for authors, as is the case at Université de Liège, Belgium, where deposit in the institution's repository is required for performance evaluations (Gargouri et al., 2012).

In the survey of head librarians at universities and higher learning institutions conducted by Science-Metrix, respondents were asked to identify every type of incentive used to promote OA publication and archiving of scholarly publications in their organisation (Table V). The responses showed that formal rewards were rare: 49% of respondents indicated that researchers in their organisation were encouraged to do so without any formal reward, and 36% indicated that their institution had no policy in this regard. Meanwhile, 15% of respondents indicated that self-archiving was mandatory, and 14% indicated that financial support was available for researchers who published in OA journals. Thus, direct advantages for researchers who make their work available in OA form remain rare at the level of institutions.

Table V Incentives used to promote open access archiving and publication of scholarly publications

Which of the following statements apply to your organisation? Check all that apply.	**Frequency**	**%**
Researchers are obliged to self-archive papers	24	15%
Researchers are rewarded to self-archive papers internally (in one or more of your institutional/researcher-level repositories)	7	4%
Researchers are rewarded to self-archive papers externally (e.g., on arXiv)	3	2%
Researchers are rewarded to publish in open access journals	2	1%
Researchers receive financial support from my organisation to publish in open access journals	23	14%
Researchers are encouraged to self-archive and/or use open access journals but there are no formal rewards	79	49%
My organisation has no policy in this regard	58	36%

Notes: Respondents could select more than one answer.
Source: Science-Metrix survey of head librarians at universities and higher learning institutions.

As the concept of OA to scholarly publications gains visibility, more universities and other research performing organisations are likely to develop mechanisms to promote its adoption by students and faculty. A few institutions have contributed further to the development of OA culture through

specific initiatives that lead by example and have made extensive efforts to ensure the compliance of their own personnel.

- The University of Southampton is home to ROAR and ROARMAP. Its School of Electronics and Computer Science adopted its OA mandate, the first of its kind, in 2002. The university followed suit in 2006, mandating all research to be deposited in its repository.[43] Although he is tenured at the Université du Québec à Montréal, Stevan Harnad, one of the early OA advocates, is affiliated with the University of Southampton's Cognitive Sciences Centre, where he and his team have been developing model policies and repository software since 1994. The university's OA policy stipulates that 'deposited record and outputs may be used for internal review of research performance and to assist in appraisals and promotions within the university' (University of Southampton, 2009).
- The European Organization for Nuclear Research (CERN) implemented a self-archiving policy in 2003 and has encouraged publication in OA journals since 2005 (Altarelli, 2005). The organisation took further steps to encourage the development of electronic OA publications in the field of physics. It recently launched the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP)[3] initiative, which aims to make all high-energy physics literature available in OA. It has provided sponsorship for specific OA journals and concluded agreements with publishers to publish research from the Large Hadron Collider accelerator under a Creative Commons licence (Bianco et al., 2007).
- The University of Minho was another pioneer of institutional repositories within the ERA, having established its repository in 2003 and adopted its OA mandate at the end of 2004 (Saraiva & Rodrigues, 2009). The university has also organised several OA conferences, seminars and workshops, prompting other Portuguese universities to develop their OA infrastructure.
- Since 2002, the University of Nottingham has led the SHERPA partnership, which operates RoMEO, JULIET, and *Open*DOAR. As such, the university has played an important part in the establishment of OA repositories by testing, evaluating, and disseminating ideas for new developments in the field. The university's own OA mandate was adopted in 2009.
- Since 2011, Harvard University's Berkman Center for Internet and Society is home to the Harvard Open Access Project (HOAP). The Project's goals include conducting research and policy analysis, providing timely and accurate information, and fostering OA within the university and beyond. The HOAP's director is Peter Suber, one of OA's most vocal advocates. The university is a strong voice for OA, having publicly denounced the budget constraints imposed on libraries by the rising price of journal subscriptions. Though, the university does not have an institution-wide OA policy, each school within the university can take part in the proposed OA policy. Eight out of nine schools participate: the Faculty of Arts and Sciences, the Business School, the Law School, the Kennedy School of Government, the Divinity School, the School of Public Health, the Graduate School of Design, and the Graduate School of Education. The university also has a common institutional repository.[44]
- Cornell University co-owns and operates arXiv, one of the most strategically important OA repositories in existence, not only for its size, but also for the leading role it played in leading

[43] University of Southampton. (2013). *ePrints Soton* [Web page]. http://www.southampton.ac.uk/library/research/eprints/.

[44] Presidents and Fellows of Harvard College. (2010). *Open access policies*. http://osc.hul.harvard.edu/policies#participating.

the OA movement. The university's Faculty Senate passed a resolution on scholarly publishing in May 2005, calling on all faculty to negotiate their intellectual property rights with the journals in which they publish and retain, at a minimum, the right of post-print archiving, as well as to deposit the pre-print or post-print copies of articles in an OA repository. The resolution also called for 'tenured faculty to cease supporting publishers who engage in exorbitant pricing, by not submitting papers to, or refereeing for, the journals sold by those publishers, and by resigning from their editorial boards if more reasonable pricing policies are not forthcoming,' for 'all faculty, and especially tenured faculty, to consider publishing in open access, rather than restricted access, journals or in reasonably priced journals that make their contents openly accessible shortly after publication,' and for the 'University Library to negotiate vigorously with publishers who engage in exorbitant pricing and to reduce serial acquisitions from these publishers based on a reasonable measure of those subscriptions.'[45] Despite the resolution's sharp wording, to this day, it does not require compliance. The university nonetheless offers comprehensive information regarding copyright transfer agreement negotiation.[46]

These institutions stand out by virtue of the specific programmes they developed to understand, measure or promote the adoption of OA in scholarly literature. Their initiatives have contributed to the spread of OA across institutions and countries, which can be illustrated by the number of active repositories and the number of records within these repositories, despite the limitations of these measures, as outlined earlier.

Not surprisingly, according to *Open*DOAR data, many of the largest institutional repositories are located in universities, and more particularly in the US—such as University of Michigan and Yale (see Table VI).

Table VI 25 largest institutional repositories as of April 2014

	Institution	Records	Institution URL	Country
1	English Heritage	8,000,000	http://www.english-heritage.org.uk/	United Kingdom
2	University of Michigan	2,499,138	http://www.umich.edu/	United States
3	Yale University	1,775,300	http://www.yale.edu/	United States
4	Ministerio de Cultura	1,086,800	http://www.mecd.gob.es/portada-mecd/	Spain
5	National Aeronautics and Space Administration	1,013,128	http://www.nasa.gov/	United States
6	Bayerische StaatsBibliothek	984,542	http://www.bsb-muenchen.de/	Germany
7	Chemical Engineering Research Information Center	939,767	http://www.cheric.org/	Korea, Republic of
8	Odum Institute at University of North Carolina	690,355	http://www.odum.unc.edu/	United States
9	University of Utah	604,252	http://www.utah.edu/	United States
10	University of Cincinnati	578,987	http://www.uc.edu/	United States
11	University of California, Los Angeles	512,500	http://www.ucla.edu/	United States
12	Fachhochschule Gelsenkirchen	423,617	http://www.hbz-nrw.de/	Germany
13	Kyushu University	374,306	http://www.kyushu-u.ac.jp/	Japan
14	University of Nebraska - Lincoln	339,207	http://www.unl.edu/	United States
15	Katholieke Universiteit Leuven	329,291	http://www.kuleuven.be/	Belgium
16	University College London	313,651	http://www.ucl.ac.uk/	United Kingdom
17	Institut national de recherche en informatique et en automatique	303,266	http://www.inria.fr/	France
18	Bibliotheca Alexandrina	301,647	http://www.bibalex.org/	Egypt
19	University of Southern California	281,401	http://www.usc.edu/	United States
20	Food and Agriculture Organization of the United Nations	268,777	http://www.fao.org/	Italy

Source: Compiled by Science-Metrix using *Open*DOAR data.

[45] Cornell University Library. (2005). Cornell university faculty senate endorses resolution on open access and scholarly communication [article]. http://www.library.cornell.edu/scholarlycomm/resolution.html.

[46] Cornell University. (2009). Copyright management [Web document]. http://copyright.cornell.edu/policies/copyright_management.cfm.

The largest university repository in Europe is located at the technical university of Gelsenkirchen in Germany, and is followed by the Katholieke Universiteit Leuven in Belgium and University College London in the UK. The largest institutional repository overall is that of public body English Heritage which practically dwarfs all others with 8 million items, compared to 2.5 million at the University of Michigan, the next largest repository. Governmental organisations are also represented, for example the Ministerio de Cultura in Spain, NASA in the US, and the Bayerische Staatsbibliothek in Germany. As mentioned before, the quality of the records in the repositories varies widely in type of contents, quality and value.

4.3 Publishers' responses to open access

As publishers' income is traditionally generated via subscription, some have feared that OA could potentially undermine existing business models, particularly if embargo periods and other restrictions on use and reuse rights are reduced (Finch, 2012). OA may also be seen as imperilling the activities of learned societies that use publication revenues to fund their wider activities in promoting and supporting scholarship in the disciplines they represent (Barbour & Patterson, 2006). As such, a common assumption in the literature is that there are vested interests to preserve the status quo of the current subscription market (Laakso & Björk, 2012).

In practice, however, publishers have vastly different stakes, and they may perceive this radical change in the industry as either an opportunity or a threat. Those who choose OA may benefit from wider dissemination, maximised market reach, greater visibility and higher journal citation impact factors for their articles (Crow, 2009; ICTP, 2008). Scholarly societies that were previously hesitant to embrace OA, including the American Association for the Advancement of Science (AAAS) and the Royal Society, have recently made announcements or established initiatives in support of OA.[47] Publishers are currently exploring a variety of OA options and seeking the most effective business model to respond to rapidly evolving market expectations.

Over the last two decades, several models for OA publishing have emerged. Authors have attempted to define these models; Abad (2009), for example, identified a number of models, which differ with respect to type of content access, retention of author's rights and type of financing. These models are as follows.

1. *OA journals that are free for authors and readers*. This is considered by many as the most desirable model; many newer OA journals are adopting this model. They may be funded by partners, donations or non-commercial sponsors, at least for an initial period, after which they may transition to another financing model (typically the 'author pays' model). About two-thirds of journals in the DOAJ have no article processing charges. Evidently, the most problematic issue here is the sustainability of the model when enthusiasm, subsidies or donations wear out.
2. *OA journals that are free for authors and readers of the online version, with subscription payment for the paper version*. These journals, which represented approximately 28% of OA journals 10 years ago, are primarily well-established print journals that are able to rely on steady income from subscriptions (Regazzi, 2004). This model is favoured more by not-for-

[47] Joseph, H. (2014). *The White House Directive: One year in, time for further action* [article]. http://www.sparc.arl.org/blog/white-house-directive-one-year-time-further-action.

profit publishers than commercial ones. Because paper is increasingly losing it relevance compared to digital media, this model is not likely to be encountered frequently in the future.

3. *'Author pays' OA journals*. OA journals that require authors to pay article processing charges or publication fees have become more common; in 2011, articles in these journals represented 49% of all OA articles (Laakso & Björk, 2012). The best known journals of this type are BioMed Central and PLoS ONE and about a quarter of the journals published by Hindawi. Publication fees vary greatly—Bird (2010) found that the majority (69%) of such journals charge between US$1,000 and $3,000 per article, and Solomon and Björk (2012) reported that they ranged between US$20 and $3,800, averaging $900. Hindawi, which publishes around 400 Gold OA journals, has a mixed model with about three quarters of the journals having no author-side fees and the majority of the journals having fees charging between $300 and $800.[48] Fees may be paid by the authors themselves, the institutions to which they belong, libraries and/or agencies that finance research (Waters, 2008). A different 'author pays' model was proposed by newly established publisher PeerJ, where authors can buy a lifetime membership between US$100, for one published paper per year, and $350, for an unlimited number of published papers per year.[49] In this new model, membership is required for each co-author, up to 12 authors per paper.
4. *Hybrid systems:* This model, also known as 'open choice' publishing, is represented by traditional, Paid Access (PA) journals that provide authors who pay publication fees with the option to allow OA to their articles (Houghton, 2009). For many publishers, this model provides a risk-free opportunity to experiment with OA. As such, most major mainstream publishers employ a hybrid model for some or all of their journals; Springer, for example, utilizes this model within the Springer Open Choice programme for the majority of its journals. Perhaps due to the dissuasive influence of relatively high fees associated with the model, there has been limited uptake—only about 2% of authors choose the OA option when submitting articles to a subscription journal (Dallmeier-Tiessen et al., 2011). Hybrid OA is most popular in disciplines that are well funded and interested in exploring OA options (Morgan, Campbell & Teleen, 2012). Hybrid OA has been criticised by funders as an unsustainable fee structure where publishers charge authors for publication while maintaining high subscription prices, a practice likened to 'double dipping' (Science Europe, 2013). Lewis (2012) suggested that 'hybrid and delayed OA are unlikely to have much long-term impact, as they are really attempts by subscription journal publishers to force open access into their established business models.'
5. *Journals with free access to certain content*. Most scientific journals provide partial OA to their content, with free access to, most commonly, the table of contents, abstracts or editorials (Bernius et al., 2009). However, more journals are allowing access to additional original content, most commonly original papers, and some allow full access to all content. Abad (2009) notes that, conceptually, the only difference between these journals and OA journals are that journals whose publishers retain the copyrights are referred to as 'free access' journals.

[48] http://www.hindawi.com/apc/

[49] https://peerj.com/.

6. *Journals with free access to the contents after a period of embargo*. Also referred to as 'Delayed OA' (DOA), this model offers a compromise between OA and subscription. While paying subscribers get immediate access, free access is allowed after an embargo period (Houghton, 2009). Embargoes typically last 6, 12 or 24 months, after which exclusive rights of the article fall back to the author. In some fields of science, such as medicine, rapid access to the latest research results is especially important; therefore, use of this model does not tend to decrease subscription income for the publisher (Björk & Hedlund, 2009). Articles that are made available after an embargo period (typically of one year) have been found to comprise 3.5% (Björk, Roos & Lauri, 2009) and 5% (Laakso & Björk, 2012) of articles available OA through journal publishers.

Finally, it is worth mentioning Rogue OA or Robin Hood OA papers (ROA), that is, papers that are freely available in spite of restrictions, usage rights, or copyrights. This occurs when researchers decide to make their papers available for free and self-archive them in institutional repositories or in some aggregating web sites, that is, when they decide to make papers available in whatever form they were finally published regardless of the rules that publishers have stated and that are compiled on the University of Nottingham's SHERPA/RoMEO list.

The most significant challenge facing OA journals around the world has been adopting a funding model that is consistent with their survival. Most of the growth in OA publishing has come from newly founded OA journals that charge authors or their organisations for the publishing services (the APC model), a proven business model. In lieu of subscription costs being met by readers, their financial survival depends on a mix of funding sources in various combinations, including (Crow, 2009; Eckman & Weil, 2010; Frantsvåg, 2010; Friend, 2011) APCs, public or charitable research funding bodies, institutional support, grants and subsidies, endowments, sponsorships, collaborative purchasing, hard copy support, and advertising revenues.

In the pioneering years of OA, journals were founded by scholars who largely volunteered their time to the cause or established society journals who wanted to publish e-versions, and much of the growth in OA has been propelled by independents, society and newly established OA publishers. However, in recent years, many traditional commercial publishers have established sizable OA journal operations, have extended their Hybrid OA operations, or have even dropped their print editions to become solely digital (Suber, 2007). The Nature Publishing Group has 16 OA journals and is now a majority investor in Frontiers, an OA publisher based in Switzerland (Frontiers, 2013). Springer acquired BioMed Central in 2008, launched SpringerOpen in 2010, and extended its OA portfolio to offer OA books in 2012.[50] Elsevier owns about 100 OA, substantially more than the 30 OA journals on which information could be found at the time of writing the previous version of this report one year ago. In April 2013, Elsevier acquired the open science social network Mendeley.[51]

[50] http://www.springeropen.com/about.

[51] Douglas, J. (2013). Elsevier announced today the acquisition of Mendeley for around $100million. STM Publishing News. http://www.stm-publishing.com/elsevier-announced-today-the-acquisition-of-mendeley-for-around-100million/.

As many of these publishers were once sceptical of—or even opposed to—OA, this provides evidence that major scholarly publishers believe the OA model to be sustainable, if not unavoidable. The data presented in the accompanying report on the measurement of OA availability showing that Paid Access-only articles being the least cited model of diffusion in 7 fields out of 22 gives credence to the suggestion that even the most established publishers will have to innovate really fast to keep their relevance (competing diffusion models were Green OA, Other OA, and papers in Gold OA journals).

'Mega-OA' journals have also been established, most notably PLoS ONE, an international, peer-reviewed, high impact factor OA publication that has achieved financial stability through high-volume publishing (Gores, 2010). The Nature Publishing Group followed suit with a mega-journal called Scientific Reports. The success of major Gold OA publishers, such as PLoS, has had a positive impact on the credibility of OA peer-reviewed publications. PLoS journals have garnered a large audience and author base, driving their impact factor up. The organisation's revenues have exceeded expenses since 2010.

Gold OA journals also offer a simple solution to authors and institutions not comfortable with the self-archiving process or lacking the appropriate infrastructure, as the journal is responsible for the preservation and circulation of the articles. Thus, the process of publishing in a Gold OA journal is very similar to the process of publishing in a Paid Access journal and may be thought of as a turn-key solution. OA publishing is now an easier choice to make for authors, learned societies, and research funding organisations than it was five or ten years ago.

Despite this, adoption of the Gold model has been rather slow. Laakso et al. (2011) reported that in 2009, the share of all peer-reviewed journal articles in OA journals had reached 7.7%. The big publishers are not converting their journals to OA on a broader scale, likely because they are not being threatened yet by significant reductions in their subscription income. Between 2005 and 2011, Elsevier increased its operating profit margin from 31% to 37%, Informa (which includes Tailor & Francis), from 25% to 36%, and Wolters Kluwer Health, from 16% to 20%; John Wiley STM increased its operating profit margin from 39% to 43% (Björk, 2013) for the 2008–2011 period. These publishers are still profiting from multi-year, 'big deal' e-licenses.

While few subscription journals have been converted to APC-funded OA, the new SCOAP^3 (Sponsoring Consortium for Open Access Publishing in Particle Physics) initiative was launched on January 1, 2014. Billed as the 'largest single global Open Access initiative built to date,' SCOAP^3 has library and publishing partners from 24 counties around the world, as well as the leading research laboratories in the field, CERN. It aims to fully or partially convert a dozen of the leading journals in high-energy physics to APC-funded OA.[52] It is a new model in which the APCs will not be paid by authors or even their institutions, but by the consortium. However, Björk (2013) noted that this model, 'even if successful, is however not likely to be replicable to other fields of science.'

[52] SCOAP3. (2014). *SCOAP3 – Sponsoring Consortium for Open Access Publishing in Particle Physics* [Web page]. http://scoap3.org/what-is-scoap3.

Impacts of publishers' strategies on authors

The research life cycle begins with authors, the initial copyright holders of the publications, and authors will ultimately decide whether OA becomes the only remaining model. Authors, academics and researchers want widespread visibility for their research outputs, ideally in high-status journals that maximise their chances of securing high impact and research grants (Ayris, 2009; Finch, 2012). OA can also provide time savings, reducing the delay between acceptance and publication in an OA journal. Research users seek increased accessibility to research outputs, easier access to material within specialised research field(s) and transparent delivery of materials at all times—the Martini Principle—as well as ease of navigation and the ability to use, and reuse, content with as few restrictions as possible (Austin, Heffernan, & David, 2008; Finch, 2012).

Interestingly, results of researcher surveys, including the European SOAP (Study of Open Access Publishing) project (Dallmeier-Tiessen et al., 2011) and the Survey on Scientific Information in the Digital Age (European Commission, 2007), have shown that there is widespread support for OA as a principle among researchers, in particular the idea that publicly funded research should be OA. However, surveys also demonstrate that researchers rank other considerations as more important than a journal's OA policies, including speed of publication, quality of peer review and the journal's scientific impact (Bird, 2010), although funders' and institutions' mandates are increasingly influencing authors' choices of where to publish. This provides evidence of a 'culture of mistrust and misunderstanding about open access amongst researchers' (Harris, 2012).

As a result, take-up of Green OA has remained relatively low, with the percentage estimated to be around 20%. Considerable disciplinary variation can be seen; the share of OA in the arts stands at 10%, while this number is 45% in mathematics (Gargouri et al., 2011). Elsevier has recently reported that the Green archiving of accepted manuscripts remains at 4–5% (Morgan, Campbell & Teleen, 2012). To further promote OA, OA publishers should engage with the author community to increase awareness and provide evidence of how publishing with an OA publisher can benefit them; they may also work with institutions and funding bodies to encourage them to publish their work with an OA publisher (MacKenzie-Cummins, 2011).

Impacts of publishers' strategies on authors

According to the Association of Research Libraries (ARL), in 1986, the price of scholarly journal subscriptions rose sharply by 18%, and it has continued a rapid ascent (Case, 2009). As prices have risen faster than inflation and the consumer price index, library budgets increased moderately, stagnated or even decreased, leading to a situation referred to as the 'serials crisis'. In response to the changing landscape of scholarly communication, publishers developed new products known as 'big deals', which are contracts between libraries and publishers whereby libraries secure access to a large set of journals (bundles) distributed by the publisher, mostly in electronic format, for all faculty and students at the subscribing university, for a set price for a period of three to five years. These deals are often negotiated by a consortium of libraries in order to secure lower prices. For example, in the UK, Jisc negotiates with the publishers at the national level for access to more than 450 journals.

Although some journals within such a package may be irrelevant to the library, the cost of the package is less than the combined cost of individual subscriptions to the journals included in the bundle. However, the restrictive aspects of big deals limit the ability of libraries to adjust their catalogue to the changing needs of faculty and students. Since the beginning of the serials crisis, mergers and acquisitions in the scholarly communication sector have increased the concentration

of journals in the hands of a limited number of publishers. As a result, librarians have little power to negotiate the terms of subscriptions contracts.

A study commissioned by the Association of American Publishers (AAP) (Gantz, 2012) examined serial expenditures for the Association of Research Libraries (ARL) and revealed that although the average serials price and change in total serials expenditure had indeed increased continuously from 1990 to 2010, the number of serials purchased had increased from 2000 to 2010. The combined effect of these variations is an increase in actual cost per serial from 1990 to 2000, followed by a plateau until 2004 and a subsequent decrease, bringing the actual cost per serial close to its 1990 level. The study attributes the change in the number of serials purchased in part to the emergence of big deal practices and to an increase in absolute scientific output in the form of peer-reviewed articles over this period (Figure 6).

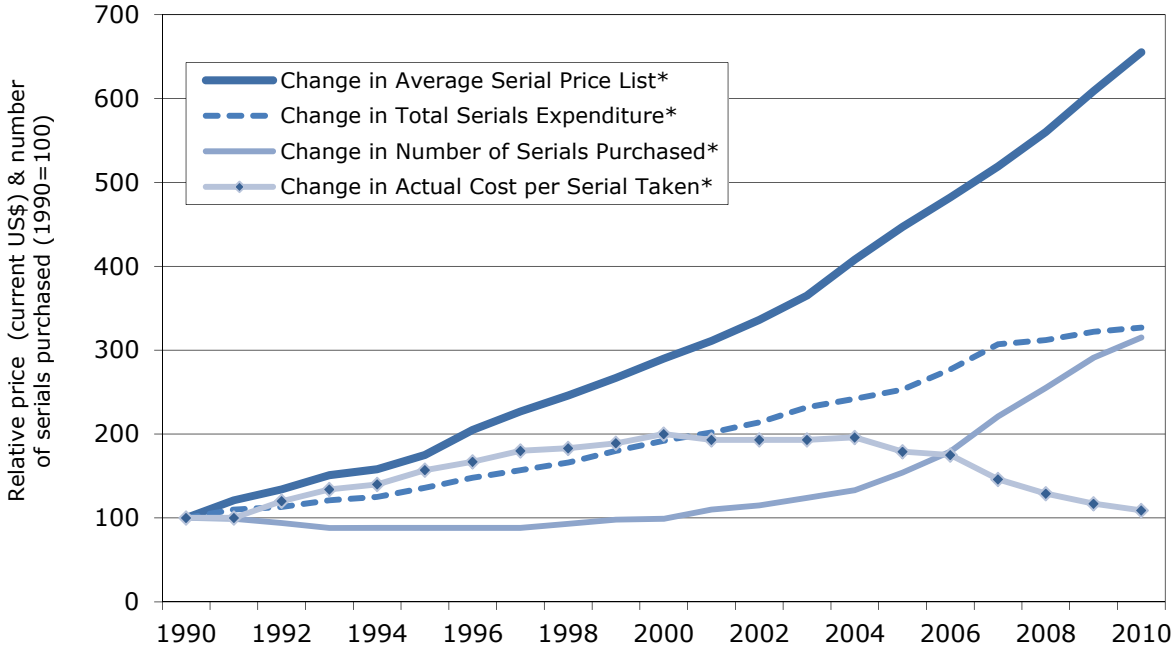

Figure 6 Evolution of libraries' serials expenditures

Note: *Based on average for ARL libraries reporting 1990-2010.
Source: Adapted from Gantz, 2012.

Librarians contend that even though they get more journals than ever before, a sizeable proportion of these are unwanted and subscribed to in order to get a reasonable price for the journals they need. Even if the price per unit is low, libraries' overall budget has been stretched to its limit. In a public memorandum dated April 17, 2012, Harvard University denounced the unsustainable cost of periodical subscriptions from major publishers (Harvard Faculty Advisory Council, 2012). Considering that Harvard's endowment was valued over $30 billion in 2012, its inability to keep up with the rising costs of serial subscriptions speaks volumes about the situation less prestigious and smaller universities are facing (Harvard Management Company, 2012). Among other recommendations, Harvard's memorandum invited faculty and students to 'move prestige to open access' by submitting their articles to OA journals or to journals with sustainable subscription costs.

In sum, institutional libraries are largely unable to keep pace with the spiralling costs of journals or to opt out of big deals. Importantly, though 'big Deals' has had the effect of theoretically lowering the subscription cost per journal, the negotiating power of research libraries has fallen, and they do not necessarily end up with an optimal mix of journals. Another effect of this strategy

is to augment the market presence of large publishers, who can impose journals of lesser interest to researchers due to their being packaged with their 'must subscribe to' journals. Considering that the profits of large publishers have increased rapidly after the introduction of these practices, it is clear that the largest beneficiaries of this model have been the dominant industry players.

Many librarians see the benefit of moving towards OA. Not only might OA reduce the pressure on library budgets, it could also provide more resources faster for users by supplementing paid resources with ones that are freely available, mitigate costs for resource purchase and access, as well as reduce the complexities involved in negotiating electronic journal and database licenses (Harris, 2012; Morrison, 2006; Palmer, Dill, & Christie, 2009).

Librarians have been in the vanguard in fighting increases in journal costs and promoting the development of repositories. Results from surveys of academic librarians (Greyson et al., 2009; Palmer, Dill, & Christie, 2009) have shown that librarians feel a strong sense of mandate to carry out OA-related activities. Librarians' main roles in the OA movement will be as operators of institutional repositories, sponsors of university presses and partners of scientists and scholars in the organisation and operation of OA journals (European Commission, 2008). As such, they may be required to develop and recommend repository guidelines to university management, liaison with faculty and help faculty members archive their research papers, make sure scholars at their institutions know how to find OA journals and archives in their fields, develop expertise on metadata and format management and emerging strategies for long-term digital preservation, and engage in dissemination and access management (CASLIN, 2009; Pinfield, 2008; Prosser, 2004).

What's more, researchers seek this help. More than half of researchers responding to a survey (Austin, Heffernan, & David, 2008) felt that their university or institution should provide guidelines instructing authors how to deposit items; promote repositories and OA policies amongst academics, management, staff and students; and explain the rights of the repository and end-users, things that libraries are uniquely positioned to do. Many also see a leading role for librarians to communicate important OA-related developments to user groups and administration (Albert, 2009). Indeed, communicating with researchers and institutions about OA will be an important function for libraries (Harris, 2012), meaning that librarians will need to learn a new skill set associated with encouraging publication in OA journals and establishing and delivering repositories. These changes confirm that universities increasingly need information scientists as opposed to librarians as we used to know them.

4.4 Global growth of open access

A number of studies have attempted to quantify the global growth of OA, typically by examining increases in the number of OA journals, OA articles, OA repositories, OA policies at funding agencies and OA policies at universities. However, such investigations are met with a number of challenges, such as a population of OA journals that is heterogeneous in size, funding mechanisms, web features, methods of peer review and scientific quality (Björk, 2011). The most prolific authors on the subject of OA growth rates have been Laakso, Björk and associates.

Though it was suggested only a few years ago that OA growth was modest, there is now undeniable evidence that the OA movement is proving to be highly disruptive and that OA is traversing the scientific, technical and medical publishing industry with the speed and force of a tsunami.

- According to the Directory of Open Access Journals (DOAJ), the primary index of OA journals, as of March 2014, there were 9,744 quality-controlled scientific and scholarly OA journals, up from the 350 contained in the directory in May 2003.
- Overall, between 1993 and 2009, OA journals experienced an annual growth rate of 18%, and during the 2000–2009 decade, the number of OA journals increased by 500% (Laakso et al., 2011).

OA articles are also experiencing notable growth.

- The DOAJ (2014) reports 1,573,847 OA articles as of March 2014.
- A study by Laakso et al. (2011) revealed the following:
  - Between 2000 and 2009, OA articles saw an annual growth rate of 30%, including articles deposited into OA repositories.
  - An average of 6.8% of the peer-reviewed journal articles published in 2009 and indexed in the three major indexes (Ulrich's, Scopus and ISI) were 'direct gold' OA articles.
  - Between 2000 and 2009, the number of OA articles increased by 900%.
  - The average yearly number of articles published per OA journal rose from about 20 to 40.
- Björk and Hedlund (2009) reported that about 5% of all peer-reviewed articles were published in OA journals.
- Dallmeier-Tiessen et al. (2011) calculated that about 120,000 scholarly OA articles were published in full or hybrid models in 2009, equalling about 8%–10% of the yearly global scientific scholarly article output.
- Overall, in the last decade, OA journal publishing has steadily increased its relative share of all scholarly journal articles by about 1% annually, according to Laakso and Björk (2012), who also noted the growth of commercial publishers, who, despite only a marginal presence a decade ago, have grown to become key actors on the OA scene, responsible for 120,000 of the articles published in 2011.
- In 2012, librarians and other industry experts at a roundtable discussion estimated that in the coming decade, the proportion of articles published as OA will rise anywhere from 15% to 50% (Harris, 2012).
- Lewis (2012) predicted that Gold OA, in particular, would 'become the dominant model for the distribution of scholarly journal content within the next decade,' accounting for 50% of the scholarly journal articles sometime between 2017 and 2021, and 90% of articles as soon as 2020 and more conservatively by 2025.

Journal publishers are also increasingly allowing article archiving. As compiled in SHERPA/RoMEO, from January 2004 to April 2014, the number of publishers' OA policies that allow some form of archiving grew steadily, from 80 to close to 1,700 (Figure 7). Of these, 31% allow post-print archiving (RoMEO Green), 33% allow pre-print and post-print archiving (Blue), and 9% allow pre-print archiving only. The remaining 27% of publishers do not formally allow any form of archiving but may agree to special arrangements with authors, particularly in the context of a funder mandate. Advocates of Green OA suggest that all significant stages of one's work—including the pre-print, the post-print and post-publication updates—be self-archived (ICTP, 2008).

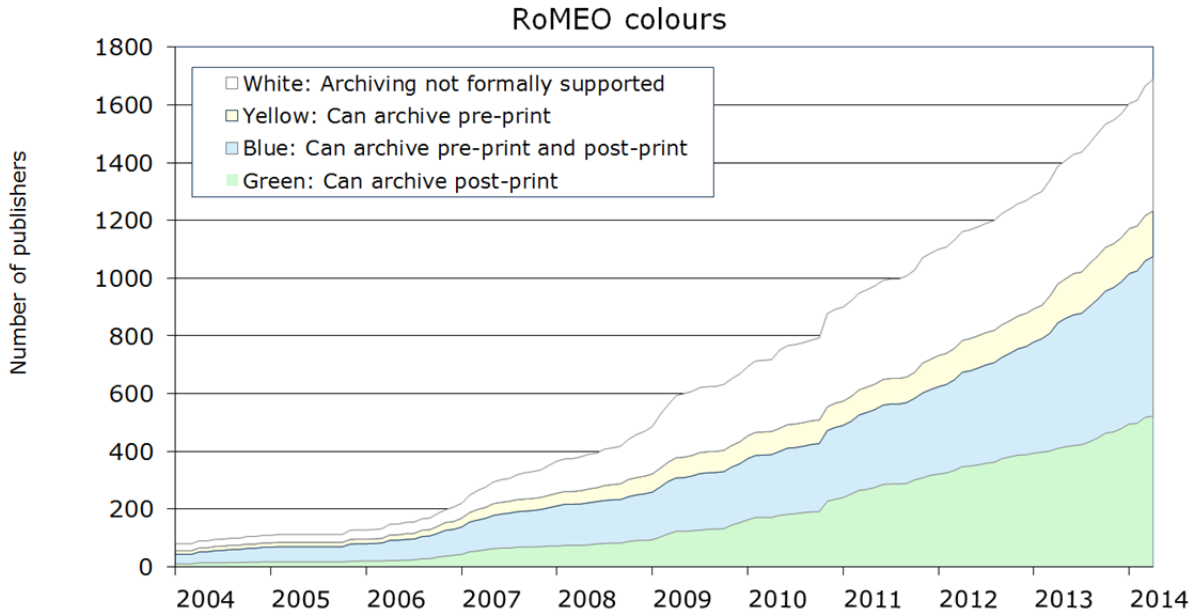

Figure 7 Evolution of publisher's policies as listed in SHERPA/RoMEO, 2004–2014

Source: Compiled by Science-Metrix using SHERPA/RoMEO data

Special programmes have also been put in place to offer greater access to researchers in institutions that cannot afford traditional journal subscriptions, including institutions in certain countries within the ERA. Research4Life[53] is a public-private partnership of the WHO, FAO, UNEP, WIPO, Cornell and Yale Universities, the International Association of Scientific, Technical & Medical Publishers, and Microsoft. Intended to facilitate the flow of knowledge from more developed countries to developing countries, it is subdivided into four separate programmes, each addressing the needs of researchers in specific disciplines.

- HINARI (Health InterNetwork Access to Research Initiative) provides free or low-cost access to over 8,500 journals in biomedical and related social sciences to local, not-for-profit institutions in developing countries.
- AGORA (Access to Global Online Research in Agriculture) provides free or low-cost access to over 3,000 journals in agriculture, fisheries, food, nutrition, veterinary science and related biological, environmental and social sciences to local, not-for-profit institutions in developing countries.
- OARE (Online Access to Research in Environment) provides free or low-cost access to over 3,900 journals in a wide range of disciplines relating to environmental sciences, not-for-profit institutions in developing countries.
- ARDI (Access to Research for Development and Innovation) provides free access to over 6,000 journals in a wide range of disciplines to local, not-for-profit institutions in developing countries and low-cost access to industrial property offices in developing countries.

Eligibility for these programmes depends on total gross national income (GNI), GNI per capita, human development index (HDI), and ranking on the UN's 'least developed country' list. Currently, the former Yugoslav Republic of Macedonia is the only ERA country eligible for these programmes.

[53] Research4life. (2014). *Programmes* [Web page]. www.research4life.org/about/.

The country is classified as 'Group B', and its institutions can benefit from low-cost, but not free, access.

The Essential Electronic Agricultural Library (TEEAL) is run by Cornell University's Albert R. Mann Library, in collaboration with major scientific publishers, societies, and index providers. It offers a low-cost, full-text searchable database of articles in agriculture and related fields. Intended to be accessible in countries with limited or unstable internet connections, the database is offered as a hard drive, with content spanning 1993 through the currently available update year.[54] Annual updates are offered at additional cost. Bulgaria, Latvia, Lithuania, Macedonia, and Romania are eligible.

The Scientific Electronic Library Online (SciELO) is an initiative launched in Brazil in the late 1990s to provide a better outlet for the publication of research conducted in developing countries, and to ensure better visibility and accessibility to this research. SciELO is both an electronic publisher and a repository, present in 12 Latin American and Caribbean countries as well as in Spain, Portugal, and South Africa. As of 2013, the cooperative has published over 472,000 articles in 1,150 journals.[55] SciELO has been described as an instrumental factor in the development of Latin American and Caribbean countries' capacity to publish high-quality peer-reviewed literature (Packer, 2010).

[54] TEEAL. (2014). *What is TEEAL? TEEAL: The essential electronic agricultural library* [Web page]. http://www.teeal.org/what-is-teeal.

[55] SciELO. (2013). *SciELO Network* [Web page]. http://www.scielo.org/php/index.php?lang=en.

5 Strengths and weaknesses of open access strategies

A number of scientific, financial and socio-political arguments for OA have been forwarded. The central argument for OA states that it improves the speed, efficiency and efficacy of research. Allowing researchers faster access to the information they need reduces duplication and results in better informed, more efficient research (Herb, 2010; Houghton & Sheehan, 2009; OASIS, nda; Swan, 2012). OA has also been said to increase the visibility and usage of research, with studies reporting an additional increase in usage of around 7–8% (Oxford University Press, 2006), and there is also some indication that it results in research having a greater impact due to increased citations.

Furthermore, and though the topic has been the subject of considerable debate (Ingwersen & Elleby, 2011), there is a clear 'citation advantage'. Based on a random sample of 1 million papers and using best practice bibliometric methods, an accompanying study report shows that Paid Access only papers are less cited on average across 22 fields than OA papers. OA has also been credited with reducing citation bias by authors, whereby authors cite only freely accessible articles and ignore the others, and hollow citations, whereby authors do not actually read the articles they cite (Kumar, 2009).

Financial arguments for OA assert that it relieves the serials crisis and saves the direct costs of print publication and dissemination (Gores, 2010), with the highest benefit/cost ratio being Green OA (Houghton et al., 2009, Harnad, 2010). A series of studies conducted to compare the economic implications of Gold and Green OA for UK universities according to their size and the intensity of their research concluded that the most economic benefits could be incurred by providing OA through the Green route during the transition period, and shifting to the Gold route once OA becomes a dominant practice (Swan & Houghton, 2012).

It is thought that OA will enable better peer review, as researchers can 'easily see and judge the work of their peers and can access data for re-analysis and independent confirmation of findings' (OASIS, nda). By making research visible to new communities, OA also creates opportunities for multi- or inter-disciplinary, inter-institutional and inter-sectoral research and collaboration. Post-publication review and comment are more easily implemented in open systems, and these types of exchanges can lead to more productive conversations about work (Lewis, 2012). In July 2013, a new scholarly site, Libre, was launched online. The platform allows researchers to solicit open reviews of manuscripts, which the site hosts. Authors are also encouraged to continually update their manuscripts in the light of the ongoing comments.[56] Greater societal benefits may result from the fact that OA reduces the digital divide, increases transparency and accountability, levels disparities and facilitates participation and results in better informed citizens (Davis, 2009; Herb, 2010; ICTP, 2008).

Given the fact that OA has recognised benefits for a number of stakeholders, why has it not been more readily adopted? Björk (2013) has noted that in the last decade, many of the biggest barriers (IT infrastructure, sustainable business models, recognition in the academic reward systems and critical mass) have been reduced. Still, certain bottlenecks continue to prevent OA from gaining greater acceptance among stakeholders. The literature shows that there is still a large gap between the acceptance of OA in principle and its actual use in practice. For example,

[56] LIBRE. (2014). *What is LIBRE?* [Web page]. http://www.openscholar.org.uk/libre/.

surveys suggest that high numbers of scholars support the new paradigm represented by OA, with one survey (Dallmeier-Tiessen et al., 2011) finding that 90% of researchers are convinced that OA is 'beneficial for their research field, directly improving the way the scientific community work,' and three-quarters of the respondents to another survey (Thorn, Morris, & Fraser, 2009) strongly supported OA. However, only one-third of researchers responding to the latter survey thought self-archiving was a good idea.

Other barriers include a lack of awareness among researchers, concerns about the quality and prestige of OA journals, concerns and confusion about copyright, the dissuasive influence of author-side fees, difficulties moving beyond the current system of subscription-based journals, a perceived lack of profitability surrounding OA business models and a lack of infrastructure to support OA in developing countries.

Lack of awareness of OA

Surveys show that the scholarly community is not yet aware of the potential of OA, that misinformation and misconceptions about OA abound, and that advocacy for OA has not succeeded in making a notable impact among researchers. Among working researchers, knowledge and awareness of OA is still low, though these are increasing incrementally (Xia, 2010). Awareness of OA among researchers is critical because it directly affects rates of deposits in OA repositories and submissions to OA journals.

A survey by Hubbard, Hodgson and Fuchs (2011) found that about one-third of researchers claimed to lack knowledge of the system. Another survey of researchers by Austin, Heffernan and David (2008) revealed that while only 2% of participants cited disagreeing with OA principles, more than half (59%) of respondents had never published in an OA journal, with 22% stating that they had not done so because they were either unfamiliar with the process or had no motivation to do so (because, for example, it was not adequately recognised or acknowledged for the purposes of promotion). Lack of awareness was also the main reason identified by 29% of these participants for not depositing an item into an institutional or other repository. Similarly, Bayer-Schur (2012) noted that while the 'ethos underlying open access repositories was appealing to most participants questioned,' a lack of knowledge—both in terms of appropriate repositories to deposit in and of the deposit process itself—was explicitly articulated as a barrier. Finally, Creaser et al. (2010) found that uncertainty over embargo periods was one of the three most frequently cited concerns regarding depositing in an OA repository among all authors surveyed, and authors in the medical sciences in particular claimed a lack of knowledge about how to deposit material. This lack of awareness also likely extends to policymakers, limiting the development of applicable policy.

As noted, awareness-raising will be a crucial role in the period ahead, especially for funders, libraries and OA publishers. Nearly half (47%) of the academic authors responding to the Austin, Heffernan and David (2008) study stated that they would like more information about OA opportunities. In particular, noted the European Commission (2008), it will be essential to instruct academics on how they can first publish in high-ranking journals and then subsequently deposit their articles in repositories, as well as to inform them about legal, technical, and organisational aspects.

Concerns about OA literature quality

In October 2013, *Science Magazine* published an article reporting on a 'sting' exercise designed to expose the flaws in the editorial processes of OA journals. The author of the article reported that more than half of the 304 OA journals to which he submitted a deliberately flawed article

accepted the paper. Although the validity of the conclusions of the paper was questioned, it echoed concerns over the quality of the editorial practices of some OA journals.[57] Simultaneously, publishers are restating the significant value-added that they bring to the publishing process to ensure quality.

Indeed, a prevailing attitude is that OA journals have 'little quality control, conflicts of interest, and no stamp of rigor or potential impact' (Agrawal, 2014). This longstanding perception of OA journals' editorial quality and quality control mechanisms have contributed to a lack of author acceptance (Björk & Solomon, 2012; European Commission, 2011b). Surveys of researchers indicate that OA publications are seen by many as not being of sufficient renown. Dallmeier-Tiessen et al. (2011) found that the second largest barrier that researchers claim prevents them from submitting to OA journals is the lack of journals of a (perceived) suitable quality; similarly, Hubbard, Hodgson and Fuchs (2011) noted that more than 90% of those who had not made use of OA options had not done so because they 'needed to publish in high-impact journals, thus implying that they do not believe OA journals to be sufficiently prestigious.' In a statistical time series analysis to examine the changing pattern of scholars' attitudes toward OA journal publishing from the early 1990s, Xia (2010) found that scholars have been consistently concerned with the 'low prestige of such journals and their lack of peer review, which is not the case in practice.' Concerns about quality are also extended to repositories: Creaser et al. (2010) found that unwillingness to place outputs where other content had not been peer-reviewed was one of the three most frequently cited concerns regarding depositing in an OA repository among the authors surveyed.

While prior to 2000, very few start-up OA journals were operated by reputable professional publishers, a number of professionally run, high quality OA journals have since been launched. It has been argued that neither the funding mechanisms nor the openness of journals correlate with their impact, prestige, quality of peer review, quality of authors, quality of editors or quality of referees (Suber, 2008; SPARC, 2011). OA journals employ various traditional as well as supplementary or alternative quality-assurance models—peer review, collaborative peer review, moderation, automatic assessment, and assessment by readers—and often a combination of models is used (European Commission, 2008). Recent research by Björk and Solomon (2012) comparing the scientific impact of OA journals with subscription journals found that OA journals indexed in Web of Science and Scopus have nearly the same scientific impact and quality as subscription journals, particularly those in biomedicine and journals that are funded by APCs.

Also important, the quality of records in repositories varies widely. Some of these records are barely populated with metadata and do not link with any full document or object (digital or real objects). It is one of the shortcomings of current repositories and repository aggregators to include all kinds of data and metadata, regardless of value and quality.

Concerns about prestige

Established interests, prejudice and traditions stand in the way of the widespread uptake of OA in the current academic reward system. OA has taken some time to reach critical mass, remaining a somewhat marginal phenomenon in the global scholarly communication system. It can take many years for journals to establish a reputation, so that most high-prestige journals are subscription-

[57] Joseph, H. (2013, October). *Science magazine's open access sting* [article]. http://www.sparc.arl.org/blog/science-magazine-open-access-sting.

based; this puts newly founded OA journals at a disadvantage. The literature on OA makes clear that there is still considerable resistance to changing the status quo, especially as changing publishing business models to OA has proven to be more difficult and time-consuming than most OA activists initially envisioned (Björk, 2004; Guédon, 2008).

Academics, in particular, continue to be conservative in their choice of publication forums. Much is at stake for researchers and faculty who want to publish in what they see as the best, most prestigious peer-reviewed journals. The current systems of peer review and publication are heavily associated with the authenticity of academic work and reliable allocations of credit, and OA threatens to upend that, despite the fact that the vast majority of OA journals still adhere to a conventional format. Further exacerbating the situation is the fact that the filtering of journals carried out by the ISI Web of Knowledge involves an acceptance rate of only around 10% of new candidate journals for indexing (Björk & Hedlund, 2009). However, according to Suber (2008), prestige is the only reason to submit work to a traditional journal, asserting that, in every other way, these journals are 'inferior to OA journals because they limit an author's audience and impact.' In other words, argues the author, prestige is their one remaining competitive advantage. As the accompanying study report on the measurement of OA availability shows, publishing in Paid Access only articles is fast becoming a certain road to lower scientific impact and, therefore, seeking that kind of prestige is fast becoming snobbish and vain.

Concerns about predatory publishers

A minority of new journals are operated by unscrupulous publishers, known as predatory OA publishers, who exploit the author-pays model of OA publishing for profit while providing little or none of the peer review services carried out by bona fide OA publishers. OA publishing attracts them as a growing segment of the scholarly communications market, with more than 1,250 journals added to the DOAJ in 2012 alone, and this growth is an opportunity to hide among the legitimate newcomers.

A useful, if quite controversial, list of suspected predatory publishers is maintained by Jeffrey Beall, librarian at the University of Colorado, Denver (Beall, 2013). The list of predatory publishers' reprehensible behaviours includes luring authors and guest editors under false pretences, acting as vanity press, publishing content without authors' formal agreement, making false claims regarding editorial boards or impact factors, plagiarism, and insufficient or inexistent peer review processes (Beall, 2012).

There are currently few safeguards against predatory publishers other than the awareness of individual authors. Internet literacy and social awareness of the risks are the key factors of vulnerability for other types of internet fraud (Bandyopadhyay, 2009). Fostering internet literacy may give authors the tools to recognise telltale signs of foul play. This weakness further contributes to the widespread misconception that peer review mechanisms are insufficient or nonexistent in OA publishing.

Concerns about copyright

While copyright issues with respect to OA remain unsettled, all of the emerging international OA protocols do explicitly require the abdication of copyright and limiting licensing restrictions for original work when publishing that work in an OA environment (Anderson, 2004; Rinaldi, 2008). The point of this is to enable the right for reuse for any responsible purpose, shifting from a 'model that uses copyright to control reuse of content to one that uses copyright to encourage republication, preservation, and translation' (Carroll, 2011).

This has been shown to pose a significant barrier to author acceptance. It is often assumed among authors that making their work OA infringes copyright, and the fear of resulting legal consequences has been identified as a crucial barrier to self-depositing in repositories (European Commission, 2011b; Pappalardo, 2008). One survey (Hubbard, Hodgson & Fuchs, 2011) found that around 40% of researchers were worried about copyright and the terms of their agreements with their publishers, and this prevented them from taking the Green route. Creaser et al. (2010) found that concern over copyright infringement was one of the three most frequently cited concerns regarding depositing in an OA repository among the authors surveyed. Finally, the second most significant reason identified by participants for not depositing an item into an institutional or other repository in the Austin, Heffernan and David (2008) study was uncertainty regarding their copyright position, chosen by 17% of respondents. Authors also simply may not know whether they have permission to upload a copy of their article onto a repository or website, nor do they know which version of their work they are allowed to deposit, tying into the lack of awareness of OA mechanisms (Bayer-Schur, 2012).

There have been some notable trends in terms of copyright and authors' rights, however. For instance, more scholars are choosing to post their articles online, even if they do not have their publishers' permission (which is called Robin Hood OA), and more journals are willing to negotiate the terms of their standard copyright transfer agreement (Suber, 2007). Authors hold the copyright for the pre-refereeing pre-print, in any case, so that it can be self-archived without seeking anyone else's permission. Furthermore, more journals are willing to let authors retain key rights (especially the right to post-print archiving). For those journals that do not give permission to self-archive a post-print, authors can attempt to modify the copyright transfer agreement to reserve the right to self-archive the post-print or can append or link a corrigenda file to the already self-archived pre-print (ICTP, 2008). Indeed, the OA environment has created a number of entirely new copyright models; among them, open content licensing such as Creative Commons licensing has become best practice, as it is 'well-understood, provides a suite of licences that cover all needs, and the licences are machine-readable' (Swan, 2012). Licensing through sample agreements and author addenda are other options (Pappalardo, 2008).

Author-side fees

Many authors are under the impression that they must pay out of pocket, using personal funds or funds from their research grants to pay for publication, a disincentive that frequently dissuades researchers from embracing OA. Almost 60% of the researchers in the Hubbard, Hodgson and Fuchs (2011) survey stated that the reason not to publish using OA methods is that it is too expensive, while the Dallmeier-Tiessen et al. (2011) survey found that the largest barrier to publishing is the availability of funding to pay publishing charges. Researchers using the hybrid model—opting to pay a fee to make their article OA in an otherwise subscription-based journal—pay some of the highest fees, which go beyond article processing and require the purchase of extra rights that go beyond statutory exceptions to copyright protection.

As a result, there is concern that OA may change the publishing system from one in which many cannot afford access to the literature to one in which many cannot afford to publish their findings. Additionally, while many publishers are reducing subscription costs in line with new OA revenue, some have been accused of engaging in so-called 'double dipping', where they accrue new revenue from OA charges without reducing the subscription price. This double funding of OA publications in the transition phase may ultimately increase the overall costs of scientific publishing (Imboden, 2009).

Another concern is that author-side fees may result in bias that favours author publication rather than peer review because the OA system would depend financially on author, not reader, payments, thus evolving into a system of 'vanity publishing' based more on the financial capacity of authors than on their merit or the rigour of their work (Abad, 2009; Bird, 2010; Hall, 2010; Suber, 2009).

As noted, however, author-side fees are often paid by institutions or written into research grants or may be reduced or waived by publishers in certain circumstances, and a number of OA publishers offer universities institutional memberships to buy the rights for their staff to publish a certain number of OA articles per annum. Additionally, two-thirds of the journals currently listed in the DOAJ do not charge APCs at all, so it would be wrong to assume that all Gold OA outlets operate on the author-pays model. Gold OA without APCs is associated with high impact factors, as demonstrated by Living Reviews in Relativity (IF=17.4) and Aldrichimica Acta (IF=16.1).

Lack of profitability

Again, the OA business model may not be seen as being lucrative for publishers who have made tidy profits from individual and institutional subscriptions and advertising revenue and who are often portrayed as being more interested in protecting their current revenue streams. After all, institutional funds have been heavily committed to journal subscriptions, and authors simply do not have the resources to replace all of these revenues in the immediate OA environment (Gores, 2010; Harnad, 2011). It is possible that established journals and publishers have not yet had strong enough incentives to change their business models, but it is expected that as OA mandates from funders and institutions become more common, subscription journals may see a decline in terms of the quality of the work they can attract (Lewis, 2012).

Lack of OA infrastructure, particularly in developing countries

OA should be of great importance to developing, emerging and transition countries: it increases the impact and visibility of researchers in these countries, makes research more accessible to them, reduces their isolation, improves opportunities for funding and international collaboration and raises the profile of an entire nation's research output (Kumar, 2009; ICTP, 2008). However, researchers and research institutions in these countries have less money to fund or publish research or to buy the research published elsewhere. An accentuated lack of access is also common. In particular, the information technology infrastructure—namely inadequate and unreliable ICT infrastructure and internet connectivity—represents a significant barrier, and this lack of availability will continue to hamper access even to OA material in these countries (Barbour & Patterson, 2006).

Researchers in developing countries may also lack the incentive to contribute to the OA global body of knowledge. For example, OA journals are of little benefit to developing country scholars wanting to publish in these journals because of the high cost of page charges, according to Papin-Ramcharan and Dawe (2006). OA via the Green road of self-archiving may not be an option for developing country researchers, due to a number of technical, financial, human, and infrastructural limitations. While some schemes to provide access have been instituted in these countries, they are not permanent, provide access only to a proportion of the literature, and do not make the literature open to all, but only to specific institutions (Swan, 2012).

6 Conclusion

The convergence of technological advances, increased research output and economic constraints has fuelled the growth of the OA movement in scholarly publications. What started as a subversive initiative, limited to a few fields of research—such as mathematics, physics and computer science—has gained substantial momentum, spread to almost all disciplines of research, and become a mainstream practice where supported by policy or infrastructure. Though only a few years ago research suggested that OA growth was modest, the present set of studies conducted by Science-Metrix for the European Commission provides undeniable evidence that the OA movement is disruptive and that OA is traversing the scientific, technical and medical publishing industry with the speed and force of a tsunami.

Considering that the sample size in this study is larger than in any previous studies (including Björk & Hedlund, 2009; Dallmeier-Tiessen, 2009; Harnad et al. 2008; Morgan et al. 2012 and others), these results either suggest that the proportion of peer-reviewed articles available in OA has been vastly underestimated or that the share of OA articles has grown significantly in recent years. Part of this growth is retroactive, as journals progressively open their archived content and as researchers self-archive their older work in OA repositories. The accompanying report on OA measurement suggests the backfilling added 700,000 older articles (published from 1996 to 2011) to the OA stack during the last year alone (April 2013 to April 2014). Growing awareness, new policies and infrastructure, as well as the growing credibility of OA journals and repositories, also account for a large part of OA growth. The sustained growth of Gold OA journals, which are now edging towards 10,000, are now accounting for 25% or more of all peer-reviewed or editorially-controlled academic and scientific journals.

As a consequence, the availability of papers in OA form is greater than 50% in all the examined countries for peer-reviewed journal articles published between 2008–2013. Even in countries with 'low' OA uptake, more than 50% of articles published in the 2008–2011 period were available in Green, Hybrid, or Gold OA. Green and Hybrid OA are more prevalent than Gold OA in every country with the exception of Brazil. Without being dominant, the Gold OA journals model accounts for a larger proportion of papers in Croatia, Estonia, Latvia, Lithuania, Malta, Poland, Portugal, Slovakia, Slovenia, Spain, Turkey, and the former Yugoslav Republic of Macedonia compared to other European countries.

The development of an OA culture among researchers can be fostered by institutions, funding bodies, and governments through initiatives that enable or provide incentives for the OA dissemination of peer-reviewed publications. Providing outlets and guidance for researchers who wish to publish or archive their work is fundamental and will be sufficient for certain researchers to adhere to OA. However, as demonstrated by the sharp rise in PubMed submissions following the NIH's decision to require OA, incentives are essential for reaching researchers who are reticent about OA or are deterred by the perceived trade-off between the costs and benefits of making their work OA. Efficient incentives include making OA mandatory to secure grants and the inclusion of OA requirements in researchers' performance evaluations, especially with respect to tenure.

Although policies and infrastructure at the national, institutional and funding body level clearly play a role in enabling the spread of OA practices among researchers, other factors also seem to play a role, especially given that OA represents close to or more than 50% of publications in countries for which there was no evidence of infrastructure or policies. This may be explained by the influence of regional infrastructure and directives as well as thematic repositories such as

arXiv allowing researchers to deposit their research outputs into repositories outside of their institution or country. Another possible explanation is that certain policies, either because they are not made public or because they are not translated, are not indexed in international registries and directories, and so were unaccounted for in this study. The high prevalence of OA articles in the absence of policies and infrastructure specific to OA could also be attributable to a general context favouring transparency and digital publication, such as in Estonia.

Governments can benefit from the implementation of OA. Greater access to research results accelerates the adoption and commercialisation of research findings, leading to increased returns on public investment in R&D. This investment may in turn lead to increased productivity and allow for the emergence of new industries based upon OA content. OA may also lead to better informed debate and policy. Governments that consider OA to be a strategic priority have established policies or a national infrastructure for OA content. The recent adoption of binding OA directives in the US and the UK is likely to induce a surge in the proportion of OA peer-reviewed articles in these countries. Considering the large scientific output and relatively high impact of research conducted in the US and UK, these directives might indeed shift prestige from toll access to OA, leading to greater acceptance of OA worldwide by ripple effect.

Barriers will remain, and institutions, funding bodies, governments, publishers, and researchers will need to adapt to the shifting scholarly publishing landscape. However, in light of the results of this examination, it is clear that OA has become the dominant form of dissemination of peer-reviewed scholarly articles in the ERA, Brazil, Canada, Japan, and the US, and the days of back end Paid Access to scientific papers as a globally relevant form of diffusion of scientific knowledge are counted.

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