Open Access Strategies in the European Research Area

August 2013

Science-Metrix

Julie Caruso, Aurore Nicol & Eric Archambault

Open Access Strategies in the European Research Area

August 2013

Produced for the
European Commission DG Research & Innovation
RTD-B6-PP-2011-2: Study to develop a set of indicators to measure open access

The views expressed in this report are those of the authors and
do not necessarily represent the views of the European Commission

by **Science-Metrix Inc.**
Brussels | Montreal | Washington
1335 Mont-Royal E., Montréal
Québec, Canada, H2J 1Y6
1.514.495.6505
info@science-metrix.com
www.science-metrix.com

Cover image: iStockphoto

Executive Summary

This report presents an overview and analysis of strategies towards open access (OA) of peer-reviewed publications in the European Research Area (ERA), Brazil, Canada, Japan and the US from the year 2000 onwards. The analysis examines strategies that aim to foster OA (e.g. researcher and institutional incentives) 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 2000, and comments on themes and debates that have emerged from the 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 proposed in the US and Brazil. 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), introduced in Congress in February 2013, would require all federal agencies with extramural research expenditures of over $100 million to develop a federal research public access policy. In Brazil, a bill (PL 1120/2007) was introduced in May 2007 proposing that all public institutions of higher education and research units be required to establish institutional repositories. However, the bill was archived in January 2012.

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, as well as the considerable influence of Jisc, a UK registered charity that aims to champion the use of digital technologies in UK education and research. The 2013 Policy on Open Access, drafted by the Working Group on Expanding Access to Published Research Findings, will make all government-funded research OA within five years, with a target of 45% in the first year.
- 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.

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 using data from JULIET, as well as BioMed Central (Funder Policies), ROARMAP and MELIBEA. The goal of this analysis was 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 15 mandates), followed by Canada (13), the US (4), Ireland (4) and Spain (3). No funder mandates could be found for the other examined countries (Brazil, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, Germany, Greece, Iceland, Latvia, Luxembourg, Malta, the Netherlands, Romania, Slovakia, the Former Yugoslav Republic of Macedonia, Liechtenstein, Lithuania, Poland, Portugal, and Slovenia). All in all, the number of policies alone is a weak indicator of commitment to OA in a given country.

An analysis of the 48 currently 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. Among these are:

- Coverage of article processing charges (APCs): 45.8% of funders indicated that they would cover the APCs, and 12.5% indicated that they would not. The remaining 41.7% of policies did not specify whether they would pay the fees.
- Preference for green or gold OA: None of the funder policies favoured gold OA, 39.6% favoured green, 2% mandated both green and gold, 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

Fewer databases exist for institutional OA policies than for funders' OA policies. Only ROARMAP and MELIBEA maintain extensive lists. According to these directories, Brazil, Canada, Japan, the US and ERA countries collectively have 231 institutional, multi-institutional, sub-institutional, and thesis OA mandates presently in place. Brazil, Canada, Japan, the US and the ERA countries collectively have 60 proposed institutional, multi-institutional, sub-institutional OA mandates and non-mandates. The largest number of mandates is in the US, followed by the UK, Finland, Italy and Portugal.

Some universities have set aside earmarked funds for the purposes of OA provision, and publishers may accept author requests to waive these fees. Many offer 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.

Effects of OA Strategies

An examination of OA availability was performed for the EU28, European Free Trade Association (EFTA), accession countries, the ERA, and four additional countries—Brazil, Canada, Japan, and the US.

- Considering the percentage of scholarly journal articles published between 2008 and 2011 that are OA, the EU28, EFTA, and ERA all have roughly the same share as that observed at the world level: around 43%, although notable differences exist among countries.
- Eight of the EU28 (30%) have reached the 'tipping point', where a majority (more than 50%) of papers published during the 2008–2011 period were made available for free, namely (by decreasing percentage of OA): the Netherlands, Portugal, Lithuania, Estonia, Denmark, Malta, Ireland, and Belgium.
- If the precision and recall of the harvesting instrument are considered, 20 of the EU28 countries (74%) would have tipped towards a majority of papers published between 2008-2011, and having been made available for free as of April 2013. The ERA countries have the same proportion of 74% when calibrating for precision and recall.
- Specifically, OA represents 50% or more of scholarly journal articles published between 2008–2011 in Belgium, Brazil, Croatia, Denmark, Estonia, Ireland, Israel, Lithuania, Macedonia, Malta, the Netherlands, Norway, Portugal, Switzerland, and the United States. If the precision and recall of the harvesting instrument is taken into account, Austria, Canada, Cyprus, Finland, Hungary, Iceland, Latvia, Liechtenstein, Luxembourg, Romania, Slovakia, Slovenia, Spain, and Sweden would also reach the 50% mark.
- When the smaller countries that have relatively few papers (less than 100 papers) are removed, the countries with the lowest rates of OA adoption are: Bulgaria, Poland, Greece, the Czech Republic, and Germany.
- Outside the ERA, the US has passed the tipping point, and Canada is approaching. Brazil's proportion of OA articles is even more notable at 63%.
- While green and hybrid OA account for the majority of available articles in all countries, gold journal publications are more frequently encountered in the Eastern part of Europe.
- Even in countries with low OA uptake, more than 40% of articles published in the 2008–2011 period was available in green, hybrid, or gold OA.

Institutional Response

Within the ERA, Brazil, Canada, Japan, and the US, nearly 8 million records are spread across 1,280 institutional repositories. Institutional repositories account for 28% of records in OA repositories (disciplinary repositories account for 38%, governmental repositories for 25%, and aggregating repositories for 9%). Importantly, these records are highly heterogeneous. OA institutional repositories contain digital images, music and text. Only a portion of the text files is made of peer-reviewed scholarly papers. Hence, the presence of records in repositories is not a

robust proxy for scientific papers availability, and will not be until repositories are characterise with all due care.

The survey of head librarians at universities and higher learning institutions asked respondents to identify all repository types maintained by their institution for OA scholarly publications. Nearly three-quarters (72%) of respondents selected central repositories, suggesting that many institutions appear to have at least one OA repository in spite of the absence of OA policy.

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 to 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. As the prices of serials have continued to rise faster than inflation, library budgets have increased moderately, stagnated or even decreased, a situation referred to as the 'serials crisis'. Since the beginning of the 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 opt out of big deals or negotiate the terms of subscriptions contracts.

Although it is commonly assumed that there exist 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 factor of their articles. However, OA journals have been challenged with adopting a funding model that is consistent with their survival. Several models for OA publishing have emerged that differ with respect to type of content access, the retention of author's rights and the type of financing. 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), that have had a positive impact on the credibility of OA peer-reviewed publications.

Journal publishers are also increasingly allowing article archiving. From January 2004 to December 2012, the number of publishers' OA policies that allow some form of archiving grew steadily, from 80 to 1,313. Of these, 31% allow post-print archiving, 9% allow pre-print archiving only, and 28% (including gold OA journals) allow pre-print and post-print archiving. The remaining 32% 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.

Strengths and Weaknesses of OA

Several strengths of the OA model have been proposed in the literature. For example, it improves 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.

However, a number of weaknesses and barriers to the acceptance of OA are also cited. There remains a gap between the acceptance of OA as principle and its actual use in practice. The main bottlenecks that have prevented OA from gaining greater acceptance among stakeholders include: 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 is poised to become the dominant form of dissemination of peer-reviewed scholarly articles in the ERA, Brazil, Canada, Japan, and US.

Contents

Executive Summary ..... **i**
Contents ..... **vi**
Tables ..... **vi**
Figures ..... **vi**
1 Introduction **1**
2 National open access strategies **3**
2.1 National and regional policies, incentives and legislation 3
2.2 Policies, incentives and legislation of public funding bodies 7
OA Policies Across Countries 8
3 Research institutions' open access strategies **13**
4 Effects of open access strategies **16**
4.1 National uptake of OA 16
4.2 Institutional responses to OA 17
4.3 Effects of OA and responses of scientific journal publishers 22
5 Strengths and weaknesses of open access strategies **31**
6 Conclusion **37**
References **39**

Tables

Table 1 Perceived priority given to Open Access scholarly publications at the national and organisational levels 13
Table 2 Prevalence of Open Access policies for scholarly publications in universities and higher learning institutions 14
Table 3 Proportion of OA papers per country, 2008-2011 17
Table 4 Types of repositories used to archive open access scholarly publications 18
Table 5 Incentives used to promote open access archiving and publication of scholarly publications 20

Figures

Figure 1 Currently implemented and proposed funder mandates within the ERA and in selected countries 8
Figure 2 Manuscripts submitted for inclusion in PubMed Central in compliance with the NIH Public Access Policy 10
Figure 3 Institutional, multi-institutional, sub-institutional, and thesis mandates within the ERA and in selected countries 14
Figure 4 Non-mandates and proposed institutional, multi-institutional, sub-institutional mandates within the ERA and in selected countries 15
Figure 5 Uptake of OA by universities, illustrated as the number of institutional repositories and number of items contained in institutional repositories. 21
Figure 6 Evolution of libraries' serials expenditures 26
Figure 7 Evolution of publisher's policies, 2004-2012 28

1 Introduction

Borne on the back of the digital revolution, the open access (OA) movement continues to transform 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 dissemination across diverse publishers, geographical regions and scientific disciplines.

The OA movement threatens to disrupt the dominant subscription-based model of scholarly publishing, shifting it from a demand-side, 'reader pays' system to a supply-side, 'author pays' system and, in turn, transforming everything from publications processes to business models.

Scholarly journal subscription prices have increased 200% from the mid-1990s to the mid-2000s—a rate six times more than inflation during the period (Kumar, 2009)—and this fact has greatly 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.

The two main routes to OA—green and gold—were originally viewed as complementary strategies that would interact and gradually form a coherent OA scholarly communication system. However, in practice, repositories and journals have progressed on parallel tracks (Guédon, 2008; Pinfield, 2009). This has created tension among the different players, with fracture lines most apparent between academia and publishers. It may be a long time before a balance is struck among the various competing modes of scholarly publishing and communication. However, the interests of the different parties are not necessarily mutually exclusive (for example, journals can work effectively with repositories), and all groups have shown some willingness to innovate.

This report presents an analysis of OA strategies in the European Research Area (ERA)[1], Brazil, Canada, Japan and the US from 2000 onwards. The analysis examines strategies that aim to foster OA—such as types of incentives given at the researcher and institutional levels and the level of compliance by researchers and funded organisations—as well as how, and whether, 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 review also presents some of the more significant barriers to the greater adoption of OA. The main stakeholders and beneficiaries of OA, their individual roles in the movement and the impacts of various strategies on these groups are also discussed, where relevant.

The report is organised as follows. The first section (Section 2.1) discusses governmental OA strategies, including national and regional legislation for peer-reviewed publications. This analysis also examines funding bodies' policies, including OA rules for grant recipients (Section 2.2). This is followed by an examination of research institutions' strategies; in practice, this

[1] 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, United Kingdom.

relates mostly to universities (Section 3). Section 4 examines the effects of these policies, including the uptake of OA by country (% of OA and of Gold OA) (Section 4.1), institutional response (e.g., presence of repositories) (Section 4.2) and effects on, and responses of, publishers of scientific journals, including the effects of 'big deals' (Section 4.3). Finally, Section 5 compares the strengths and weaknesses of existing OA strategies for peer-reviewed publications in the ERA and selected countries.

2 National open access strategies

2.1 National and regional policies, incentives and legislation

Governments are increasingly aware of the benefits of endorsing and implementing national OA strategies. For instance, greater access to research results will accelerate and broaden opportunities for 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) (Houghton & Sheehan, 2009). OA may also have positive impacts on policy development through better informed debate and enhanced access to the information underpinning policy decisions. In many European countries, national policy debates are centred on information access and dissemination activities, including publications and data, the development of repositories and stakeholder involvement (European Commission, 2011a). Those governments that consider OA to be a particularly important science and research strategic priority have established national archives for OA content or harvesting systems that can access OA material through national portals (de Blaaij, 2006; European Commission, 2011a).

Although legislation directly addressing OA has been proposed in the United States and Brazil, most national governments 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 does not directly address OA).

In the 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 United States became the first country to adopt a national OA mandate. The Act states: 'The Director of the National Institutes of Health shall require that all investigators funded by the NIH submit or have submitted for them to the National Library of Medicine's PubMed Central an electronic version of their final, peer-reviewed manuscripts upon acceptance for publication, to be made publicly available no later than 12 months after the official date of publication: Provided, That the NIH shall implement the public access policy in a manner consistent with copyright law.' Although the Act applied only to NIH-funded research, the Institutes' annual budget of more than $30 billion accounts for a substantial number of papers published annually (NIH, 2013).

In February of 2013, the Fair Access to Science and Technology Research Act (FASTR) was introduced in Congress. If passed, it will require all federal agencies with extramural research expenditures of over $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 it will require each federal agency to submit annual reports on its federal research public access policy. FASTR replaced the Federal Research Public Access Act (FRPAA), which was introduced successively in 2006, 2009, and 2012 but never voted on. At the time of writing, FASTR had not been passed but had been referred to the US Senate Committee on Homeland Security and Governmental Affairs (S.350) and to the House Committee on Oversight and Government Reform (H.R.708).

On February 22, 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 $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.' According to the OSTP, the directive was issued in response to a *We the People* petition asking for expanded public access to the results of taxpayer-funded research. This directive is very similar to FASTR but could be rescinded by another future president. The OSTP directive was criticised by OA advocates for allowing too many restrictions and exceptions; however, its potential impact is considerable, with 24 federal agencies affected. Considering the significance of the research output of the US, the directive's application is likely to have a sizeable impact on the spread of OA in the peer-reviewed publications market.

In Brazil, a bill was introduced in May 2007 (PL 1120/2007) proposing 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 (Brazil House of Representatives, 2007). 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. Science-Metrix found no evidence of legislation stemming from the bill.

The UK is a leader in the development of OA to peer-reviewed publications. Major stakeholders in the allocation of public research funds, such as the Higher Education Funding Council for England (HEFCE) and the Research Councils UK (RCUK), have pushed for greater public access to publicly supported research. The development of OA in the UK has also benefited from JISC's influence. This unique organisation receives its funding from higher education and further education funding bodies. In turn, it provides initiative, 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, OpenDOAR, 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 aim to propose a programme of action to broaden access to research findings and outcomes (Research Information Network, 2011). The Group, supported by the Department of Business and Skills (BIS), the Publishers Association, Research Councils UK (RCUK), and the Higher Education Funding Council for England (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).

Later that year, the RCUK announced that it would modify its policy to require gold OA, and Mark Thorley[2] stated that the Councils would 'provide block grants to universities for paying Article Processing Charges (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

[2] 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.

policy' (Suber, 2012). The announcement was met with much criticism. 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 Open Access with the maximum opportunity for re-use.' It will make all UK government-funded research OA within 5 years, with a target of 45% in the first year.

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, now must 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).

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 *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 (Kronman, 2012).

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 (CNRS, 2008). HAL's features to 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, with the exception of the social sciences and humanities branch of the *Agence nationale de la recherche*; thus, compliance to existing policies is still voluntary.

Croatia does not currently have an OA mandate at the national level. 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; Hrcak, 2013).

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 has 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 (Estonia.eu, 2013). 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 (Narusk, 2013. Estonian National Electoral Committee, 2013). Computer and internet

literacy may contribute to the development of an OA culture among researchers in the absence of a national mandate.

At the Europe-wide level, in August 2008, the European Commission launched the Open Access Pilot in 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, 2012).

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, 2007a). 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 consortium, 2012). Together, the infrastructure and services developed through DRIVER and OpenAIRE form a model that could facilitate the uptake and valorisation of OA on a large scale.

In July 2012, the EC emitted a Communication and a Recommendation to member states proposing to define clear policies to make all publicly funded research conducted within the EU OA 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 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 within the speech or through subsequent communications (as of April 1, 2013).

The OA policies of international research performing organisations, such as the World Bank, may also play a role in the spread of OA. 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 World Bank's new OA policy, effective since July 1, 2012, 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 (World Bank, 2012). 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 (Creative Commons Corporation, nd). 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 (World Bank, 2013). 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.[3]

2.2 Policies, incentives and legislation of public funding bodies

Research funding bodies aim to ensure maximum impact from the research they support by ensuring the widespread accessibility of publications arising from that research. Funders are also interested in bearing down on costs as much as possible. As most research is funded through taxpayers, public and private funders have implemented diverse policies mandating the deposit of their funded research outputs in open online archives so that it be made freely available on the internet (Houghton, Rasmussen & Sheehan, 2010; ICTP, 2008).

Funding bodies across Europe have put in place a multitude of initiatives. These include regulations and policies on OA that typically require researchers deposit results of funded research into an appropriate repository or publish in an OA journal (European Commission, 2011a). 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). Many research funders also allow OA publishing costs to be included in research budgets.

By mandating OA archiving, research funders could set in motion a significant 'ripple effect'. For instance, a US study by Houghton, Rasmussen and Sheehan (2010) estimated that the potential incremental benefits of an OA archiving mandate for all US Federal Research Public Access Act (FRPAA) agencies' funded R&D would be worth around $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 the Wellcome Trust's OA policy. The 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 (Wellcome Trust, 2012). Another example is the US-based NIH, whose policy requires grant recipients to make articles resulting

[3] Highly regarded and well-established definitions of OA are those provided by the three 'B's: the Budapest Open Access Initiative (BOAI, 2002), the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003) and Bethesda Statement on Open Access Publishing (2003). The Berlin Declaration and Bethesda Statement built on the definition developed in Budapest, which remains authoritative. BOAI defined 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).

from their grant funding freely available within 12 months of publication in a peer-reviewed journal.

OA 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 an additional 108 publishers (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.

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' (PubMed Central, 2012).

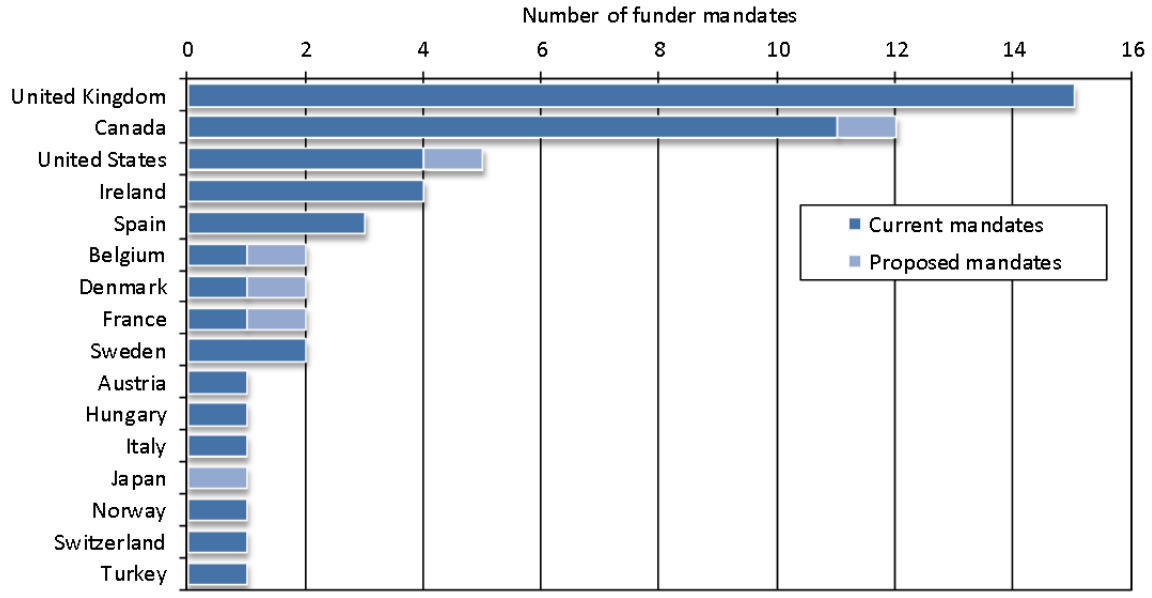

Figure 1 Currently implemented and proposed funder mandates within the ERA and in selected countries

Source: Compiled by Science-Metrix

For the following countries, no funder OA mandates appear in the databases used in this study: Brazil, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, Germany, Greece, Iceland, Latvia, Luxembourg, Malta, the Netherlands, Romania, Slovakia, The Former Yugoslav Republic of Macedonia, Liechtenstein, Lithuania, Poland, Portugal, and Slovenia.

The situation is unclear for Israel. 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[4]. However, no evidence of this could be found in other databases or on the Foundation's translated website[5]. 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.

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.

However, 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 and gathering such data would require a substantial investment. Still, a tentative analysis of the 48 currently implemented funder policies in the countries covered (registered as of 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 article processing charges (as part of the grants or separately), Science-Metrix found that over 40% of policies made no mention of APCs. 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 12 key points, 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 Open Access fee. The definition of OA will have an impact on the ability of users to create derivative works, commercial uses, or to 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

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

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

articles published as a result of NIH-supported research for this period is unavailable. However, considering that the NIH's total budget has increased 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, or they may leave that decision to the author. As of December 2012, none of the 48 funder policies reviewed favoured gold OA, 39.6% favored 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.

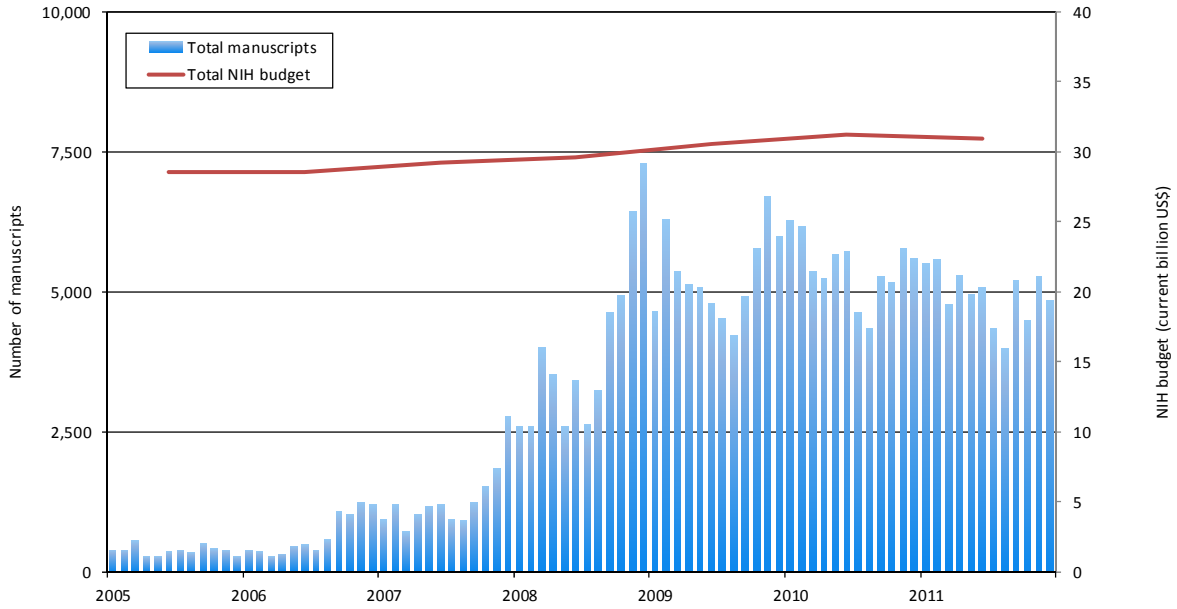

Figure 2 Manuscripts submitted for inclusion in PubMed Central in compliance with the NIH Public Access Policy

Note: Budget not indexed for inflation.
Source: NIH Manuscript Submission System (NIHMS, 2013) and NIH Office of Budget (2013) data compiled by Science-Metrix.

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. Ultimately, the most important characteristic of a repository—central, institutional, or otherwise—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 *et al.*, 2012).

Acceptable types of documents and metadata need to 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 might prove complicated, considering that projects may span many years, while funding and team composition fluctuate.

If the policy supports green OA, embargoes may be accepted to give publishers exclusivity for a limited time. Embargoes are characteristic of current publication contracts and not of green OA in itself. 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. 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 funder's 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 transfer to the publishers under the subscription access model. Permission must then be granted by the publishers to give open access. 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 common in the most 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 can come from the grant itself, they 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. Science-

Metrix analysed 48 funder policies and found that 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

Universities and research institutes often lead national OA initiatives. Many have also 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 (Chantavaridou, 2009). Also noteworthy, faculty groups have increasingly passed resolutions in support of OA (Blixrud, 2010).

Universities are chiefly concerned with managing their intellectual assets (not only articles but 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 (Nguyen, 2008).

More universities are requiring researchers to deposit their research in institutional repositories or participate in a shared repository; Harvard's 'model' Open Access Policy (2010) for the deposit of scholarly articles in OA repositories is one example. More than 100 universities have issued mandates requiring green posting from authors that have received funding from them (Björk & Paetau, 2012a). One study (Gargouri *et al.*, 2012) 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 and application development for OA repositories (Chantavaridou, 2009).

Some universities have also set aside earmarked funds for the purposes of OA provision, and publishers may accept author requests to waive these fees. For example, 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, 73% of respondents agreed or strongly agreed with the statement that 'Providing open access to scholarly publications is a priority in [their] organisation' (Table 1).

Table 1 Perceived priority given to Open Access scholarly publications at the national and organisational levels

	Head librarians (n=162)	
To what extent 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 percentage includes all respondents, including those who did not provide a rating.
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 open access policy regarding peer-reviewed scholarly publications (Table 2). This discrepancy could be attributed to a number of factors, including delays in the elaboration 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 (such as theses or data). Among the respondents whose institutions have an OA policy, 22% declared that it is not publicly available. This suggests that there may be relatively large gaps in institutional OA policies databases.

Table 2 Prevalence of Open Access policies for scholarly publications in universities and higher learning institutions

	Head librarians	
	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. Brazil, Canada, Japan, the US and ERA countries collectively have 231 institutional, multi-institutional, sub-institutional, and thesis OA mandates presently in place (Figure 3).

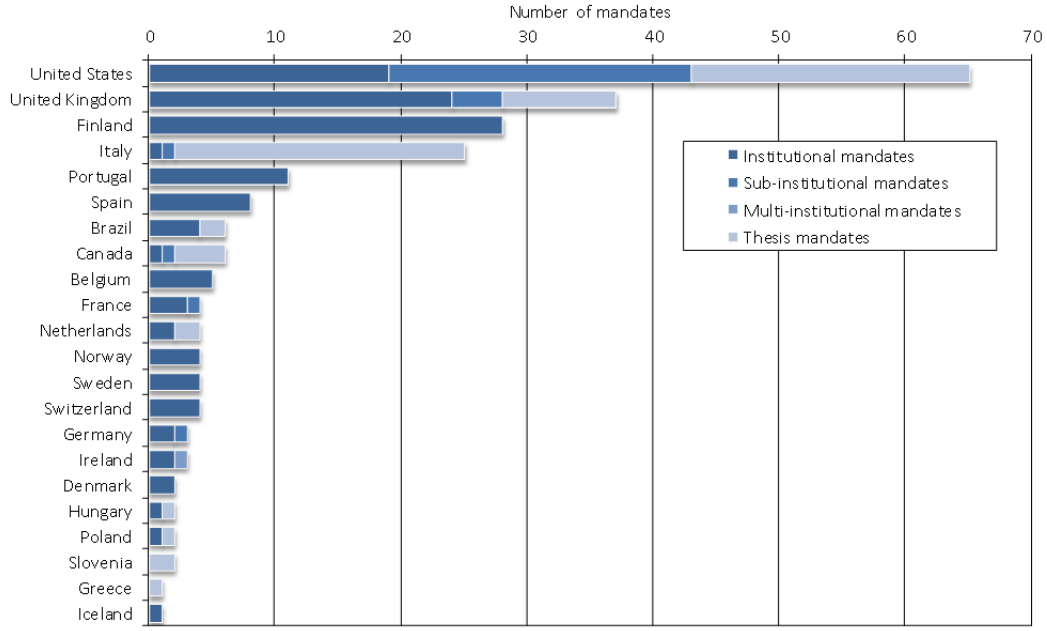

Figure 3 Institutional, multi-institutional, sub-institutional, and thesis mandates within the ERA and in selected countries

Source: Compiled by Science-Metrix

Once again, 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 the following countries: Austria, Bulgaria, Cyprus, Czech Republic, Estonia, Croatia, Israel, Japan, Liechtenstein, Lithuania, Latvia, Luxembourg, Macedonia, Malta, Romania, Slovakia, and Turkey.

Brazil, Canada, Japan, the US and the ERA countries collectively have 60 proposed institutional, multi-institutional, sub-institutional OA mandates and non-mandates (Figure 4). No such policies appear in the databases used in this study for the following countries: Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Israel, Ireland, Latvia, Liechtenstein, Luxembourg, Macedonia, Malta, Romania, Slovakia, Slovenia, Switzerland, and Turkey.

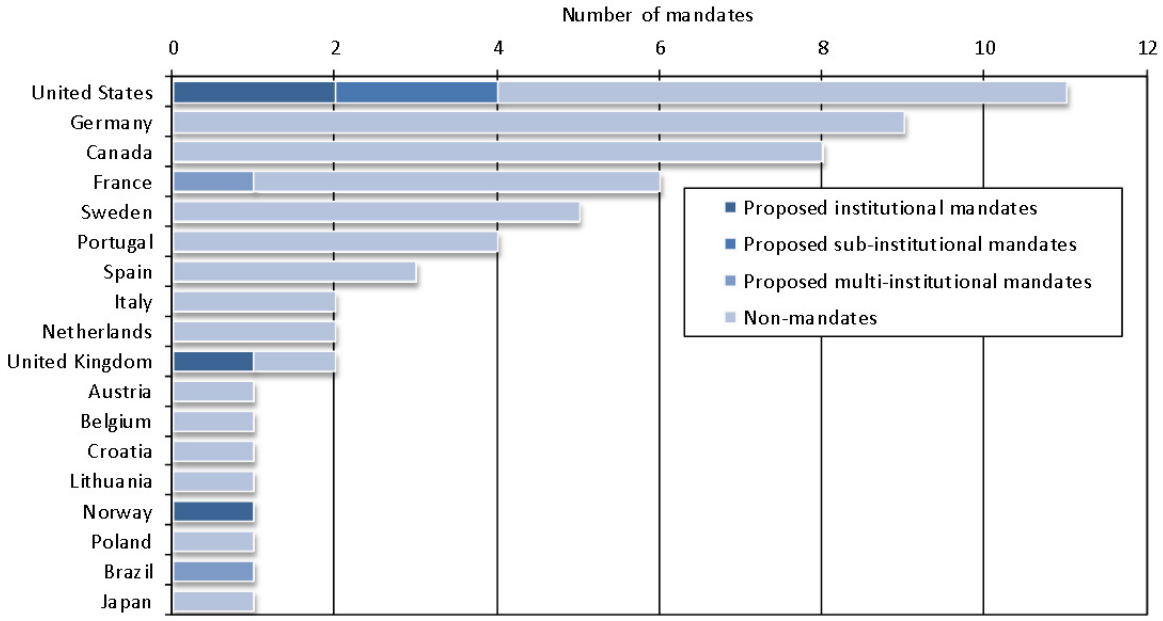

Figure 4 Non-mandates and proposed institutional, multi-institutional, sub-institutional mandates within the ERA and in selected countries

Source: Compiled by Science-Metrix

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, and gathering them would require substantial investments.

4 Effects of open access strategies

4.1 National uptake of OA

An examination of OA availability was performed for the EU28, the European Free Trade Association (EFTA), the accession countries, the European Research Area (ERA), and four additional countries—Brazil, Canada, Japan, and the US. Fractional counting was used due to its greater precision. In fractional counting, if two authors are from separate countries, each country is given half a publication; in contrast, full paper counting would have ascribed one paper to each country. An advantage of fractional counting is that fractions for all countries' outputs can be added in order to obtain a total, while a drawback is that statistics may not be as intuitive[6].

The EU28, EFTA, and ERA all have roughly the same level of OA as that observed at the world level (around 43% for the 2008–2011 period, a figure that is not recalibrated for precision and recall), although there are notable differences among countries (Table 3). For the 2008–2011 period as a whole, eight (about 30%) of the EU28 countries have reached a 'tipping point'. They are (in order of decreasing percentage of OA): the Netherlands, Portugal, Lithuania, Estonia, Denmark, Malta, Ireland, and Belgium. If the precision and recall of the harvesting instrument are taken into account, 20 out of 27 countries (74%) would have tipped towards a majority of papers published in 2008-2011 being made available for free in April 2013, considering that the retrieval instrument presents more false negative results than false positives (based on a 500-article calibration, the correction factor is 224/198, meaning actual results should be about 1.13 times the measured score).

When the smaller countries that have relatively few papers (less than 100 papers) are removed, the countries with the lowest rates of OA adoption are: Bulgaria, Poland, Greece, the Czech Republic, and Germany. In EFTA countries, both Norway and Switzerland have clearly tipped towards having a majority of papers in OA. Counting Israel, 14 (or 40% of) ERA countries had made the majority of their 2008–2011 papers freely available by 2013. Calibrating for precision and recall, the proportion of ERA countries that have more than 50% of papers in OA is 74%, the same proportion as for the EU28.

In countries outside the ERA, it is noteworthy that the US has passed the tipping point and Canada is getting close. Even more salient is the proportion of 63% 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.

While green and hybrid OA account for the majority of available articles in all countries, publishing in gold journals is much more frequently encountered in Eastern Europe. A clear pattern can be observed, as the percentage of papers in gold journals is greater in Macedonia, Croatia, Turkey, Malta, Lithuania, Estonia, Slovenia, Poland, Latvia, Slovakia, Spain, the Czech Republic and Romania.

[6] Archambault, É. et al. (2013). *Proportion of Open Access Peer-Reviewed Articles at the European and World Levels—2004-2011*. Produced by Science-Metrix for the European Commission. DG Research and Innovation.

Table 3 Proportion of OA papers per country, 2008-2011

Group	Country	Papers in Sample	Green & Hybrid		Gold		OA	
			Papers	%	Papers	%	Papers	%
EU28	Austria	1,349	545	40 ± 3	105	8 ± 1	650	48 ± 3
	Belgium	2,088	939	45 ± 2	126	6 ± 1	1,065	51 ± 2
	Bulgaria	293	91	31 ± 5	21	7 ± 3	112	38 ± 6
	Croatia	403	147	36 ± 5	95	24 ± 4	242	60 ± 5
	Cyprus	88	35	40 ± 11	3	3 ± 4	38	43 ± 11
	Czech Republic	1,252	411	33 ± 3	130	10 ± 2	541	43 ± 3
	Denmark	1,392	633	45 ± 3	103	7 ± 1	736	53 ± 3
	Estonia	161	63	39 ± 8	23	14 ± 6	86	53 ± 8
	Finland	1,178	488	41 ± 3	80	7 ± 1	568	48 ± 3
	France	7,959	3,205	40 ± 1	472	6 ± 0.5	3,677	46 ± 1
	Germany	10,531	4,026	38 ± 0.9	673	6 ± 0.5	4,699	45 ± 0.9
	Greece	1,336	452	34 ± 3	116	9 ± 2	568	43 ± 3
	Hungary	709	279	39 ± 4	49	7 ± 2	328	46 ± 4
	Ireland	833	358	43 ± 3	75	9 ± 2	433	52 ± 3
	Italy	6,094	2,389	39 ± 1	421	7 ± 0.6	2,810	46 ± 1
	Latvia	71	23	32 ± 11	8	11 ± 8	31	44 ± 12
	Lithuania	228	88	39 ± 6	35	15 ± 5	123	54 ± 7
	Luxembourg	37	13	35 ± 17	2	5 ± 9	15	41 ± 17
	Malta	23	8	35 ± 21	4	17 ± 17	12	52 ± 22
	Netherlands	3,759	1,936	52 ± 2	263	7 ± 0.8	2,199	58 ± 2
	Poland	2,474	707	29 ± 2	326	13 ± 1	1,033	42 ± 2
	Portugal	1,047	479	46 ± 3	97	9 ± 2	576	55 ± 3
	Romania	734	289	39 ± 4	75	10 ± 2	364	50 ± 4
	Slovakia	368	127	35 ± 5	41	11 ± 3	168	46 ± 5
	Slovenia	358	110	31 ± 5	50	14 ± 4	160	45 ± 5
	Spain	5,461	2,074	38 ± 1	604	11 ± 0.8	2,678	49 ± 1
	Sweden	2,301	922	40 ± 2	181	8 ± 1	1,103	48 ± 2
	United Kingdom	11,781	5,100	43 ± 0.9	728	6 ± 0.4	5,828	49 ± 0.9
	Total EU28	53,622	20,204	37 ± 0.4	4,192	8 ± 0.2	24,396	45 ± 0.4
EFTA	Iceland	85	39	46 ± 11	3	4 ± 4	42	49 ± 11
	Liechtenstein	6	1	17 ± 38			1	17 ± 38
	Norway	1,159	494	43 ± 3	110	9 ± 2	604	52 ± 3
	Switzerland	2,642	1,214	46 ± 2	208	8 ± 1	1,422	54 ± 2
	Total EFTA	3,830	1,705	45 ± 2	319	8 ± 0.9	2,024	53 ± 2
Candidate	Turkey	2,873	657	23 ± 2	598	21 ± 1	1,255	44 ± 2
	Macedonia	39	15	38 ± 16	11	28 ± 15	26	67 ± 16
	Total Candidate	3,303	672	23 ± 2	608	21 ± 1	1,280	44 ± 2
	Israel	1,376	640	47 ± 3	92	7 ± 1	732	53 ± 3
Total ERA		59,852	22,085	37 ± 0.4	5,009	8 ± 0.2	27,094	45 ± 0.4
Others	United States	41,740	20,894	50 ± 0.5	2,535	6 ± 0.2	23,429	56 ± 0.5
	Japan	9,703	3,264	34 ± 0.9	804	8 ± 0.5	4,068	42 ± 1
	Canada	6,676	2,885	43 ± 1	411	6 ± 0.6	3,296	49 ± 1
	Brazil	4,224	876	21 ± 1	1,799	43 ± 1	2,675	63 ± 1
World		160,000	53,072	33 ± 0.2	15,538	10 ± 0.1	68,610	43 ± 0.2

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

4.2 Institutional responses to OA

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 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 at universities and higher learning institutions 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, surprisingly, many institutions appear to have at least one OA repository but no OA policy.

Table 4 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%
	184	

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

The limitations of using the contents of OA repositories should be noted. 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 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. 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 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.

Longer-term challenges faced by digital repositories include intellectual property rights, data curation and long-term preservation (DRIVER, 2008). Infrastructure development, in particular, remains a major issue; technical challenges that can arise with repositories include the non-uniformity of manuscript files and metadata formats, embargo management and author authentication for repository deposit (Pinfield, 2009; Wallace, 2011). 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 also critical, but the repository infrastructure is still relatively new, leading 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.

The promotion of OA within the academic community is another challenge in the implementation of policies. 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 where an OA policy is in place, compliance is not absolute. 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 5). 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.

As the concept of open access 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 gone above and beyond in their 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 (University of Southampton, 2013). 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 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).

Table 5 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%
Don't know/Not applicable	11	7%
	207	

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

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 and 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 OpenDOAR (SHERPA, 2006). 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 on OA, providing timely and accurate information about OA, 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. Surprisingly, the university does not have an institution-wide OA policy. Each school within the university can take part in the policy. Eight out of fifteen 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. It does however have a common institutional repository (Presidents and Fellows of Harvard College, 2010).

Cornell University co-owns and operates arXiv, clearly one of the most important OA repositories in existence. The university's Faculty Senate passed a resolution on scholarly publishing in May 2005. The resolution called for all faculty to 'become familiar with the pricing policies of journals in their specialty,' to 'negotiate with the journals in which they publish either to retain

intellectual property rights and transfer only the right of first print and electronic publication, or to retain at a minimum the right of post-print archiving,' and to 'to deposit preprint or postprint copies of articles in an open access repository such as the Cornell University DSpace Repository or discipline-specific repositories such as arXiv.org.' 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'(Cornell University Library, 2005). 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 (Cornell University, 2009).

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. Within the ERA, Brazil, Canada, Japan, and the US, nearly 8 million records are spread across 1,280 institutional repositories. Their repartition is shown in Figure 5. Countries above the regression line, such as the Czech Republic and Belgium, have larger repositories (more records per repository) while those below the line, such as Croatia and Norway, have comparatively more but smaller repositories relative to other countries.

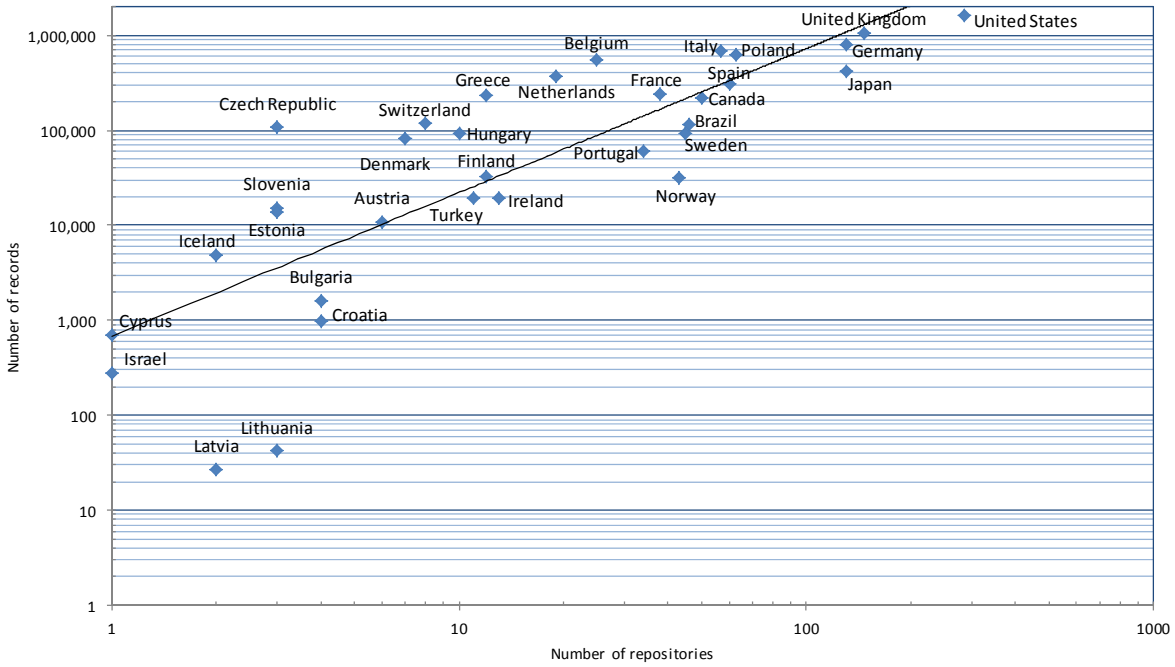

Figure 5 Uptake of OA by universities, illustrated as the number of institutional repositories and number of items contained in institutional repositories.

Source: Compiled by Science-Metrix from DOAR and OpenDOAR.

Twelve countries, Austria, Bulgaria, Croatia, Cyprus, Estonia, Iceland, Ireland, Israel, Latvia, Lithuania, Slovenia, and Turkey, have less than 30,000 records in their respective institutional repositories. Only six countries, Liechtenstein, Luxembourg, Macedonia, Malta, Romania and Slovakia had no institutional repositories that could be localised at the time of writing. Institutional repositories account for 28% of records in OA repositories, whereas disciplinary repositories account for 38%, governmental repositories for 25%, and aggregating repositories for 9%.

4.3 Effects of OA and responses of scientific journal publishers

As publishers' income is traditionally generated largely via subscription, some of them fear that OA could potentially undermine existing business models, particularly if embargo periods and other restrictions on use and re-use 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 exist vested interests to preserve the status quo of the current subscription market (Laakso & Björk, 2012).

In practice, however, publishers are vastly different stakes, and responses towards OA including perceiving this radical change in the industry change as an opportunity or as a threat. Those who choose OA benefit from wider dissemination, maximised market reach, greater visibility and higher journal citation impact factor of their articles (Crow, 2009; ICTP, 2008). 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, the retention of author's rights and the 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; newer OA journals typically adopt 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).
2. *OA journals that are free for authors and readers of the online version, with subscription payment for the paper version*. These journals, which represent approximately 28% of OA journals, 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-profit publishers than commercial ones.
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. Publication fees vary greatly; Bird (2010) found that the majority (69%) of such journals charge between $1,000 and $3,000 USD per article, and Solomon and Björk (2012) reported that they ranged between $20 and $3,800 USD, averaging $900 USD. Fees may be paid by the authors themselves, the institutions to which they belong, libraries and/or agencies that finance research (Waters, 2008). A different 'author-pays' model was proposed by newly established publisher PeerJ, where authors can buy a lifetime membership between 100$, for one published paper per year, and 350$, for an

unlimited number of published papers per year (PeerJ, 2013). 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, subscription journals that provide authors who pay publication fees with the option to allow OA to their articles (Houghton, 2009b). 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).
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.
6. *Journals with free access to the contents after a period of embargo*. Also referred to as 'delayed OA', this model offers a compromise between OA and subscription. While paying subscribers get immediate access, free access is allowed after an 'embargo' period (Houghton, 2009b). 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.

To date, the most significant challenge facing OA journals around the world has been adopting a funding model that is consistent with their survival. 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; European Commission, nd; Frantsvåg, 2010; Friend, 2011):

- article processing charges,
- 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, and to this day much of the growth in OA has been propelled by independent, society and newly established OA publishers. However, in recent years, many traditional commercial publishers have established sizable OA journal operations or have extended their hybrid OA operations. 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 (SpringerOpen, 2013). Elsevier owns 31 OA journals and recently acquired the open science social network Mendeley (Wise, 2012; Douglas, 2013).

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. '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 Publsihing Group has followed suit with a maga journal called *Scientific Reports*. Some journals have even dropped their print editions to become solely digital (Suber, 2007).

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 organisations' revenues have exceeded expenses since 2010 (PLoS, 2011; PLoS, 2012). OA journals also offer a simple solution to authors and institutions that are not comfortable with the self-archiving process or lack 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 toll-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.

In addition to finding a financing strategy that works, OA journal start-ups must attempt to build a reputation and an author base while charging authors for publication in an unproven journal. Given these challenges, adoption of the gold model (whereby the publisher manages the distribution of, and access to articles) has been rather slow (Björk & Paetau, 2012a). About 10% of all scholarly journals are gold OA, and the majority of these are newly created, electronic-only journals or established journals that make their electronic versions available but finance their operations with income from their print versions (Björk, 2011).

Impacts of Publisher Response on Authors

The research life cycle begins with authors, the initial copyright holders of the publications (Waaijers, 2009), and it is authors who will ultimately decide whether OA becomes popular. 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). By engaging in OA, authors will gain a larger potential audience than

any subscriber-restricted journal can give them, even the most prestigious, and potentially increase the impact of their work (SPARC, 2004). It will also equal time savings by shortening the delay between acceptance and publication in an OA journal. Repositories may also lead to time saved, as authors no longer have to respond to email requests for copies of their articles (OASIS, nda). As users of research, they 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 re-use, 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 EU's 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 funder and university-level mandates are increasingly influencing authors' choices of where to publish. This suggests that there may remain a 'culture of mistrust and misunderstanding about open access amongst researchers' (Harris, 2012).

A JISC/Romeo survey of more than 10,000 scholarly journals reported that 90% had given their authors the green light to self-archive (Harnad *et al.*, 2008). These publishers typically allow authors to publish their manuscripts in repositories prior to peer review (pre-prints) or after publication in a journal (post-prints). Indeed, 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). Nevertheless, take-up of green OA has been estimated to remain relatively low—only about 10–20% of articles have been self-archived, and Elsevier has recently reported that the green archiving of accepted manuscripts remains at 4–5% (Harnad *et al.*, (2008); 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 Publisher Response on Libraries

According to the Association of Research Libraries (ARL), in 1986, the price of scholarly journal subscriptions rose by 18% in one year and 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, 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', or journal bundles. Big deals refer to contracts 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 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 deals practices and to an increase in absolute scientific output in the form of peer-reviewed articles over this period.

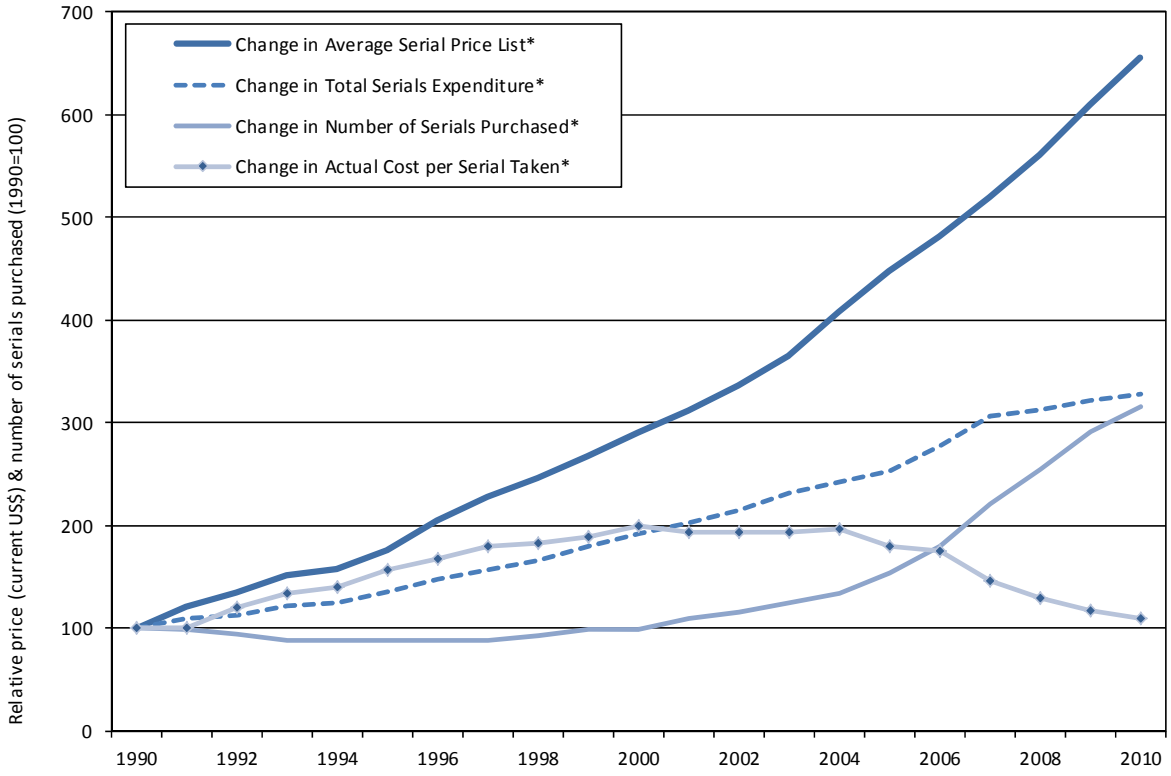

Figure 6 Evolution of libraries' serials expenditures

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, their overall budget has been stretched to its limit. In fact, 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 serials 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. 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.

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 (Suber, 2007). 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. These investigations have demonstrated a modest growth of OA. Overall, between 1993 and 2009, OA journals experienced an annual growth rate of 18%, and during the decade 2000–2009, the number of OA journals increased by 500% (Laakso *et al.*, 2011). According to the Directory of Open Access Journals (DOAJ) (2012), the primary index of OA journals, as of December 2012 there were 8,453 quality-controlled scientific and scholarly OA journals, up from the original 350 in May 2003.

Regarding the growth of individual OA articles, Laakso *et al.* (2011) reported an annual growth rate of 30%, including those articles deposited into OA repositories. The authors also reported that 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. In 2009, Björk and Hedlund reported that about 5% of all peer-reviewed articles were published in OA journals. Dallmeier-Tiessen *et al.* (2011) also 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. Between 2000 and 2009, the number of OA articles increased by 900%, while the average yearly number of articles published per OA journal rose from about 20 to 40 (Laakso *et al.*, 2011). Overall, in the last decade, OA journal publishing has steadily increased its relative share of all scholarly journal articles by about 1% annually (Laakso & Björk, 2012). 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).

From January 2004 to December 2012, the number of journal publishers' OA policies that allow some form of archiving has been growing steadily from 80 to 1,313 (Figure 7). Of these 1,313, 31% support post-print archiving, 9% support pre-print archiving only, and 28% support pre-print and post-print archiving. Gold OA journals are assigned to the latter category. The remaining 32% of publishers do not formally support any form of archiving but may agree to special arrangements with authors, particularly in the context of a funder mandate.

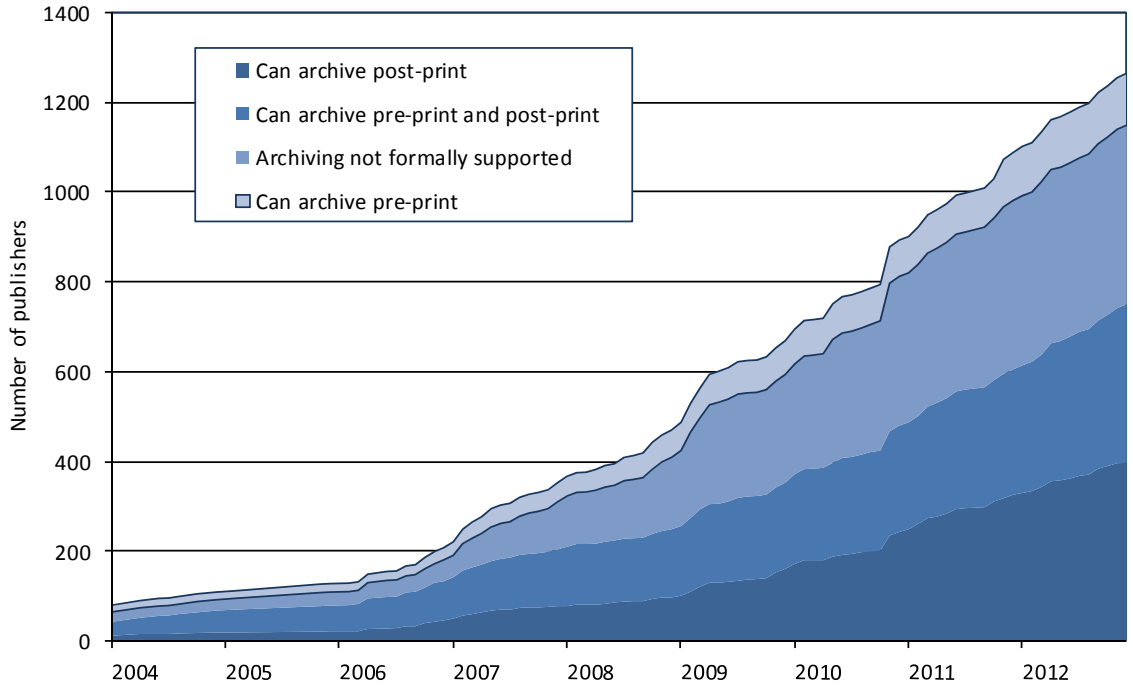

Figure 7 Evolution of publisher's policies, 2004-2012
Source: Data from SHERPA/RoMEO compiled by Science-Metrix

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 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 least developed country list. Currently, the former Yugoslav Republic of Macedonia is the only ERA country eligible for these programs. 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 2009 (TEEAL, 2010). 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. So far, the cooperative has published over 400,000 articles in 1,057 journals (SciELO, 2013). 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).

While the primary target of OA was once the journal literature, the movement has grown to encompass masters' theses and doctoral dissertations, e-books and research data. In particular, e-books are of growing interest to research libraries and their users; these are projected to be the next large form of content to be made available to the user (Ayris, 2009). Similarly, e-theses, which are increasingly available in OA from institutional repositories, are gaining greater visibility and greater importance to the research community. As such, there is a growing movement to make such theses even more discoverable, where possible, and e-theses projects have been 'estimated to lead the next pan-European projects related to open access' (Chantavaridou, 2009). For example, DART-Europe is a partnership of research libraries and library consortia that aims to improve global access to European research theses. Additionally, new media and delivery modes are being used to deliver OA content, including blogs, wikis, podcasts, RSS feeds and P2P networks, and these are finding more serious scholarly applications

(Suber, 2007). Finally, more journals are requiring OA to the data underlying published articles and are integrating text and data. In fact, the scholarly article itself is being broken down into its various components and its data, multimedia objects and supplementary materials will become more directly accessible from supporting databases (Pringle, 2004; Suber, 2007). Ultimately, complementary concepts—such as Open Educational Resources, Open Science, Open Innovation and Open Data—are joining OA in a broader open agenda and lending further credence to the OA movement (Swan, 2012).

Finally, mainstream, non-academic search engines such as Google are indexing OA repositories and journals, making authors' works more easily retrievable. Their role is so crucial that Nicholas, Huntington, & Jamali (2007) called the search engine the 'major driver, change agent and the real friend of the digital scholarly user in opening up scholarly content.' Emerging technologies and tools, including text mining and semantic tagging, are resulting in faster knowledge discovery (Barbour & Patterson, 2006; Chan *et al.*, 2011). To make their work more findable, scholars and scientists are increasingly uploading 'grey literature', such as presentations, survey articles, position papers or lecture scripts onto the Web (European Commission, 2008). Harnad *et al.* (2008) reported that as many as 39% of authors provide OA for at least one article by self-archiving on arbitrary websites (such as their own homepages), central disciplinary archives or distributed university archives or institute servers.

5 Strengths and weaknesses of open access strategies

Strengths of OA

A number of scientific, financial and socio-political arguments for OA have been forwarded. The central argument for OA, however, states that it improves the speed, efficiency and efficacy of research. Allowing researchers faster access to the information that 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 greater impact of research, due to increased citations (see debate on the 'citation advantage', below). OA has even 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 is 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*., 2009a, Harnad, 2010b). 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).

OA may 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 enables opportunities for multi- or inter-disciplinary, inter-institutional and inter-sectoral research and collaboration (Houghton & Sheehan, 2009; OASIS, nda; Swan, 2012). 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; OASIS, nda).

Weaknesses and Barriers to Acceptance

The literature on OA shows that there is a large gap between the acceptance of OA as principle and its actual use in practice. For example, surveys have shown that high numbers of scholars support the new paradigm represented by OA: one survey (Dallmeier-Tiessen *et al*., 2011) found 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, *et al*. 2009) strongly supported OA. However, only one-third of researchers responding to the latter survey thought self-archiving was a good idea, and Dallmeier-Tiessen *et al*. (2011) reported that only 8%–10% of articles are published yearly in OA journals. Given the fact that OA has recognised benefits for a number of stakeholders, why has it not been more readily adopted?

There are also bottlenecks that have prevented OA from gaining greater acceptance among stakeholders. These include 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.

Lack of Awareness

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 dismally low, though it is 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 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

The OA literature has revealed a number of long-standing misconceptions among authors about editorial quality and quality control mechanisms related to OA journals that have led to a lack of author acceptance (Björk & Solomon, 2012; European Commission, 2011b). 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). Although there is a perception by some that they are associated with a lack of peer review, 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).

However, the stigma of low quality among OA journals remains. Surveys of researchers indicate that OA publications are seen by many as not carrying 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 been 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 authors surveyed.

Concerns about Copyright

A minority of new journals are operated by unscrupulous 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. They are known as predatory 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. This growth is an opportunity to hide among the legitimate newcomers. The list of predatory publisher's reprehensible behaviors is long, but it includes luring authors and guest editors under false pretenses, acting as vanity press, publishing content without the authors' formal agreement, making false claims regarding editorial boards or impact factors, plagiarism, and insufficient or inexistent peer review process (Beall, 2012). An authoritative list of suspected predatory publishers is maintained by Jeffrey Beall, librarian at the University of Colorado Denver (Beall, 2013).

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 contributes to the widespread misconception that peer review mechanisms are insufficient or nonexistent in OA publishing. It should be noted that the vast majority of OA publishers are not predatory.

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 re-use 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-deposit 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 Open Access repository among 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 that 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, 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 preprint, 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 of 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 Hubbard, Hodgson and Fuchs' (2011) survey stated that the reason not to publish by 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 (Barbour & Patterson, 2006). 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 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 (Björk & Hedlund, 2009). 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 compatible with high impact factors, as demonstrated by Living Reviews in Relativity (IF=17.462) and Aldrichimica Acta (IF=16.091).

Entrenched Current System

Only about 10% of all peer-reviewed articles are currently published in OA journals in the ERA, Brazil, Canada, Japan, and US. When it comes to the uptake of OA in the current academic reward system, established interests, prejudice and traditions stand in the way. OA has taken some time to reach critical mass, remaining a somewhat marginal phenomenon in the global scholarly communication system. 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 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. Additionally, many new OA journals have not had the chance to create a brand image. 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.

Lack of Data on Open Access

The OA movement has been hindered by a persistent lack of available data that would allow researchers to determine how OA has developed over time. Most studies examining the quantitative development of OA publishing have used variable methods and data sources that provide only brief snapshots of OA subsets for specific years (Laakso *et al.*, 2011; Laakso & Björk, 2012). Robust data would be particularly useful for policy-makers who would be interested in knowing how common OA is today, how fast the share of OA has increased and what proportion of journal articles are currently OA. Both policy-makers and scholars would use the information to measure OA's impacts and benefits, determine the different levels of interest in OA among stakeholders adapt and improve existing indicators and develop and apply new indicators (Gilbert *et al.*, 2011). Finally, better data and analysis would help provide stakeholders with important information on OA repository costs, impacts and operational statistics and determine the operational viability of alternative OA publishing models, such as academic e-book publishing (Houghton *et al.*, 2009d).

Perceived Lack of Profitability

Again, the OA business model may not be seen as lucrative for publishers, who have made tidy profits from individual and institutional subscriptions and advertising revenue and who are often portrayed as being most 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, 2011b). Although experiments continue and opportunities for greater profitability are emerging, in 2005 it was reported that more than 40% of OA journals were still not meeting their costs (Kaufman, 2005, as cited in Abad, 2009), and in 2006, BMC and PLoS still had not demonstrated the economic sustainability of their business models (Albert, 2006). It is possible

that established journals and publishers have not had strong enough incentives to change their business models.

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 open access 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.

OA represents 50% or more of scholarly journal articles published between 2008–2011 in Belgium, Brazil, Croatia, Denmark, Estonia, Ireland, Israel, Lithuania, Macedonia, Malta, the Netherlands, Norway, Portugal, Switzerland, and the United States. If the precision and recall of the harvesting instrument is taken into account, Austria, Canada, Cyprus, Finland, Hungary, Iceland, Latvia, Liechtenstein, Luxembourg, Romania, Slovakia, Slovenia, Spain, and Sweden would also reach the 50% mark. Even in countries with 'low' OA uptake, more than 40% of articles published in the 2008–2011 period were available in green, hybrid, or gold OA. Bulgaria and Liechtenstein are the only exceptions with, respectively, 38% and 17% OA. Green and hybrid OA are more prevalent than gold OA in every country with the exception of Brazil. Without being dominant, the gold model accounts for a larger proportion of papers in the former Yugoslav Republic of Macedonia, Croatia, Turkey, Malta, Lithuania, Estonia, Slovenia, Poland, Latvia, Slovakia, Spain, the Czech Republic and Romania compared to other European countries.

Considering that the sample size in this study is larger than in previous studies (Björk & Hedlund, 2009; Dallmeier-Tiessen, 2009; Harnad *et al.* 2008; Morgan *et al.* 2012), 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 could be retroactive, as journals progressively open their archived content and as researchers self-archive their work in OA repositories. However, growing awareness, new policies and infrastructure, as well as the growing credibility of OA journals and repositories, probably account for a larger part of OA growth.

The development of an OA culture among researchers can be fostered by institutions, funding bodies, and governments through initiatives that enable or provide incentive 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 to OA or are deterred by the 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 researcher's 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, such as OpenAIRE, 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

infrastructures specific to OA could also be attributable to a general context favoring transparency and digital publication, for example 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 national infrastructure for OA content. The recent adoption of binding OA directives in the US and 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 open access, 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, OA is likely to soon become the dominant form of dissemination of peer-reviewed scholarly articles in the ERA, Brazil, Canada, Japan, and US.

References

Altarelli, G. (2005). Continuing CERN action on Open Access. CERN technical report retrieved from http://cds.cern.ch/search?ln=en&f=reportnumber&p=cern-open-2005-006&sc=1

Bianco, S., et al. (2007). Towards Open Access publishing in high energy physics. Report of the SCOAP3 working party. Retrieved from http://cern.ch/oa/Scoap3WPReport.pdf

Bird, C. (2010). Continued adventures in open access: 2009 perspective. *Learned Publishing, 23*(2), 107–116.

BIS. (2012). Government Response to the Finch Group Report: 'Accessibility, sustainability, excellence: how to expand access to research publications'. Retrieved from https://www.gov.uk/government/news/government-to-open-up-publicly-funded-research

Blixrud, J. C. (2010, April). Strategies for opening up content: Laying the groundwork for an open system of scholarship. *Research Library Issues: A Bimonthly Report from ARL, CNI, and SPARC*, 269, 1–4. Retrieved from http://www.arl.org/resources/pubs/rli/archive/rli269.shtml.

Brazil House of Representatives. (2007). PL 1120/2007, Projeto de Lei. Retrieved from http://www.camara.gov.br/proposicoesWeb/fichadetramitacao?idProposicao=352237

Budapest Open Access Initiative (2002). *Read the Budapest Open Access Initiative* [Web page]. Retrieved from http://www.opensocietyfoundations.org/openaccess/read

Carroll, M. W. (2011).Why full open access matters. *PLoS Biology, 9*(11): e1001210. Retrieved from http://www.plosbiology.org/article/info%3Adoi%2F10.1371%2Fjournal.pbio.1001210

Case, M. (2009). Scholarly Communication: ARL as a Catalyst for Change. Portal: Libraries and the Academy, 9(3), pp. 381-395.

Chan, L., Kirsop, B., & Arunachalam, S. (2011). Towards open and equitable access to research and knowledge for development. *PLoS Medicine, 8*(3), e1001016. Retrieved from http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.1001016

Chantavaridou, E. (2009). Contributions of open access to higher education in Europe and vice versa. *OCLC Systems & Services, 25*(3), 167–174. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=1810664

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

Cornell University. (2009). Copyright management. Retrieved from http://copyright.cornell.edu/policies/copyright_management.cfm

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

Creaser, C., Fry, J., Greenwood, H., Oppenheim, C., Probets, S., Spezia, V., & Sonya, W. (2010). Authors' awareness and attitudes toward open access repositories. *New Review of Academic Librarianship, 16*(Supplement 1), 145–161. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/13614533.2010.518851

Creative Commons Corporation. (nd). Attribution 3.0 Unported. Retrieved from http://creativecommons.org/licenses/by/3.0/legalcode

Crow, R. (2009, September). *Income models for open access: An overview of current practice*. Report produced for the Scholarly Publishing & Academic Resources Coalition (SPARC). Retrieved from http://www.arl.org/sparc/bm~doc/incomemodels_v1.pdf.

Dallmeier-Tiessen, S., et al. (2011, January). *Highlights from the SOAP project survey. What scientists think about open access publishing.* Retrieved from http://arxiv.org/ftp/arxiv/papers/1101/1101.5260.pdf

Davis, P. M. (2009). How the media frames 'open access'. *Journal of Electronic Publishing, 12*(1). Retrieved from http://dx.doi.org/10.3998/3336451.0012.101

de Blaaij, C. (2006). Public funded research and open access: Perspectives and policies. *The Grey Journal, 2*(1), 7-16. Retrieved from http://www.greynet.org/images/GL7,_page_176.pdf

Directory of Open Access Journals (DOAJ). *Home page* [Web page]. Retrieved from http://www.doaj.org/doaj?func=home&uiLanguage=en

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

Estonia.eu. (2013). Economy & IT. Retrieved from estonia.eu/about-estonia/economy-a-it/e-estonia.html

Estonian National Electoral Committee. (2013). Statistics about internet voting in Estonia. Retrieved from http://www.vvk.ee/voting-methods-in-estonia/engindex/statistics

European Commission. (2007a). *DRIVER-II Fact sheet*. Retrieved from http://www.driver-repository.eu/PublicDocs/FACT_SHEET_I3_driver_ii.pdf

European Commission Directorate-General for Research and Innovation. (2008). *Open access: Opportunities and challenges: A handbook*. Retrieved from http://unesco.de/fileadmin/medien/Dokumente/Kommunikation/Handbook_Open_Access_English.pdf

European Commission Directorate-General for Research and Innovation. (2011a). *National open access and preservation policies in Europe: Analysis of a questionnaire to the European Research Area Committee*. Retrieved from http://ec.europa.eu/research/science-society/document_library/pdf_06/survey-on-open-access-in-fp7_en.pdf

European Commission Directorate-General for Research and Innovation. (2011b). *Sharing knowledge: Open access and preservation in Europe: Conclusions of a strategic workshop - Brussels, 25-26 November 2010.* Retrieved from http://ec.europa.eu/research/science-society/document_library/pdf_06/oa-preservation-2011_en.pdf

European Commision. (2012a). *Towards better access to scientific information: Boosting the benefits of public investments in research*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Retrieved from ec.europa.eu/research/science-society/document_library/pdf_06/era-communication-towards-better-access-to-scientific-information_en.pdf

European Commision. (2012b). Commission Recommendation of 17.7.2012 on Access to and preservation of scientific information. Retrieved from ec.europa.eu/research/science-society/document_library/pdf_06/recommendation-access-and-preservation-scientific-information_en.pdf

European Heads of Research Councils (EUROHORCs). (2008). *EUROHORCs' Recommendations on Open Access (OA)*. Retrieved from http://www.eurohorcs.org/SiteCollectionDocuments/EUROHORCs_Recommendations_OpenAccess_200805.pdf

Finch, J. (2012, June). *Accessibility, sustainability, excellence: how to expand access to research publications*. Report of the Working Group on Expanding Access to Published Research Findings. Retrieved from http://www.researchinfonet.org/wp-content/uploads/2012/06/Finch-Group-report-FINAL-VERSION.pdf

Frontiers. (2013). NPG and Frontiers form alliance to further open science. Retrieved from http://www.frontiersin.org/news/Nature_Publishing_Group_and_Frontiers_form_alliance_to_further_open_science/266

Gantz, Paula (2012). Digital licenses Replace Print Prices as Accurate Reflection of Real journal Costs. Professional/Scholarly Publishing Bulletin. Vol. 11, No. 3, Summer/Fall.

Gargouri, Y., Hajjem, C., Larivière, V., Gingras, Y., Carr, L., Brody, T., & Harnad, S. (2010). Self-selected or mandated, open access increases citation impact for higher quality research. *PLoS ONE, 5*(10), e13636. Retrieved from http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0013636

Gargouri, Y., Lariviere, V., Gingras, Y., Brody, T., Carr, L., Harnad, S. (2012) Testing the Finch Hypothesis on Green OA Mandate Effectiveness. Open Access Week 2012. Retrieved from http://eprints.soton.ac.uk/344687/

Gilbert, J., Kullman, L., Lindholm, J., & Stjernberg, H. (2011). *To follow-up open access policies: What to measure, how to do it and who to tell*. Retrieved from http://www.berlin9.org/bm~doc/tofollowupoapolicieschalmersmalmoeposter.pdf

Gores, G. J. (2010). Open access journals: Why are we not there yet? (!) *Hepatology, 52*(6), 1869-1871. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/hep.24004/pdf

Guédon, J. C. (2008). Mixing and matching the green and gold roads to open access—Take 2. *Serials Review, 34*(1), 41-51. Retrieved from http://depts.washington.edu/uwbri/PDF%20Files/green%20and%20gold%20mixing%20and%20matching%20take%202.pdf

Hall, S. (2010). A commentary on 'The economic implications of alternative publishing models.' *Prometheus: Critical Studies in Innovation, 28*(1), 73-84. Retrieved from http://www.informaworld.com/smpp/content~db=all~content=a920245214~frm=titlelink

Harnad, S. (2006). The immediate-deposit/optional-access (ID/OA) mandate: Rationale and model. Retrieved from http://openaccess.eprints.org/index.php?/archives/71-guid.html

Harnad, S., Brody, T., Vallières, F., Carr, L., Hitchcock, S., Gingras, Y., Oppenheim, C., Hajjem, C., & Hilf, E. R. (2008). The access/impact problem and the green and gold roads to open access: An update. *Serials Review, 34*(1), 36-40. Retrieved from http://depts.washington.edu/uwbri/PDF%20Files/access-

impact%20problem%20and%20the%20green%20and%20gold%20roads%20to%20open%20acceac-an%20update.pdf

Harnad, S. (2010). The immediate practical implication of the Houghton Report: Provide green open access now. *Prometheus: Critical Studies in Innovation, 28*(1), 55-59. Retrieved from http://www.tandfonline.com/doi/pdf/10.1080/08109021003676367

Harnad, S. (2011). Open access is a research community matter, not a publishing community matter. *Lifelong Learning in Europe, XVI*(2), 117-118. Retrieved from http://eprints.soton.ac.uk/272403/

Harvard Faculty Advisory Council. (2012). Faculty Advisory Council Memorandum on Journal Pricing. Major Periodical Subscriptions Cannot Be Sustained. Retrieved from http://isites.harvard.edu/icb/icb.do?keyword=k77982&tabgroupid=icb.tabgroup143448

Harvard Management Company. (2012). Harvard Management Company Endowment Report. Message from the CEO. Retrieved from http://www.hmc.harvard.edu/docs/Final_Annual_Report_2012.pdf

Hebran Grgic, Ivana. (2011) Open Access to Scientific Information in Croatia: Increasing Research Impact of a Scientifically Peripheral Country. Lambert Academic Publishing, Saarbrücken. Retrieved from http://darhiv.ffzg.hr/1397/

Herb, U. (2010). Sociological implications of scientific publishing: Open access, science, society, democracy and the digital divide. *First Monday, 15*(2). Retrieved from http://www.uic.edu/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/2599

Houghton, J., & Sheehan, P. (2009, March). Estimating the potential impacts of open access to research findings. *Economic Analysis & Policy, 39*(1), 127-142. Retrieved from http://vuir.vu.edu.au/15221/1/v39_i1_10_-houghton.pdf

Houghton, J., de Jonge, J., & van Oploo, M. (2009a). *Costs and benefits of research communication: The Dutch situation*. Utrecht: SURFfoundation. Retrieved from http://www.surffoundation.nl/en/publicaties/Pages/CostsandBenefitsofOpenAccessPublicationlTheDutchSituation.aspx

House of Lords. (2013). The implementation of open access, Oral and Written evidence. Retrieved from http://www.parliament.uk/documents/lords-committees/science-technology/Openaccess/OpenAccessevidence.pdf

Hrcak. (2013). *About Hrcak.* Retrieved from http://hrcak.srce.hr/?lang=en

Hubbard, B., Hodgson, A., & Fuchs, W. (2011, March). *Current issues in research communications: Open access—The view from the academy*. Retrieved from http://eprints.nottingham.ac.uk/1480/1/RCS_March_2011.pdf

ICTP (The Abdus Salam International Centre for Theoretical Physics). (2008). *Science dissemination using open access.* Retrieved from http://sdu.ictp.it/openaccess/SciDissOpenAccess.pdf

Imboden, D. M. (2009). Scientific publishing: The dilemma of research funding organisations. *European Review, 17*(1), 23-31. Retrieved from http://journals.cambridge.org/action/displayFulltext?type=1&fid=4324632&jid=&volumeId=&issueId=01&aid=4324624&bodyId=&membershipNumber=&societyETOCSession=

Kroes, N. (2013). *Opening up Scientific Data*. SPEECH/13/236, given on March 18 for the launch of the Research Data Alliance. Stockholm. European Commission. Retrieved from http://europa.eu/rapid/press-release_SPEECH-13-236_en.htm

Kronman, Ulf. (2012). OpenAcess.se – a National Programme for Promotion and Coordination of Open Access in Sweden [Web page]. In OpenAIRE.eu. Retrieved from http://www.openaire.eu/en/component/content/article/76-highlights/435-openaccessse-a-national-programme-for-promotion-and-coordination-of-open-access-in-sweden

Kumar, M. (2009). Open access publication of scientific research: Facts and myths. *Bulletin of the Royal College of Surgeons of England, 91*, 312-317. Retrieved from http://dx.doi.org/10.1308/147363509X472018

Laakso, M., Welling, P., Bukvova, H., Nyman, L., Björk, B. C., & Hedlund, T. (2011, June). The development of open access journal publishing from 1993 to 2009. *PLoS ONE, 6*(6), e20961.

Laakso, M., & Björk, B. (2012). Anatomy of open access publishing: A study of longitudinal development and internal structure. *BMC Medicine, 10*(124). Retrieved from http://www.biomedcentral.com/1741-7015/10/124?fmt_view=classic

Lewis, S., de Castro, P., Jones, R. 2012. SWORD: Facilitating Deposit Scenarios. D-Lib Magazine, 18 (1/2). Retrieved from http://www.dlib.org/dlib/january12/lewis/01lewis.html

MacKenzie-Cummins, P. (2011, December). *Open access: Awareness and attitudes amongst the author community*. Retrieved from http://www.intechopen.com/js/ckeditor/kcfinder/upload/files/InTech_WhitePaper_FutureofOA_Dec11.pdf

Manghi, P., Manola, N., Horstmann, W. Peters, D. (2010). An Infrastructure for managing Ec funded research output – The OpenAIRE project. *The Grey Journal,* 6(1):31-40.

Narusk, Ene, Ed. (2013). Quarterly Bulletin of Statisticsa Estonia. 1/2013. Statistics Estonia. Talinn. Retrieved from http://www.stat.ee/publication-download-pdf?publication_id=34214

National Institutes of Health. (2005). Policy on Enhancing Public Access to Archived Publications Resulting from NIH-Funded Research. Notice NOT-OD-05-022. Retrieved from http://grants.nih.gov/grants/guide/notice-files/NOT-OD-05-022.html

National Institutes of Health. 2008. Revised Policy on Enhancing Public Access to Archived Publications Resulting from NIH-Funded Research. Notice NOT-OD-08-033. Retrieved from http://grants.nih.gov/grants/guide/notice-files/NOT-OD-08-033.html

National Institutes of Health. 2013. National Institutes of Health History of Congressional Appropriations, Fiscal years 2000-2012. Retrieved from http://officeofbudget.od.nih.gov/br.html

National Institutes of Health Manuscript Submission System. (2013). NIHMS Statistics, monthly aggregate submission statistics. Data retrieved from http://nihms.nih.gov/stats/

Nicholas, D., Huntington, P., & Jamali, H. R. (2007). The impact of open access publishing (and other access initiatives) on use and users of digital scholarly journals. *Learned Publishing, 20*(1), 11-15. Retrieved from http://www.ingentaconnect.com/content/alpsp/lp/2007/00000020/00000001/art00004

Nguyen, T. (2008, April). *Open doors and open minds: What faculty authors can do to ensure open access to their work through their institution*. A SPARC/Science Commons White Paper. Retrieved from http://www.sciencecommons.org/wp-content/uploads/opendoors_v1.pdf

OpenAIRE Consortium. (2012). *OpenAIRE Guidelines 2.0, guidelines for content providers of the OpenAIRE information space.* Retrieved from http://www.openaire.eu/en/about-openaire/publications-presentations/public-project-documents/doc_details/431-openaire-guidelinesv2-0en

Oxford University Press. (2006, June). *Assessing the impact of open access: Preliminary findings from Oxford Journals*. Retrieved from http://www.oxfordjournals.org/news/oa_report.pdf

Packer, A.L. (2010) The SciELO Open Access: A gold way from the South. *Canadian Journal of Higher Education*. 39 (3): 111-126. Retrieved from http://ojs.library.ubc.ca/index.php/cjhe/article/view/479

Papin-Ramcharan, J., & Dawe, R. A. (2006). The other side of the coin for open access publishing—A developing country view. *Libri, 56*, 16-27. Retrieved from http://www.librijournal.org/pdf/2006-1pp16-27.pdf

Pappalardo, K. (2008). *Understanding open access in the academic environment: A guide for authors*. Retrieved from http://eprints.qut.edu.au/14200/3/Understanding_Open_Access_in_an_Academic_Environment-_A_Guide_for_Authors_[web_version].pdf

PeerJ. (2013). Signup & pricing, pay once, publish for life. Retrieved from https://peerj.com/pricing/

PLoS Medicine Editors. (2011). On the path to global open access: A few more miles to go. *PLoS Medicine, 8*(3): e1001014. Retrieved from http://europepmc.org/articles/PMC3070749/pdf/pmed.1001014.pdf

Presidents and Fellows of Harvard College. (2010). Open Access Policies. Retrieved from http://osc.hul.harvard.edu/policies#participating

Pringle, J. (2004, May). Do open access journals have impact? *Nature Web Focus*. Retrieved from http://www.nature.com/nature/focus/accessdebate/19.html

PubMed Central. (2012). Copyright Notice. http://www.ncbi.nlm.nih.gov/pmc/about/copyright/

RCUK. (2013). RCUK Policy on Open Access and Supporting Guidance. Retrieved from http://www.rcuk.ac.uk/documents/documents/RCUKOpenAccessPolicyandRevisedguidance.pdf

Regazzi, J. (2004) The shifting sands of Open Access publishing, a publisher's view. Serials Review 30(4), 275-280. Retrieved from http://dx.doi.org/10.1016/j.serrev.2004.09.010.

Research4life. 'Programmes'. Accessed 05/02/2013. www.research4life.org/about/

Research Information Network. (2011, Sepember). Working Group on Expanding Access to Published Research Findings. Media Statement. Retrieved from http://publishers.org.uk/index.php?option=com_docman&task=doc_download&gid=606&Itemid=

Rinaldi, A. (2008). Access Evolved? *EMBO Reports, 9*(4), 317-321. Retrieved from http://www.nature.com/embor/journal/v9/n4/pdf/embor200840.pdf

Saraiva, R., Rodrigues, E. (2009) Open Access in Portugal: a state of the art report. Repositorio Cientifico de Acesso Aberto de Portugal Report. Retrieved from http://repositorium.sdum.uminho.pt/handle/1822/10552

SciELO. (2013). SciELO Network. Retrived from http://www.scielo.org/php/index.php?lang=en

Science Europe. (2013). Science Europe position statement, principles for the transition to Open Access to Research Publications. Retrieved from http://www.scienceeurope.org/uploads/Public%20documents%20and%20speeches/SE_OA_Pos_Statement.pdf

SHERPA. (2009) About SHERPA. Retrieved from http://www.sherpa.ac.uk/about.html

SPARC. (2011). *HowOpenIsIt?* Retrieved from http://www.plos.org/wp-content/uploads/2012/10/OAS_English_web.pdf

SpringerOpen. (2013). About us. Retrieved from http://www.springeropen.com/about

Suber, P. (2007). Trends favoring open access. *SPARC Open Access Newsletter, 109*. Retrieved from http://www.earlham.edu/~peters/fos/newsletter/05-02-07.htm#trends

Suber, P. (2009) Open Access Policy Options for funding agencies and universities. SPARC Open Access Newsletter (SOAN), 130. Retrieved from http://legacy.earlham.edu/~peters/fos/newsletter/02-02-09.htm

Suber, P. (2012) Clarification of the new open-access policy at the Research Councils UK (RCUK). Retrieved from https://plus.google.com/109377556796183035206/posts/WLGYaT8AEVu

Swan, A. (2012). *Policy guidelines for the development and promotion of open access.* Report published by the United Nations Educational, Scientific and Cultural Organization. Retrieved from http://unesdoc.unesco.org/images/0021/002158/215863e.pdf

Swan, A. and Chan, L. (2009). Open Access Scholarly Information Sourcebook, Open Access Repositories for Administrators. Retrieved from http://www.openoasis.org/index.php?option=com_content&view=article&id=137&Itemid=333

Swan, A. and Houghton, J. (2012). Going for Gold? The costs and benefits of Gold Open Access for UK research institutions: further economic modelling. Report to the UK Open Access Implementation Group. Retrieved from http://www.ucml.ac.uk/sites/default/files/pages/131/Modelling_Gold_Open_Access_for_institutions_-_final_draft3.pdf

TEEAL. (2010). What is TEEAL? TEEAL: The essential electronic agricultural library. Retrieved from http://www.teeal.org/what-is-teeal

Thorn, S., Morris, S., & Fraser, R. (2009, March). Learned societies and open access: Key results from surveys of bioscience societies and researchers. *Serials: The Journal for the Serials Community, 22*(9). Retrieved from http://uksg.metapress.com/content/rt327514t0126320/fulltext.pdf

University of Southampton. (2009) University policy on self-archiving and Open Access provision. Retrieved from https://www.southampton.ac.uk/library/research/eprints/policies/oapolicy.html

University of Southampton. (2013) ePrints Soton. Retrieved from http://www.southampton.ac.uk/library/research/eprints/

U.S. Government Printing Office. H.R. 2764 (enr) - Consolidated Appropriations Act, 2008. http://www.gpo.gov/fdsys/search/pagedetails.action?packageId=BILLS-110hr2764enr

Van der Graaf, M. (2008). The European repository landscape 2008: Inventory of digital repositories for research output in the EU. Retrieved from http://dare.uva.nl/document/150724

Waaijers, L. (2009). *A brief overview of international trends in open access*. Retrieved from http://www.kb.se/dokument/Om/projekt/open_access/International_trends_OA_LeoWaaijers.pdf

Wallace, J. M. (2011). PEER: Green open access—Insight and evidence. *Learned Publishing, 24*(4), 267-277. Retrieved from http://www.ingentaconnect.com/content/alpsp/lp/2011/00000024/00000004/art00004?crawler=true

Waters, D. J. (2008). Open access publishing and the emerging infrastructure for 21st-century scholarship. *Journal of Electronic Publishing 11*(1). Retrieved from http://dx.doi.org/10.3998/3336451.0011.106

Wellcome Trust. (2012). *Open Access Policy* [Web page]. Retrieved from http://www.wellcome.ac.uk/About-us/Policy/Policy-and-position-statements/WTD002766.htm

Wise, A. (2012). Open Access from a publisher's perspective. The Journal of Academic Librarianship, 39(1), 98.

World Bank. (2012). World Bank announces Open Access policy for research and knowledge, Lauches Open Knowledge Repository. Press Release No:2012/379/EXTOP. Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:23164491~pagePK:64257043~piPK:437376~theSitePK:4607,00.html

World Bank. (2013). About The World Bank Open Knowledge Repository. Retrieved from https://openknowledge.worldbank.org/about

Xia, J. (2010, March). A longitudinal study of scholars attitudes and behaviors toward open-access journal publishing. *Journal of the American Society for Information Science and Technology, 61*(3), 615–624. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/asi.21283/full