Scholarly communications revisited : journal publishing, open access, and digital-age Journals

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Scholarly Communications Revisited: Journal Publishing, Open Access, and Digital-Age Journals

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Abstract

The development of digital technology has drastically changed scholarly communication. The advent of electronic journals has changed the industrial structure of academic publishing. As the market concentration of journal publishing continues to increase, the pricing of journals has been dominated and controlled by large publishers. The never-ending rise of subscription prices is approaching a tipping point that libraries/institutions—even in high-income countries—can no longer bear. In these circumstances, the open access (OA) movement has been promoted over the past 15 years, and new types of publications have appeared. This paper discusses the definition and history of OA, the position of each stakeholder in the OA landscape, and new digital-age journals, which include OA mega-journals and research funders' OA platforms.

Keywords: Scholarly Communication, Open Access, OA Mega-journals, OA Publishing Platforms

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Scholarly Communications Revisited: Journal Publishing, Open Access, and Digital-Age Journals

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INTRODUCTION

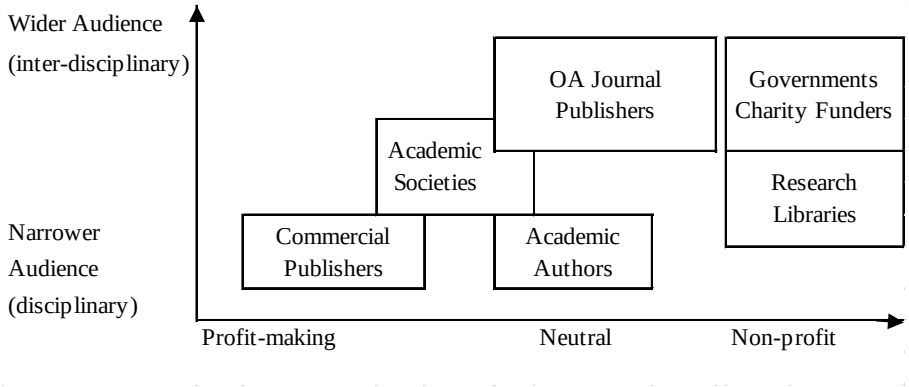
The development of information technology (IT) has drastically changed people's attitudes toward information collection. Around the globe, as long as people can access the Internet, useful information can easily be obtained free of charge. As this IT revolution has evolved, academic publishing, especially journal publishing, has dramatically changed, with the most significant innovation being the advent of electronic journals.

Electronic journals have drastically changed the attitudes of researchers. Scholars no longer need to visit a library building to read and photocopy journal articles because they can easily access and download those articles from their offices or their home computers. This remarkable convenience, however, has brought about a major problem, i.e., the skyrocketing of journal-subscription prices over nearly three decades. Currently, not only libraries (i.e., research libraries) in low-income countries but also those in high-income countries face serious difficulties paying the subscription fees of the journals they need.

From these circumstances, the open access (OA) movement was born. Over the past 15 years, numerous OA arguments have been made and new types of publications have appeared. As described in the next section, the extensive growth of open access publications is indisputable. Regrettably, however, traditional toll-access (TA) journals have not been replaced by full-OA journals (i.e., Gold OA journals, which will be explained in the next section; hereafter, this type is called OA journals), and the problem of exorbitant increases in subscription prices, the so-called "serials crisis," does not seem as though it will end in the near future.

The promotion of open access is not straightforward. Various stakeholders have a variety of interests in open access. The main stakeholders are libraries, authors (researchers), funding agencies, commercial publishers, and OA journal publishers. Their positions on the OA map are illustrated in Figure 1.

Figure 1. Standing Position of OA Stakeholders



Libraries, who take a strong hostile attitude toward oligopolistic commercial publishers, vehemently hope to reduce the cost of journal subscriptions. Libraries have to meet the needs of researchers and students under budgetary constraints. Although they expect the OA movement to lighten their budgetary burdens, it seems that this expectation will not be met in the near future.

Academic authors take a neutral stance on the OA movement: they are rather indifferent about open access. They hope to publish articles in prestigious journals, i.e., well-known high-ranking journals; they want their articles to be read by academics in the same sub-discipline and want to contribute to their fields. Publishing in core academic journals garners academic prestige, and a list of publications certifies the academic standing of researchers. The future of academics, i.e., their tenure, promotion, or funding, is heavily dependent on academic publication.

Academic associations/societies, especially those that publish high-ranking journals, have benefited substantially from the sale of their TA journals, which are published through large commercial publishers. Although these societies are not profit-making entities, the income from the sale of their journals has been locked into their activity budgets. As turning TA journals into OA journals will certainly decrease income, these societies are placed in an awkward position with regard to the OA movement (Bull 2016b; Hockschild 2016).

Funding agencies such as governments and charity funders are playing an important role in the promotion of OA. Research funders are not profit-making, and they strongly desire to contribute to the global community. They have strongly endorsed open access to the publications that result from the research they fund. The UK government, the EU, and charity foundations have issued OA mandates to require grantees to make their research results open. These mandates from funders are powerful and certainly serve to promote open access.

Commercial publishers that publish TA journals are profit-making entities. Leading publishers are Elsevier, Springer, Wiley, and Taylor & Francis. These publishers have been reluctant to promote OA but have recently shown interest in OA publishing because they have also identified a

business opportunity in OA publications. The number of titles currently published by these entities is shown in Table 1.

Table 1. Number of Journals Indexed in Scopus, Published by Four Major Publishers, 2018

	Elsevier	Springer	Wiley	Taylor & Francis
No. of TA journals (A)	2,401	2,077	1,711	1,463
No. of OA journals (B)	214	115	45	53
B/(A+B)	8.2%	5.2%	2.6%	3.5%

Source: Scopus, accessed on April 13, 2018.

Non-commercial and commercial publishers that mainly publish OA journals are, of course, the primary advocates of OA and are new business entities of the digital revolution. They run their businesses based on an article processing charge (APC). A large number of full OA journals are currently published, but it is unlikely that they will replace existing TA journals. However, a unique and innovative journal model has emerged, known as an OAMJ (open access mega-journal). These mega-journals and other similar journals may have a great impact on the journal publishing landscape, which is described in detail in Section 3.7.

The positions of respective stakeholders, as suppliers of research products, are different from one another, but from the demand side, beneficiaries – including authors, academics, students, and citizen-researchers – welcome OA movements. Readers simply prefer free and instantaneous access that can be obtained with one click on the Internet (Bjork 2016).

The next section defines open access and summarizes the history of scholarly communication and open access. In Section 2, the prevalence of OA and its impact will be described. In Section 3, the situations of the above-mentioned stakeholders are described in detail. The final section concludes the discussion.

1. WHAT IS OPEN ACCESS?

1.1. The Definition of Open Access

The OA movement is strongly championed by librarians who have become exasperated by prohibitively high – and rising – journal subscription fees. The UK government and charity funders have also promoted OA due to their belief that research results funded by public or charity funds should be freely available to the public. In addition, the movement is also promoted by the

increasingly recognized – and much broader – concept of open science, which is a movement to make scientific research and data accessible to all people so that they can contribute to the further development of science.

Suber (2012) states succinctly that "Open access (OA) literature is digital, online, free of charge, and free of most copyright and licensing restrictions" (p.4). The term was introduced by the Budapest Open Access Initiative (BOAI) in February 2002. The original BOAI stated the following:

> By "open access" to this (peer-reviewed academic) literature, we mean its 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.[1]

This is a rather rigorous/idealistic definition. It is sometimes called "libre OA," as it allows people to read, reuse, and perform data-mining free of charge.[2] This definition is idealistic because making research results free and reusable should further contribute to reproducibility, finding new research methods, and creating new discoveries (the essence of open science). However, the realization of libre OA is not straightforward, as it requires authors or publishers to relinquish their copyrights (e.g., publication rights, rights to derivative works) on their publications. In conjunction with this definition, there is a coarse definition of OA. This is called "gratis OA," which only allows people to read information.

There are several routes to attaining OA (libre, gratis, and in between). These routes are described as follows:

(1) Gold OA: A route to making peer-reviewed articles free to read and reuse (libre OA). This type of OA is realized by the publication of articles in OA journals (the Directory of Open Access Journals [DOAJ] lists 11,185 journals as of April 2018). The basic idea is that the author-side pays the cost of publishing in a journal by paying the APC (article processing

[1] http://www.budapestopenaccessinitiative.org/read

[2] Peter Suber introduces open access (OA) in detail for those who are new to the concept. http://legacy.earlham.edu/~peters/fos/overview.htm; OA has been widely and deeply discussed in the sciences and is currently discussed in the social sciences. OA is not popular in the humanities. See Eve (2014) for comprehensive arguments in the humanities.

charge), so readers are not required to pay a subscription fee.[3] As nearly 95% of OA journals use creative commons licenses (basically CC BY),[4] almost all articles in OA journals are reusable. The UK and Dutch governments advocate this Gold OA route.

(2) Green OA: A route to making peer-reviewed articles (self-archived versions) free to read. This access is enabled by the self-archiving of final manuscripts that are accepted for publication in a subscription journal. These articles are called "postprints" (any versions of an article approved by peer-review) and are archived either in institutional repositories (IRs) or disciplinary repositories. OpenDOAR (Directory of Open Access Repositories) and ROAR (Registry of Open Access Repositories) list various repositories. Well-known disciplinary repositories are ArXiv (physics, mathematics, computer science, quantitative biology, quantitative finance, statistics, electrical engineering and systems science, and economics) and PubMed Central (biomedical and life sciences). Reuse rights depend on the respective articles. Repositories also include any versions of an article produced prior to peer review; these articles are called "preprints."

(3) Hybrid OA: A route to making published (printed) articles free to read. Many TA journals have increasingly adopted an open access option. This option makes an article immediately freely available on the journal website to everyone, although authors have to pay high fees for this option. Authors choosing this option can opt for reuse rights by selecting one of the available creative commons licenses.

(4) Delayed OA: In this route, articles published in a TA journal are free to read, but they are only made available on a journal's website after an embargo period (Laakso and Bjork 2013). Reuse rights are limited.

(5) Academic Social Networks: In this route, articles published in a TA journal are free to read; they are shared on commercial online social networks such as ResearchGate and Academia.edu. However, this route is problematic because many articles are said to be illegally posted and hosted because of authors' negligence/ignorance of copyrights.

(6) Robin Hood/Rogue OA: A route to making articles published in a TA journal free to read; the articles are shared on illegal pirating sites. A well-known popular site is Sci-Hub (Archambault et al. 2014).

Open access (or open science) has been predominantly discussed in science disciplines, and OA has gained a foothold in scientific fields. However, the social sciences and humanities also follow this trend, and funders' OA mandates do not distinguish these disciplines from those in the

[3] However, more than 70% of OA journals charge no fees.
[4] http://oad.simmons.edu/oadwiki/OA_by_the_numbers

natural sciences.[5] The next section describes the history of the OA movement.

1.2. The History of Open Access[6]

The history of the OA movement is described below in chronological order.

1970-1995: Serials crisis. Journal subscription fees continually rise too fast and too high for libraries to tolerate. Libraries had to sacrifice book acquisition to maintain journal subscriptions.

1990: The first web page appeared.

1990s: Word-processing and typesetting software revolutionized the printing industries. The emergence of electronic journals drastically changed scholarly communication. The distribution of academic publications in photocopies, microfilm, and CD-ROMs was outdated.

Libraries began to purchase rights of access to electronic journals rather than owning them. The whole concept of collection building in libraries began to change.

1991: An online repository for high-energy physics papers (preprint/e-prints) was founded at the Los Alamos National Laboratory (renamed ArXiv.org in 1999). This repository is often cited as a successful example of Green OA. Other disciplines followed suit but were not successful.

1995-2005: Academic Press introduced the Big Deal in 1996, offering a discount to institutions that bought access to a whole set of journals (a lower cost per title but a higher total cost for a library). This business model was quite successful, and other large publishers followed suit.

1997: SciELO (Scientific Electronic Library Online: an electronic library covering a selected collection of Brazilian scientific journals) was launched. Currently, 14 Latin American countries are members of this network.

1997-98: Taylor & Francis acquired several journals from Gordon & Breach Science Publishers, Harwood Academic Polishers, Scandinavian University Press, Carfax Publishing, and Routledge. Elsevier acquired several small publishers such as Butterworth-Heinemann, Ablex Publications, JAI Press, Gauthier-Villars, and Expansion Scientifique Française (Lariviere, Haustein, and Monggeon 2015)

1998: Google was launched.

2000: PubMed Central (a free digital repository for biomedical and life science journals) was launched. BioMed Central (commercial OA publisher) published its first free online article.

2001: PLOS (Public Library of Science; a non-profit OA publisher) was founded.

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[5] OA in social and political science is discussed from the standpoints of academics and publishers in *European Political Science* 15(2) 2016, in which seven articles based on a symposium are featured.

[6] Data are based on Guedon (2017), Tennant et al. (2016). A very detailed timeline is provided by the Open Access Directory (http://oad.simmons.edu/oadwiki/Timeline).

2001: Elsevier acquired Academic Press, Churchill Livingstone, Mosby, and WB Saunders. Wiley acquired 156 journals by 2004 (Lariviere, Haustein, and Monggeon 2015).

2002.2: Budapest Open Access Initiative (BOAI).

2002: Thomson Reuters made the Web of Science database widely accessible.

2003: Green/Gold roads concepts appeared.

Green—libraries began to set up repositories rapidly all around the world.

Gold—BioMed Central and PLOS established a stable foundation, but lots of predatory journals followed, and the image of OA journals was tainted.

2004: Springer acquired Kluwer Academic Publishers. Springer started "Open Choice," i.e., the birth of the hybrid model.

2004: Elsevier released Scopus as a rival to the Web of Science.

2004: Google Scholar (beta version) was released.

2005.4: The Wellcome Trust (the second largest charitable funder of scientific research in the world) mandated that all its funded research should be made OA (becoming the first UK research funder to implement an OA policy).

2006: PLOS launched an OAMJ (*PLOS ONE*) and made it into a successful business.

2008.10: BioMed Central was acquired by Springer, and thus one of the major commercial publishers entered into OA journal publishing. Large commercial publishers gradually added open access to their business plans, either as full OA journals or hybrid journals.

2008: A law was enacted under which NIH (National Institutes of Health under the U.S. Department of Health and Human Services) grantees have to deposit final peer-reviewed journal manuscripts to the digital archive PubMed Central no later than 12 months after publication. In 2009, legislation was passed to make the NIH policy a permanent statute.

2011: Sci-Hub (a website providing free, but illegal, access to subscription journal papers on a massive scale) was founded.

2012.6: The Wellcome Trust revised its policy and required authors to publish in OA and to self-archive the author manuscript in Europe PubMed Central.[7]

2012.7: Following the Finch report, "Accessibility, Sustainability, Excellence: How to Expand Access to Research Publications," the UK government announced its OA policy in favor of Gold OA or hybrid OA. The Research Councils UK (RCUK), the UK's major research funder, revised its OA policy, announcing its preference for the Gold rather than Green road, which had been preferred previously.[8]

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[7] https://wellcome.ac.uk/press-release/wellcome-trust-strengthens-its-open-access-policy

[8] Mafalda Picarra, "Open Access in the UK: Briefing on the UK Open Access Case Study." 2015.

2013: The Obama administration issued a sweeping Executive Memorandum, requiring all US Departments and Agencies who fund scientific research to make both articles and data resulting from that funding publicly available. However, the FASTR (Fair Access to Science and Technology Research) Act has yet to be implemented as law.

2013: More than half of published articles were published by five major commercial publishers.[9]

2014.3 (revised in 2015): the UK Funding Councils announced their OA policy, requiring the deposit of peer-reviewed articles and conference proceedings in repositories (Green OA), effective from April 1, 2016.

2014: Horizon 2020 (the biggest EU Research and Innovation program) required open access to the results of all EC-funded research.

2015.1: The Bill and Melinda Gates Foundation's open access mandate became effective.[10]

2015: Elsevier filed a lawsuit against Sci-Hub and LibGen.

2016.4: UK HEFCE (Higher Education Funding Council) decided that journal articles and conference papers must have been deposited in an open access repository to be eligible for the next REF submission, which is the first national policy to explicitly link public access with research evaluation (Steele 2014).

2016.6 The Wellcome Trust created Wellcome Open Research, an OA publishing platform. The concept of this platform is quite similar to that of OAMJs.

2016: Research institutions formed national-level consortia and negotiated subscription fees with publishers, e.g., in Germany, Finland, South Korea, Taiwan, and France.

2017.8: The Bill and Melinda Gates Foundation created Gates Open Research, an OA publishing platform the concept of which is quite similar to OAMJs. This platform is quite similar to Wellcome Open Research.

2017.12: The EC proposed funding a European Commission Open Research Publishing Platform.

2017: The Taiwan consortium (CONCERT), representing more than 140 institutions, canceled its contract with Elsevier; Peru's government stopped providing funding to its National Council for Science, Technology, and Technological Innovation (CONCYTEC) for access to Elsevier

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http://www.pasteur4oa.eu/sites/pasteur4oa/files/resource/UK%20Open%20Access%20briefing_FINAL.pdf

[9] According to Lariviere, Haustein, and Mongeon (2015), five major publishers accounted for 20% (1973), 30% (1996), 50% (2006), and 53% (2013) of all papers published in NMS (Natural and Medical Sciences) fields. Three publishers accounted for more than 47% of all papers in 2013, i.e., Elsevier (24.1%); Springer (11.9%); and Wiley (11.3%). The same is true for SSH (Social Sciences and Humanities), in which five major publishers accounted for 10% (1975-90), 15% (mid-1970s), and 51% (2013). In 2013, they were Elsevier (16.4%); Taylor & Francis (12.4%); Wiley (12.1%); Springer (7.1%); and Sage (6.4%).

[10] https://www.gatesfoundation.org/How-We-Work/General-Information/Open-Access-Policy

products (Schierneier and Mega 2016). The University of Montreal canceled its big deal subscription with Taylor & Francis (University of Montreal 2017). The University of Maryland decided to cancel its Taylor and Francis package effective FY2018 (http://lib.guides.umd.edu /serials_review).[11] A German consortium asked Elsevier for a collective deal on future subscription contracts at about half the price that they had paid in the past. However, no agreement was reached, and more than one hundred academic institutions declared that they would not renew their subscription contracts with Elsevier.[12] Nearly 300 South Korean research institutions formed a consortium and negotiated with publishers; they reached an agreement with Elsevier in January 2018 after long standoff, with a discount of approximately 1%.[13]

2017. Elsevier and the American Chemical Society (ACS) filed a lawsuit in Germany against ResearchGate.[14]

2017: The Netherlands' National Plan Open Science set a goal of 100% OA for all publicly funded scientific publications by 2020.[15] Switzerland approved a National Open Access Strategy that aims at 100% OA for all publicly funded publications by 2024. The Swiss National Science Foundations (SNSF) decided to realize OA implementation of SNSF-funded publications by 2020.[16]

2018.1: The Japan Association of National University Libraries (92 members) issued a press statement claiming that its academic journal subscriptions are in a critical situation due to price hikes, budget cuts, foreign exchange rates, and taxation on subscriptions.

2018.4.10: Clarivate Analytics, the owner of the Web of Science, bought a start-up company, Kopernio, whose tool gives people one-click, legal access to journal articles.[17]

2018.4: Couperin, representing 250 French universities, grandes écoles, and other research bodies, has not yet agreed on a new contract with Springer Nature after more than one year, though their access to Springer content has not yet been cut.

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[11] According to Anderson (2017), the University of Wisconsin-Milwaukee ($500,000), Towson University ($350,000), University of Calgary ($1.5 million), University of New Mexico ($468,000), University of Missouri ($200,000), and Colorado State University ($135,000) cut their budgets for journal subscriptions in recent years.

[12] The list of academic institutions is available at https://www.projekt-deal.de/vertragskundigungen-elsevier-2017/. Although these institutions' contracts no longer exist, Elsevier is still permitting their access to subscription journals until an agreement is reached. *Nature News* doi: 10.1038/d41586-018-00093-7

[13] Dennis Normile, "South Korean Universities Reach Agreement with Elsevier after Long Standoff," January 15, 2018. doi:10.1126/science.aat0225

[14] *Science and Policy*. doi:10.1126/science.aaq1560

[15] https://www.openscience.nl/binaries/content/assets/subsites-evenementen/open-science/national_plan_open_science_the_netherlands_february_2017_en_.pdf

[16] http://www.snf.ch/en/theSNSF/research-policies/open-access/Pages/default.aspx#OA%202020%20Policy

[17] Nature News, April 10, 2018. Doi:10.1038/d41586-018-04414-8

2. HOW DOES OA WORK?

2.1. The Prevalence of OA

Many studies have estimated the proportion of articles that are free to read, and studies have also analyzed the citation advantage of OA articles. For example, Archambault et al. (2014) analyzed data on 2,500,000 articles from Scopus, and Piwowar et al. (2018) analyzed 100,000 articles, randomly sampled, from each of Crossref, Web of Science, and Unpaywall data. Despite using different data and different estimation methods, those authors agreed that nearly 50% or more of articles published recently seem to be freely available online. The proportion of OA is said to be relatively high in biomedical research and mathematics (more than 50%) but notably low in engineering, chemistry, and the humanities (less than 20%). The social sciences stand at approximately 25%.

Archambault et al. (2014) examined OA availability for 44 countries (EU28, ERA[18], Brazil, Canada, Japan, and the US) during 2008-2013 period. All countries had more than 50% of their papers available through OA. For the Netherlands, Portugal, Croatia, Estonia, and Switzerland, the figure surpassed 70%. Rates of OA in other countries were as follows: the United States (67.9%), Canada (64.4%), Brazil (76%), and Japan (50%).

Table 2 shows the data from the Web of Science Core Collection, which illustrates the number of articles written by authors in certain countries (countries show the location of the author's affiliation. An article written by multiple authors with different nationalities has plural nationalities). England, the Netherlands, and Brazil show high shares of OA.

Table 2. Number of Articles by Country, 2017 (Web of Science)

	Total	OA Article	OA/Total
USA	424,504	120,807	28.5%
China	351,018	92,717	26.4%
Germany	115,485	35,622	30.8%
England	113,873	45,858	40.3%
Japan	85,149	28,508	33.5%
India	83,420	19,081	22.9%
France	78,117	21,207	27.1%
Canada	72,443	19,888	27.5%
Italy	71,780	21,444	29.9%
Australia	68,279	18,009	26.4%
Spain	67,314	23,334	34.7%
South Korea	62,571	19,221	30.7%

[18] Albania, Bosnia and Herzegovina, Faroe Islands, Former Yugoslav Republic of Macedonia, Iceland, Israel, Moldova, Montenegro, Norway, Serbia, Switzerland, Turkey, and Ukraine.

Brazil	56,013	23,496	41.9%
Netherlands	41,009	17,459	42.6%
Switzerland	32,666	12,282	37.6%
Taiwan	25,737	8,580	33.3%

Source: Web of Science (accessed on April 13, 2018).

Note: Author's affiliation. An article written by multiple authors has more than one country, but a country is counted only once even if multiple authors are from the same country.

2.2. The Impact of OA

Open access is expected to bring about many benefits, such as higher citation counts, higher media exposure, new findings via data-mining, and availability to low-income people.

First, one of the most interesting questions is whether there is a citation advantage to OA. Tennant et al. (2016) examined 33 survey articles (2001-2015), each of which estimated the citation advantage of OA publication, and tabulated the studied disciplines and OA citation advantages by article. Although the magnitude of the advantage varies substantially depending on the discipline, the general tendency showed at least some association between OA publishing and increased citation counts. A more comprehensive list of studies is available on SPARC Europe's Open Access Citation Advantage Service (OACA).[19] The list includes article titles, disciplinary areas, sample sizes, basic analytical approaches, citation advantage, and attribution of advantage to a particular OA component. The list contains 70 studies published by 2015, showing that 46 studies found a citation advantage; 17 studies found no citation advantage; and 7 studies were inconclusive. In addition, Archambault et al. (2014) analyzed data on 2.5 million articles from Scopus, Archambault et al. (2016) analyzed data on 3.3 million articles from the Web of Science, and Piwowar et al. (2018) analyzed 0.1 million random samples from Web of Science article data; all authors agreed that open access confers citation advantages compared with publishing in TA journals.

Second, media exposure is also important for impact. A variety of alternative metrics (e.g., social media attention, Mendeley readership, and media attention) have been proposed recently as measurements that can complement traditional bibliometrics (e.g., journal impact factor [JIF] based on citation counts).[20] Alternative metrics are capable of tracking articles that attract attention in media other than journals. Many studies show that OA publications get more media coverage than do TA journal articles. Alternative metrics do not necessarily evaluate the quality of

[19] https://sparceurope.org/what-we-do/open-access/sparc-europe-open-access-resources/open-access-citation-advantage-service-oaca/

[20] Alternative metrics are suitable for viewing societal impact. These include usage metrics (downloads), mentions (blog posts, comments, reviews), and social media metrics (likes, shares and tweets).

articles, but it is reasonable to expect that easily accessible articles will have more chances of being noticed and cited.

Third, the text- and data-mining (TDM) of OA literature has the potential for innovative impact (Tennant et al. 2016). License-free publications, such as articles published in OA journals, allow computer reading. Automated extraction of information from academic literature using TDM can be used to investigate the scholarly literature at an enormous scale. TDM also enables automated screening for errors and automated literature searches. TDM makes it possible to easily compare one's results with those of the published literature, identify convergence of evidence, and discover frequent tentative hypotheses that can be used for new research. TDM also enables computer applications to download all scholarly literature containing certain search terms. Clearly, TDM can be used in various innovative ways and is an emerging and rapidly advancing field. Non-restrictive licensing through OA certainly promotes its wider application (pp. 11-12).

Last, OA not only benefits academics in both developed and low-income countries but also has wider impacts on many other segments of the population, e.g., citizen scientists, retired academics, medical patients, and various NGOs. The Internet and OA will open up possibilities for knowledge to be used in unexpected and innovative ways, far beyond mainstream professional research (Tennant et al. 2016).

In summary, OA is expected to bring about various benefits to society, but the promotion of OA is not straightforward. The next section describes the attitudes of actors who are engaged in scholarly communication.

3. STAKEHOLDERS

3.1. Libraries

Librarians are strong advocates of OA movements. Facing budget constraints and increasing journal subscription costs, they want OA movements to lighten their budgetary burdens. SPARC (Scholarly Publishing and Academic Resources Coalition), the members of which are more than 200 research libraries in the United States and Canada, has been actively promoting the open sharing of research outputs. SPARC has a global network of partners, including more than 600 libraries and research institutions around the world. Its website provides a list of recent negotiations and cancellations of big deals between universities/consortia and publishers, as well as other resources relating to open access initiatives. In addition, library publishing has become a much-discussed topic over the course of the OA movement. The LPC (Library Publishing Coalition), the members of which are more than 70 academic/research libraries, has been supporting the library publishing initiative.

How do librarians view the future of research libraries? Pinfield, Cox, and Rutter (2017) conducted a survey of library staff (261 respondents) at UK higher education libraries and 33 interviews of experts in the UK, the United States, and other countries to elucidate librarians' views about the next decade. The authors discovered that library professionals are overwhelmingly optimistic about the future of libraries and positive about the value of their skills, while they still recognize that they will face many challenges in the near future, e.g., fewer library jobs, repurposing of the library's role, and new skill requirements. The need to shift focus from collection management to services was widely acknowledged. The librarians were aware that libraries need to add new services to support the creation, curation, and discoverability of internally created contents. This report proposed that the traditional image of libraries should be questioned.

Wolff (2017) reports the results of the "Ithaka S+R US Library Survey 2016." The respondents to this survey are 722 deans/directors at US academic libraries, and they anticipate increased resource allocation toward services. Spending on e-resources has been increased at the cost of spending on print resources, but dependence on e-resources has potentially peaked. These respondents are concerned about budget cuts affecting their purchasing of print books. Library directors are increasingly recognizing that discovery does not and should not always happen in the library. Doctoral university libraries gave high ratings to the role of the library in paying for resources needed by faculty members, maintaining a repository, and providing active support for faculty research. These libraries are considering new positions focusing on faculty research support, including digital humanities, GIS, and data management.[21]

Fruin (2017) surveyed 12 out of 37 RLUK (Research Libraries of the UK) member libraries in 2015-2016 and compared the results with a comparable survey from the US (Radom, Feltner-Reichert, and Stringer-Stanback 2012), which included 60 out of 126 ARL (Association of Research Libraries) member libraries. The types of scholarly communication services provided by UK libraries and US libraries are very similar, with a few exceptions. All the UK libraries provide financial support for OA publishing through open access publishing funds, but only 33% of the US counterparts have those funds.[22] In addition, UK libraries have more personnel dedicated to scholarly communication than do US libraries. These differences are due to differences in circumstances surrounding research funding and funders' open access mandates. Ensuring compliance with the OA mandate has become a crucially important job for UK research libraries.

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[21] The intention of UK academic libraries to hire those personnel is referred to in Steele (2014) and Fruin (2017).

[22] As an increasing number of open access mandates have been given by various research funders, mandate compliance has become a priority for UK research libraries, including the management of the block grants disbursed by funding agencies in order to cover APC.

Librarians are aware that the OA movement requires them to reconsider their roles. As electronic journals, newspapers, statistics, and eBooks are now available in a digital format, the tasks of collecting hard copies and preserving them at physical library buildings have become less important. Fewer and fewer people, except for academics in the arts and humanities, physically visit the library building. Lewis (2013) noted that academic libraries need to avoid a downward spiral of outdated services and local collections. His future prospects for research libraries are not optimistic. He suggests the following: (1) deconstruct legacy print collections; (2) move from item-by-item book selection to purchase-on-demand and subscription; (3) manage the transition to open access journals; (4) curate the unique; and (5) develop new mechanisms to fund national infrastructure.[23]

3.2. Authors

Governments and research funders, especially in the UK and other European countries, have been increasingly requiring accountability from research institutions. Universities and academics are required to show the quality of their research, e.g., articles in well-established journals with a high JIF; to make that research open to the public; and to contribute to society. Although there are strong doubts about the validity of the metrics publicized by commercial entities, e.g., university league tables[24] and journal rankings[25], universities and academics cannot turn a blind eye to those rankings (Wilsdon et al. 2015; Gingras 2014).

In this context, open access is here to stay, but awareness and knowledge of OA among academics is insufficient, even in the UK. This lack of awareness is especially severe in social and political sciences (Bull 2016a), and it is even worse in the arts and humanities. Publishing an article in a prestigious journal, with a well-known journal title and/or high JIF, is given priority. Authors do not care whether the journal carrying their papers is OA or not (Armstrong 2015). As there is no strong motivation/incentive for academics to publish their articles in OA journals, they will not take a leadership role in the promotion of open access.

Nicholas (2017) surveyed 116 early career researchers in seven countries and reported that they are still especially eager to publish articles in prestigious journals. These scholars want to earn

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[23] Hernon and Matthews (2012) offer six academic library scenarios for future discussion. Directors surveyed suggested that there will likely be mergers of institutional libraries in approximately 15 years, meaning that efficiency will be forced on institutional libraries.

[24] There are as many as ten major global university rankings! (Wilsdon et al. 2015, p. 73).

[25] The journal impact factor (JIF) has a number of well-documented deficiencies as a tool for research assessment. The limitations include (1) citation distributions within journals are highly skewed; (2) citation culture is quite different among various disciplines; (3) impact factors can be manipulated (or "gamed"); and (4) many studies have pointed out that high citation is not always correlated to high quality. http://www.ascb.org/dora/

reputational credit, and they show little interest in OA publications, institutional repositories, and Open Science. Tenopir et al. (2016) surveying 2,021 scholars at four research universities (Univ. of British Columbia–Vancouver, Univ. of California–Davis, Univ. of California–Irvine, and Ohio State University), reported that open access is the least important attribute when scholars are choosing where to publish.

Many studies note that OA journals requiring APC limit the publishing abilities of researchers with less funding, such as academics in low-income countries or those in less-funded non-natural-science disciplines, such as arts/humanities and social sciences. This is also a reasonable explanation for why academics may take a passive attitude toward the OA movement.

In the "Ithaka S+R US Faculty Survey 2015," Wolff, Rod, and Schonfeld (2016a) surveyed 9,203 faculty members in humanities, social sciences, sciences, and medical science at US four-year colleges/universities. When asked about starting points for their research, a general purpose search engine (more so than in 2012) and specific electronic research resources/databases (less so than in 2012) came first, followed by online library websites/catalogues (more so than in 2012). This report offers many interesting findings in the context of open access or open science arguments: (1) Monographs in print format are still preferred; (2) Faculty members still believe that more recognition should be awarded for traditional research publications, i.e., journal articles and books, compared to products such as data, media, and blog posts. Scholars in the social sciences and in medical disciplines think that preprints should also be rewarded; and (3) Over half of social scientists and medical faculty members agreed that societal impact should be a key measure of research performance.

In the "Ithaka S+R UK Survey of Academics 2015," Wolff, Rod, and Schonfeld (2016b) surveyed 6,679 academic staff in arts and humanities, social sciences, sciences, and medical/veterinary science at UK higher education institutions (i.e., both RLUK and non-RLUK institutions). In response to a question about starting points for research in academic literature, a general purpose search engine was the most-cited answer, followed by specific electronic research resources/databases (less so than in 2012) and online library websites/catalogues (more so than in 2012).

Many interesting findings can be noted in relation to the above-mentioned US survey, as follows: (1) when respondents lack immediate access through their library's physical or digital collections to monographs/articles that they want, their first choice is to search for a freely available version online, followed by giving up, followed by using interlibrary loan or document delivery services. A much greater share of humanists and social scientists purchase materials themselves; (2) respondents still believe that more recognition should be awarded for traditional research publications, i.e., journal articles and books, compared to products such as data, media, and blog posts.

Scholars think that preprints/e-prints and software/code should also be rewarded; (3) 65% of medical/veterinary academics and about half of social scientists agreed that societal impact should be a key measure; and (4) nearly 70% of respondents have received or are currently receiving extramural funding for their scholarly research from a public or government grant-making organization. Overall, it is reasonable to expect that funders' OA mandates affect the attitudes of UK scholars more strongly than their US counterparts.

3.3. Academic Societies

Large academic societies, especially those that own high-ranking journals, receive a sizable amount of income by licensing their journals to major publishers. For example, the UK's Political Studies Association earned £0.51 million in 2014 from the publishers of its journals (Bull 2016b). This association publishes five journals, including *Politics* (Sage), *BJPIR-British Journal of Politics and International Relations* (Sage), *Political Studies* (Sage), *Political Studies Review* (Wiley), and *Political Insight* (Sage). In 2014, the American Sociological Association (2015) recorded publication revenue of $2.74 million, against $1.45 million in publication and editorial office costs. This association publishes 14 journals (including OA journals), of which the representative journals published by Sage are *American Sociological Review*, *Contemporary Sociology*, *Journal of Health and Social Behavior*, and *Sociological Theory.*

These societies utilize this income to fund their activities, such as outreach, support for young and early career researchers, conferences, and so on (Hockschild 2016). As their activities have been largely dependent on publication income, most scholarly associations have a vested interest in maintaining the current subscription model. Moving away from the current model risks costing them their financial return.

However, academic societies are non-commercial and have charitable status, so it is difficult for them to go against the OA movement. Maintaining hybrid journals would be easy, but this option is no more than a transitional strategy. It is not realistic to expect that the income from APC will match the current income level generated from the subscription model (Bull 2016b; Siler 2017). As Armstrong (2015) says, "it would be a pity if the special interests of associations were an impediment to widening access to research" (p. F20).

Thus, academic societies, especially those earning large incomes from their subscription-based publishing, are placed in an awkward position.

3.4. Research Funders

An increasing number of research funders and institutions have adopted OA policies, though the specifics of their requirements are slightly different from one another. According to

ROARMAP (Registry of Open Access Repository Mandates and Policies),[26] there are 889 policies registered, i.e., 83 funder policies, 56 funder and research organization policies, 666 research organization policies (e.g., universities and research institutions), and 74 policies concluded at the department, faculty, or school level. As these policies are voluntarily registered by the sponsor organization, there are undoubtedly many more policies around the world.

SHERPA Juliet provides research funders' OA policies. This database includes data for 142 research funders (UK 62, US 15, Canada 14, and other countries). The statistics page shows that 101 funders (71%) require OA archiving, 42 funders (30%) require OA publishing, and 40 funders (28%) require data archiving.[27]

For example, the Wellcome Trust's OA policy states that articles from funded projects must be made openly available within six months of publication; in particular, projects receiving publishing fee support are required to publish under a creative commons attribution (CC-BY).[28] The Bill and Melinda Gates Foundation's open access mandate requires that publications be deposited in a specified repository(s) under CC-BY immediately upon their publication.[29]

The research excellence framework (REF) in the UK has already made OA a core feature of evaluation. The HEFCE policy for open access in the next REF2021 requires that to be eligible for REF submission, journal articles and conference papers accepted from 1 April 2016 must have been deposited in an open access repository within three months of acceptance for publication.[30]

Science Europe (the association of research funding and research performing organizations with 44 member organizations from 27 European countries) collectively endorsed moving to a system of open access in 2012.[31]

All beneficiaries of the EU's research fund, Horizon 2020, are required to deposit peer-reviewed scientific publications related to funded research (publication is not necessarily obligation) and to ensure OA. This mandate requires free online access but recommends free reuse rights. A machine-readable copy of the published version or a final peer-reviewed paper accepted for publication must be deposited in a repository upon publication (at the latest), and access must be made open within six months (12 months for social sciences and humanities).[32]

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[26] http://roarmap.eprints.org/view/policymaker_type/

[27] http://v2.sherpa.ac.uk/view/funder_visualisations/1.html

[28] https://wellcome.ac.uk/funding/managing-grant/open-access-policy

[29] https://www.gatesfoundation.org/How-We-Work/General-Information/Open-Access-Policy

[30] http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/2016/201635/HEFCE2016_35.pdf; Not only the open access promotion but also the publication of articles are (un)intentionally promoted by the research evaluation scheme. The research evaluation system has been firmly established as a formalized and standardized system in UK higher education and has strongly influenced other countries (Marques et al. 2017).

[31] http://www.scienceeurope.org/wp-content/uploads/2014/05/ScienceEurope_Roadmap.pdf

[32] http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-pilot-

Canada's three federal granting agencies (the Canadian Institutes of Health Research [CIHR], the Natural Sciences and Engineering Research Council of Canada [NSERC], and the Social Sciences and Humanities Research Council of Canada [SSHRC]) issued the Tri-Agency Open Access Policy on Publications. Grantees are required to make their research publications (i.e., peer-reviewed journal publications) freely accessible within 12 months of publication. Only the CIHR require the deposit of data as well.[33]

The Australian Research Council, a funding entity that provides national competitive grants, also requires grantees to make their publications open within 12 months of the publication date. The metadata of the publication must be made open in an institutional repository within a three-month period from the date of publication. The most unrestricted CC BY is recommended but not required.[34]

It is recognized that the mandates of funders are an effective way to fill up repositories. Wolff, Rod, and Schonfeld (2016b) reveal the influence of funders' OA policies based on surveys of US and UK academics' behaviors. For example, the share of researchers who preserve their research data in a repository has substantially increased. Compared with their US counterparts, UK academics more frequently make their findings freely available online in preprint or e-print digital archives and/or online under a Creative Commons or Open Source license. These facts seem to be related to the growing compliance of UK academics with funders' open access mandates.

According to the report of the Charity Open Access Fund (COAF),[35] which was produced in early 2017, 91% of grantees' articles fully complied with the COAF's OA policy (full text article available within Europe PubMed Central with a CC BY license), which was a remarkable improvement from 74% the previous year. The number of articles published using this fund in 2015/16 was 3,552, a 21% increase from the previous year. Total COAF spending in 2015/2016 was £6.6 million, a 32% increase from the previous year. Table 3 illustrates the breakdown of OA types into full OA journals and hybrid journals. The number of publications in hybrid journals is still much larger than that in full OA journals, though the share of the former type is declining. The APC of hybrid journals remains higher than that of full OA journals. High dependence on the hybrid-type publication is not be sustainable because of its high cost and double-dipping problems. To tackle the continuing increase in APC payments, a number of European funders have reportedly placed caps on APCs.

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guide_en.pdf

[33] http://www.science.gc.ca/eic/site/063.nsf/eng/h_F6765465.html

[34] http://www.arc.gov.au/arc-open-access-policy-version-20171

[35] Funders include Arthritis Research UK, Breast Cancer Now, Bloodwise, British Heart Foundation, Cancer Research UK, Parkinson's UK, and Wellcome. https://wellcome.ac.uk/funding/managing-grant/wellcome-and-coaf-open-access-spend-2015-16

Table 3. APCs Covered by the Charity Open Access Fund (COAF)

	OA Journals			Hybrid Journals		
	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16
No. of articles published in	607	775	1,038	1,894	2,065	2,514
Share (%)	24.3%	27.3%	29.2%	75.7%	72.7%	70.8%
Average APC	£1,241	£1,396	£1,644	£2,030	£2,104	£2,209
Median APC	-	£1,352	£1,397	-	£2,005	£2,125

Source: Wellcome website. https://wellcome.ac.uk/funding/managing-grant/wellcome-and-coaf-open-access-spend-2015-16
Note: COAF members are Arthritis Research UK, Breast Cancer Now, Bloodwise, British Heart Foundation, Cancer Research UK, Parkinson's UK, and Wellcome.

Table 4 shows the top five publishers that received the most APCs paid by COAF-funded articles. Elsevier tops the list and is followed by big publishers such as Springer Nature, Wiley, Oxford University Press, and PLOS.

Table 4. Top Five Publishers: APC Paid by COAF-supported Research, 2015-16

	No. of articles	Average APC	Total spend
Elsevier:	830		£2,083,111
Hybrid	767	£2,473	£1,896,812
Fully OA	63	£2,957	£186,299
Springer Nature:	637		£1,159,639
Fully OA	444	£1,781	£790,974
Hybrid	193	£1,910	£368,665
Wiley:	423		£840,156
Fully OA	20	£1,289	£25,782
Hybrid	403	£2,021	£814,374
OUP:	269		£559,383
Fully OA	39	£1,415	£55,169
Hybrid	230	£2,192	£504,214
PLOS:			
Fully OA	258	£1,379	£355,759

Source: Wellcome website. https://wellcome.ac.uk/funding/managing-grant/wellcome-and-coaf-open-access-spend-2015-16
Note: Funders include Arthritis Research UK, Breast Cancer Now, Bloodwise, British Heart Foundation, Cancer Research UK, Parkinson's UK, and Wellcome.

To increase compliance with OA mandates and probably to reduce the burden of APC payments, the Wellcome Trust (*Wellcome Open Research*) and the Bill and Melinda Gates Foundation (*Gates Open Research*) launched OA publishing platforms in 2016 and 2017, respectively. The concept of these platforms is to provide researchers who receive grants from the funders with a place for speedy publication (in one week) without traditional novelty-emphasized subjective peer review.

Referee comments are openly given after publication (post-publication peer review), and revisions are completed by authors. Articles need to be published with data. APC is essentially not required (paid by respective funders). EC also plans to launch the European Commission Open Research Publishing Platform, which will provide Horizon 2020[36] grantees with a free and fast open-access publishing venue with open peer review. This will assist grantees in complying with the Horizon 2020 open access mandate.[37]

3.5. TA Journal Publishers

Before the digital revolution, academic publishing was not a profitable business. In other words, profit was not the objective of academic publishing. The courtesy of academics, learned societies, and university presses made publishing viable and sustainable.

Ever since the Second World War, the environment surrounding academic publishing has gradually changed. Academic research products expanded around the world, underpinned by world economic development. The number of universities and researchers has increased remarkably. Various new sub-disciplines have emerged. The number of libraries and their budgets have expanded. Then, with the development of digital technologies, academic publishing turned into a lucrative business (Fyfe et al. 2017).

Currently, academic journal publishing is dominated by several oligopolistic commercial publishers. Elsevier, Wiley, Springer, Taylor & Francis, and Sage dominate academic journal publishing. These publishers have increased their share of published outputs, especially since the advent of the digital era in the mid-1990s. As of 2017, the Scopus database covers 5,000 publishers and 21,548 journal titles.[38] Among them, Elsevier publishes 2,915 titles (8.2%), Wiley publishes 1,756 titles (2.6%), Springer publishes 2,192 titles (5.2%)[39], Taylor & Francis publishes 1,516 titles (3.5%), and Sage publishes 834 titles (3.0%).[40] The above-mentioned five most prolific publishers account for more than 50% of all articles published in 2013. These commercial publishers have the most influence in the social sciences, where they publish 70% of articles (Larivière, Haustein, and Mongeon 2015).

These publishers have been enjoying huge profits from publishing TA journals (including a hybrid version), but the OA movement and research funders' OA mandates have forced them to

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[36] An EU research and innovation program with 80 billion euro over 2014-2020.

[37] "Information Note: Towards a Horizon 2020 Platform for Open Access." https://ec.europa.eu/research/openscience/pdf/information_note_platform_public.pdf#view=fit&pagemode=none

[38] Scopus factsheet. https://www.elsevier.com/__data/assets/pdf_file/0008/208772/0031-Scopus-Global-Research-Factsheet-A4-v4-LO.pdf. Accessed December 28, 2017.

[39] The titles published by group companies are not included. Nature publishes 162 titles, and Springer Nature publishes 22 titles.

[40] Scopus, accessed on April 17, 2018.

begin publishing Gold OA journals as well as to accept the Green route for articles published in TA journals. Bjork et al. (2014) examined the OA policies of TA journals (i.e., the Green route) published by the top 100 publishers indexed in Scopus in 2010. The top 100 publishers accounted for 68% of all articles indexed in Scopus. It is noted that 62% of articles were permitted to be self-archived, 4% were given a 6-month embargo, 13% were given a 12-month embargo, and 2% were given an 18-month embargo. Thus, 79% of published articles could be made open within 12 months if authors actually and promptly self-archived their articles. This figure was not realized because of authors' misunderstanding and reluctance, but the actual figure will surely increase because an increasing number of research funders have begun to strongly require grantees to abide by their OA mandates.

3.6. OA Journal Publishers (Gold OA road)

The Directory of Open Access Journals (DOAJ) lists 11,105 journals published in 124 countries as of April 2, 2018. There are 1,198 institutions that publish two or more OA journals. Big commercial journal publishers also publish OA journals (Elsevier 375; Springer 212; Sage 113; Taylor & Francis 104, and Wiley 72) (see Table 5). The share of articles published in OA journals indexed in Scopus was 0.9% in 1996 but grew to 12.8% in 2012 (Archambault et al. 2014). As of October 2017, Scopus indexes 3,784 DOAJ-listed active OA journals, which accounts for nearly 16% of all active journals indexed in Scopus (23,507 journals). The JCR indexes 1,054 OA journals, which accounts for approximately 9% of all journals indexed in the JCR (approximately 12,000 journals; 2016 JCR year). In summary, approximately 11,000 subscription journals with JIF, 1,000 full OA journals with JIF, and 10,000 full OA journals without JIF are currently published.

Table 5. Top 10 OA Journal Publishers

Publisher's Name	Number of OA Journals	
	Total (DOAJ)	Of Which Indexed in Scopus
Hindawi Publishing Corporation	566	175
Elsevier	375	214
De Gruyter Open	362	46
BioMed Central	308	246
Springer	212	115
MDPI AG	169	55
Wolters Kluwer Medknow Publications	130	0
Sage Publishing	113	25
Taylor & Francis Group	104	53
Dove Medical Press	101	62

Sources. DOAJ website (accessed on March 2, 2018) and Scopus (accessed on April 2, 2018).

Essentially, the cost of the Gold OA publishing model is covered by the APC for accepted papers, which is paid by the authors' side. However, more than 70% of OA journals listed in the DOAJ do not charge an APC as of December 2017 (Open Access Directory [OAD] provides a list of numbers measuring the status/growth of open access). While major OA journals charge an APC, they have full/partial fee waiver schemes for researchers, especially those from low-income countries (Lawson 2015). Authors are allowed to use grants/funding for the payment of APC.

Regarding the social sciences, publishers have been cautious about OA journal publishing because research in the social sciences, let alone in the humanities, is far less funded than science research. In other words, social scientists do not have enough funding to pay APCs or may not need to follow funders' OA mandates. Nevertheless, social science publishers have certainly begun to engage in OA publishing. Nearly 40 OA journals were launched by major traditional publishers after 2012, with approximately 25 new titles in 2014 alone. Although the funding and editorial models are different from one another, the majority of the journals require APCs, with prices ranging from US$195 to $1,360 per article. Over a third of the titles require no APC, which is covered by third-party financial support such as from universities, private foundations, learned societies, and national funding bodies (Mainwaring 2016).

A number of OA journals are currently being published, but the emergence of OAMJs deserves special mention. This type of OA journal has innovative features, which will be described in the next section.

3.7. Emergence of OA Mega-journals

Special attention should be paid to the so-called OA mega-journals (hereafter OAMJ). What distinguishes these from other ordinary OA journals – as well as from conventional TA journals – is their innovative approach to scope and quality (Wellen 2013; Wakeling et al. 2017a).

A representative example is *PLOS ONE*, which was launched in 2006. This journal has many unique features: (1) most importantly, the publication criteria emphasize articles' high ethical standards and the rigor of the methodology and conclusions; there is a departure from the traditional peer-review criteria emphasizing the novelty and perceived future impact of articles. *PLOS ONE*'s website states that "When PLOS ONE launched, editors and reviewers asked a simple yet groundbreaking question: 'Should this research be part of the scientific record?' instead of 'Is it appropriate for this journal?'; (2) The creative commons attribution (CC BY) license is applied to all articles; (3) Publication fees are charged (US$1,495 per manuscript as of April 2018) and billed upon acceptance; (4) There is a broad subject scope covering research from the natural sciences, medical research, engineering, as well as the related social sciences and humanities, contrasting with the increasing disciplinary specialization of the past; (5) The journal accepts a

broad range of article types, such as systematic reviews; papers describing methods, software, databases, or other tools; qualitative research; and studies reporting negative results; (6) A tremendous number of articles are published each year: 18,210 articles were published in 2017; and (7) Publication is rapid.

PLOS ONE created a new journal concept and showed that this business model is viable. The success of the *PLOS ONE* model invited the emergence of similar journals, which adopted a similar editorial policy, such as a broader scope, a non-traditional peer-review standard, rapid publication, and low-cost open access publishing. This type of journal is called an OAMJ; it is typically defined as a journal with a huge volume, objective peer review, and broad subject scope, as shown in Table 6.

Table 6. Criteria for OAMJ

Primary Criteria	Secondary Criteria
Big publishing volume or aiming at it	Rapid publication
Peer review by scientific soundness only	Moderate author fee
Broad subject area	High-prestige publishers
Full open access	
Funded by authors paying publishing fees	

Source: Bjork (2018).

Tables 7 and 8 illustrate the characteristics and development of OAMJs. *Scientific Reports* was launched by Nature Publishing Group in 2011 and also covers a wide subject scope (natural and clinical sciences). This journal also adopts the non-traditional peer-review standard, and 24,077 articles were published in 2017. *PLOS ONE* and *Scientific Reports* are the top two OAMJs. The American Institute of Physics publishes *AIP Advances,* launched in 2011, which covers all physical sciences, adopts the non-traditional peer review standard, and published 1,426 articles in 2017. BMJ publishes *BMJ Open*, launched in 2011, which covers all fields of medicine and adopts the non-traditional peer review standard; it published 1,683 articles in 2017. The Company of Biologists publishes *Biology Open* (BiO), launched in 2012, which covers all biological sciences, adopts the non-traditional peer review standard, and published 179 articles in 2017. *F1000 Research*, launched in 2013, covers life science and clinical research, adopts post-publication peer review, and published 713 articles in 2017. *PeerJ*, launched in *2*013, covers biology, medicine, and the environment, adopts the non-traditional peer review standard, and published 1,364 articles in 2017. *IEEE Access,* launched in 2014, covers multidisciplinary subjects, adopts the traditional selective peer review standard with quick binary decision making, and published 2,070 articles in 2017.

Table 7. Development of Article Volumes in Mega-journals, 2011–2017

	2011	2012	2013	2014	2015	2016	2017
PLOS ONE	13,700	23,426	31,404	30,394	27,858	21,771	20,099
Scientific Reports	208	820	2,499	3,940	10,707	20,384	24,137
AIP Advances	251	373	396	558	930	1,240	1,395
BMJ Open	98	625	894	1,086	1,318	1,844	1,803
Biology Open	14	194	217	199	245	338	300
*Medicine**			28	296	1,814	2,844	2,845
IEEE Access			62	118	230	758	2,428
F1000Research		42	204	269	201	421	339
eLife		42	300	809	988	1,217	1,370
Scientific World Journal		984	1,351	3,318	585	117	54
PeerJ			229	474	829	1,354	1,404
Royal Society Open Science				50	246	414	648
Heliyon					29	156	263
SAGE Open	46	116	222	327	289	367	304
Palgrave Communications					34	73	130

Sources: Scopus (accessed on March 1, 2018). Data for *Palgrave Communications* is from its website (accessed on March 1, 2018).
**Medicine* was flipped to the OAMJ model in mid-2014 from a highly selective TA journal that had been founded in 1922 (Wakeling et al. 2017c).

Table 8. APC and Other Related Information on OAMJs

	APC	Publisher	Publisher's Keywords	Review	License	2016 JIF
PLOS ONE	1,495USD	Public Library of Science	Science, medicine	Peer review	CC BY	2.806
Scientific Reports	1,110GBP	Nature Publishing Group	natural sciences, biology, chemistry, earth sciences, physics	Blind peer review	CC BY	4.259
AIP Advances	1,350USD	American Institute of Physics	physical sciences, engineering, biology, physics, chemistry, materials science	Peer review	CC BY	1.568
BMJ Open	1,350GBP	BMJ Publishing Group	clinical science, clinical practice, health policy, healthcare delivery, medical education, medical research	Open peer review	CC BY-NC	2.369
Biology Open	1,495USD	The Company of Biologists	cell science, developmental biology, experimental biology, cell biology, animal physiology	Blind peer review	CC BY	2.095
Medicine	1,200USD	Wolters Kluwer	medicine, health	Peer review	CC BY-NC-ND	1.804
IEEE Access	1,750USD	IEEE	bioengineering, communication, engineered materials, dielectrics, geoscience	Blind peer review	Publisher's own license	3.244
F1000 Research	1,000USD	F1000 Research	life sciences	Open peer review	CC BY	-

eLife	2,500USD	eLife Sciences Publications	biomedicine, life sciences	Peer review	CC BY	7.725
Scientific World Journal	800USD	Hindawi Publishing	life sciences, biomedical sciences, medicine, environmental sciences	Blind peer review	CC BY	1.219 (2013)
PeerJ	1,095USD	PeerJ	biomedical, health, genetics, ecology, biology	Blind peer review	CC BY	2.177
Royal Society Open Science	900GBP (2018-)*	Royal Society	Science	Open peer review	CC BY	2.243
Heliyon	1,250USD	Elsevier	biological sciences, physics, chemistry, applied sciences, health sciences, earth sciences	Blind peer review	CC BY	-
SAGE Open	395USD	Sage Publishing	social sciences, humanities	Double blind peer review	CC BY	-
Palgrave Communications	750GBP	Palgrave Macmillan	social sciences, humanities, business studies, interdisciplinary research, multidisciplinary research	Blind peer review	CC BY	-
Wellcome Open Research	775GBP (covered by Wellcome)	Wellcome	translational research, clinical research, clinical trials	Open peer review	CC BY	-

Source: DOAJ website (accessed on February 25, 2018).

*From its launch in 2014 through 2017, the APC waiver has operated.

Although natural sciences account for the majority of articles published in OAMJs, there are some mega-journal initiatives in the humanities and social sciences (Spezi et al. 2017). *SAGE Open*, started in 2011, covers social and behavioral sciences and the humanities, and 304 articles were published in 2017. Peer review focuses only on the validity of the scientific and research methods of each article. Sage's *Research & Politics* started in 2014, covers political sciences, and published 44 articles in 2017. The peer-review standard is selective, but papers of null-findings, forecasts, updates of seminal articles, critiques/replications or exploratory research are acceptable. Papers need to be a short article (up to 4,500 words) or research note (2,000 words). APC is necessary, but authors were not required to pay in 2016 and 2017 because the APCs for those two years were covered by a grant from the Carnegie Corporation of New York. The *Open Library of the Humanities* (OLH) started in 2015, covers any humanities discipline in any language, adopts traditional selective peer review, and requires no APC. Twenty-seven articles were published in 2017. The costs of publication are covered by an international library consortium. *Palgrave Communications* also started in 2015, covers all humanities and social sciences, adopts traditional

selective peer review, and requires APCs. In January 2018, University College London also announced the issuance of its OAMJ, though the details are not yet known.[41]

As mentioned in Section 3.4, the Wellcome Trust (*Wellcome Open Research*) and the Bill and Melinda Gates Foundation (*Gates Open Research*) have created OA publishing platforms, the concept of which is quite similar to OAMJs. The service and management of both platforms are provided by F1000 Research. These platforms aim at providing researchers who have received grants from the funders with a place for speedy publication (in one week) without subjective (novelty-emphasized) peer review. Referee comments are openly given after publication (post-publication peer review), and revision is completed by the authors. Articles need to be published with data. Although peer review is not conducted before publication on these platforms, the basic concept of these platforms, i.e., speedy publication, a different peer-review standard from traditional journals, and broad scope of article types, is almost the same as the concept of OAMJs. The European Commission also plans to launch a European Commission Open Research Publishing Platform, which will provide Horizon 2020 grantees with a free and fast open-access publishing venue with open peer review.

I need to mention here that there exists another type of journal that publishes a huge number of articles, e.g., more than 1,000 papers per year, but is not categorized as an OAMJ. This type of journal claims to use a selective peer review policy and focuses on narrow disciplinary coverage but publishes a huge number of papers. It seems to me that the concept of these journals is quite similar in substance to that of OAMJs; thus, this type may be called "sub-disciplinary OAMJ." Table 9 shows 19 OA journals indexed in the JCR that published more than 1,000 citable items (articles, reviews or proceedings papers) in 2016.

There are pros and cons of OAMJs (including sub-disciplinary OAMJs), and their future is uncertain. OAMJs are sometimes criticized for their non-traditional peer review standard, which is seen to be less strict than traditional standards, but in my experience as a journal editor for nearly thirty years, it is arguably true that there are many not-bad papers that are rejected because they fall slightly below the high and strict acceptance standard of referees and editorial boards. Even if many of those articles are eventually published in OAMJs, the rather high acceptance rate of OAMJs should not be disparaged as weak filtering.[42]

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[41] https://www.timeshighereducation.com/news/ucl-launch-open-access-megajournal

[42] The reality of peer review conducted by these journals is reported in Spezi et al. (2018), which is based on interviews of mega-journal publishers and editors. In fact, as reviewers are not accustomed to soundness-only peer review, they have been unable to change their mindset. As a result, soundness-only peer review has not been strictly enforced.

Table 9. List of OA Journals that Published More than 1,000 Articles in 2016

	APC	Publisher	Publisher's Keywords	No. of Citable Items*	2016 JIF
Nature Communications	3,150GBP	Nature Publishing Group	natural sciences, biology, chemistry, earth sciences, physics	3,534	12.124
Nucleic Acids Research	2,770USD	Oxford University Press	DNA, biochemistry, computational biology, genomics, molecular biology, RNA	1,270	10.162
Cell Reports	5,000USD	Cell Press	cytology, neuroscience, biochemistry	1,062	8.282
Journal of High Energy Physics	No	International School for Advanced Studies	elementary particle physics, high-energy physics, astroparticle physics, collider physics, quantum field theory, standard model phenomenology	1,861	6.063
Frontiers in Plant Science	2,490USD	Frontiers Media S.A.	agricultural science, paleobotany	1,921	4.291
Frontiers in Microbiology	2,490USD	Frontiers Media S.A.	food microbiology	2,015	4.076
Remote Sensing	1,600CHF	MDPI AG	microwave remote sensing	1,016	3.244
International Journal of Molecular Sciences	1,800CHF	MDPI AG	molecular science	2,117	3.226
Molecules	1,800CHF	MDPI AG	synthesis	1,720	2.861
Sensors	1,800CHF	MDPI AG	electrochemical sensors	2,190	2.677
Materials	1,400CHF	MDPI AG	materials science	1,019	2.654
Biomed Research International	2,000USD	Hindawi	biomaterials, cell biology, genetics, biotechnology, bioinformatics	1,754	2.476
Frontiers in Psychology	2,490USD	Frontiers Media S.A.	cultural psychology, evolutionary psychology, psychopathology, organizational psychology, developmental psychology, educational psychology	1,812	2.321
BMC Public Health	1370GBP	BioMed Central	public health, health policy	1,209	2.265
Energies	1500CHF	MDPI AG	energy sources	1,082	2.262
International Journal of Environmental Research and Public Health	1600CHF	MDPI AG	health sciences	1,220	2.101
Sustainability	1400CHF	MDPI AG	economic sustainability	1,331	1.789
Mathematical Problems in Engineering	2000USD	Hindawi	electrical engineering, differential equations, stochastic processes, nonlinear analysis, engineering, mathematical problems	1,069	0.802

Sources: DOAJ website and Journal Citation Report (accessed on April 1, 2018).

* Citable items are those items that comprise the figure in the denominator of the JIF calculation. These items are those identified in the Web of Science as an article, review or proceedings paper and are considered substantive articles.

The advent of the concept of OAMJs is certainly an innovative challenge to traditional scholarly communication. If academics increasingly recognize the status of OAMJs, and if good

OAMJs appear and embrace the social sciences/arts and humanities, mainstream journal types may converge on two types of journals, i.e., selective high-ranking TA journals adopting a hybrid option and well-recognized OAMJs (Lăzăroiu 2017). These two satisfy the necessary conditions for future scholarly communication in the OA environment, i.e., acceptable academic prestige and an open access norm that is strongly promoted by governments and research funders. A large number of small-volume sub-disciplinary TA journals and OA journals may face difficulties because we live in a digital age when researchers search for articles using a search engine. The titles of all but the well-established brand-name journals may lose value. Furthermore, the practice of the cascade model, explained below, will also make the future of low-ranking TA journals and less-known small-scale OA journals bleak in the long run.[43]

Currently, major publishers have both types of journals, which means that they not only hold on to traditional TA journals (must-have titles) as they are but also make use of the merits of OAMJ publishing. Researchers would prefer to publish in OAMJs published by major publishers, as opposed to publishing in other OA journals published by lesser-known publishers. Major publishers have a strategy called a cascade model, under which articles rejected by selective TA journals are recommended for resubmission to sister journals, such as OAMJs or more specified OA journals published by the same publisher.

For example, Elsevier has an article transfer service. If your manuscript is declined for publication in one journal, e.g., a selective journal, you may receive a transfer offer from the editor by email, with a link to this service. If, from those suggestions, you select an appropriate journal for the next submission, your manuscript's files and information, as well as any existing reviews, will be automatically transferred, without the need to edit, reformat or resubmit your paper. For example, *Heliyon*, a mega-journal published by Elsevier, has partnered with over 1,000 journals, including some journals published by Cell Press and *The Lancet*, using this article transfer service.

As referee reports are portable, if declined articles are submitted to an OAMJ, no new referees need to be assigned. This process can save considerable time when decisions are made about whether to accept the article, and this time-saving is a great advantage, as one referee period would take several months at least. Authors whose articles are declined usually make their next submission to a similar- or lower-level journal. This process repeats again and again until the article is finally accepted by a journal. If authors prioritize speedy publication over publication in a top-ranked journal, this cascade model can work well for authors as well as publishers. Wakeling

[43] There is one journal to date, *Medicine*, that has changed from a selective TA journal model to an OAMJ model in order to survive in the future. "Tips for Journal Editors Transitioning to Open Access and the Role of Mega-Journals in the Publishing Landscape." Editage Insights, May 15, 2015; https://www.editage.com/insights/tips-for-journal-editors-transitioning-to-open-access-and-the-role-of-mega-journals-in-the-publishing-landscape

et al. (2017a, b) suggests that this model allows publishers to retain articles rejected by the selective titles in their business while also preventing those articles from flowing to the journals of rival publishers. This model helps group journals to ensure a stable number of submissions and possibly retain good papers, as papers rejected by highly selective journals are still likely to be of high quality.

Solomon, Laakso, and Björk (2018) conducted an extensive literature survey on journal flipping (converting from TA to OA) to learn the methods, pathways, or scenarios that occurred during the flipping (83 cases are reported).. Each journal's situation and motivation is very different. The number of journals flipped (280) is small compared with the total number of OA journals (more than 11,300).[44] It is hard to imagine that flipping journals will become a mainstream way to develop OA journals in the near future.

Table 10. Top 20 Article-contributing Countries--Nationalities of Author's Institutions in 2012 and 2017

PLOS ONE					*Scientific Reports*				
2017			2012		2017			2012	
Rank	Country	%	Country	%	Rank	Country	%	Country	%
1(1)	US	29.4	US	37.4	1(3)	**China**	31.0	US	35.5
2(2)	**China**	15.7	**China**	15.5	2(1)	US	25.8	Japan	19.4
3(3)	Germany	8.9	Germany	9.9	3(5)	Germany	9.3	**China**	19.4
4(4)	England	8.0	England	9.3	4(4)	England	8.7	England	8.4
5(7)	Japan	6.2	France	7.0	5(2)	Japan	8.6	Germany	6.3
6(5)	France	5.4	Canada	5.7	6(8)	France	5.7	Spain	6.2
7(6)	Canada	5.1	Japan	5.3	7(15)	**S. Korea**	5.6	Italy	6.2
8(8)	Australia	5.0	Australia	5.1	8(7)	Italy	5.0	France	6.0
9(18)	**S. Korea**	4.7	Italy	4.6	9(10)	Australia	4.6	Canada	4.9
10(11)	Spain	4.5	Spain	4.4	10(9)	Canada	4.1	Australia	4.3
11(9)	Italy	4.1	Netherlands	4.4	11(6)	Spain	4.1	Switzerland	4.3
12(11)	Netherlands	4.1	Sweden	3.1	12(25)	**Taiwan**	3.3	Singapore	3.4
13(16)	Brazil	3.7	Switzerland	2.8	13(13)	India	3.1	India	2.8
14(16)	Switzerland	2.9	India	2.3	14(17)	Netherland	2.7	Finland	2.6
15(12)	Sweden	2.9	**Taiwan**	2.3	15(11)	Switzerland	2.7	**S. Korea**	2.5
16(15)	**Taiwan**	2.9	Brazil	2.1	16(18)	Sweden	2.6	Israel	2.0
17(14)	India	2.0	Belgium	1.9	17(19)	Brazil	2.0	Netherlands	2.0
18(19)	Denmark	1.9	**S. Korea**	1.8	18(10)	Austria	1.6	Sweden	1.9
19(22)	Norway	1.8	Denmark	1.7	19(26)	Belgium	1.6	Brazil	1.8
20(17)	Belgium	1.7	Scotland	1.6	20(23)	Denmark	1.5	Russia	1.8

Source: Web of Science (March 5, 2018 accessed).

Notes: 1. Rankings in parentheses are those of 2012.

2. An article written by multiple authors has more than one country, but a country is counted only once, even if multiple authors are from the same country.

Table 10 illustrates trends in author nationality. The growing number of authors from China, South Korea, and Taiwan is conspicuous. It is well known that in these countries, the evaluation

[44] The Open Access Directory listed 280 OA journals that converted from TA journals as of November 11, 2017 (http://oad.simmons.edu/oadwiki/Journals_that_converted_from_TA_to_OA#C) whereas DOAJ listed 11,315 OA journal as of March 17, 2018.

of academic performance is strongly based on academic publication. As *PLOS ONE* and *Scientific Reports* are well known and have good JIFs despite using soundness-based peer review, these journals match the needs of authors who are under pressure from their governments and funders. As the number of articles produced by researchers in newly industrializing economies is expected to increase steadily, OAMJs will play an important role in the development of scholarly communication in the near future.

CONCLUSION

Academic institutions and research funding institutions have been using bibliometrics, such as JIF, directly or indirectly, to evaluate the performance of researchers. Researchers want to publish their articles in high-ranking, i.e., high JIF, TA journals to gain academic prestige, which contributes to acquiring tenure, promotions, and research funding.[45] Thus, if Gold OA journals are to be sustainable, they need to acquire greater academic prestige or be indexed in well-known abstract and citation databases, such as the Web of Science and Scopus at the very least. Hybrid journal are not a solution to the serials crisis because this is not a substitute for the TA model.

In the past, the most prestigious journals were non-OA TA journals, but circumstances are gradually changing. An increasing number of Gold OA journals have come to be indexed in the abstract and citation database, and they have obtained JIFs and the like. However, few journals in social sciences, arts and humanities have done the same.

As of April 2018, the JCR had indexed more than 12,000 journals, of which more than one thousand are OA journals. Some OA journals have gained high citation rates. In the 2012JCR, 39 OA journals had a JIF over 5.0, and nine journals had a JIF over 10.0 (Mckiernan et al. 2016). In the biological and medical sciences, journals with a moderate to high 2016JIF include *PLOS Medicine* (11.862), *Nature Communications* (12.124), and BioMed Central's *Genome Biology* (11.908). OA journals indexed in the abstract and citation database are increasingly becoming an option for researchers choosing a journal for submission. In this context, OAMJs and sub-disciplinary OAMJs will play an important role in the future of OA scholarly communication.

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[45] As of February 14, 2018, 447 organizations across the world have signed DORA, which recommends eliminating the use of journal-based metrics in funding, appointment, and promotion considerations. However, according to a survey of UK research organizations, 75 out of 97 organizations have not signed this declaration and have no research-metrics policy to stop the misuse of research metrics in the evaluation of academics' work. While seven UK research-funding councils signed this declaration, only 16 UK universities signed (Nature news, 12 February 2018). https://www.nature.com/articles/d41586-018-01874-w?utm_source=briefing-dy&utm_medium=email&utm_campaign=20180213

Although they may not give authors the academic prestige they want, newly launched OA platforms such as Wellcome Open Research, Gates Open Research, and the would-be EC Open Research Publishing Platform may also play a crucial role in the future of academic publishing. As many academics conduct research based on grants made by research funders, they have to abide by the OA mandates issued by these research funders. These platforms may bring about an innovative change in scholarly communication.

In the promotion of the Green OA route, a fully functioning OA infrastructure is indispensable. This infrastructure includes various identifiers, e.g., ORCID, FundREF, and DOI; abstracting and indexing services, e.g., DOAJ, PubMed, and OpenAIRE (Open Access Infrastructure for Research in Europe); repository support, e.g., SHERPA and OpenDOAR; and services realizing the interoperability of individual repositories, e.g., OpenAIRE and COAR (Confederation of Open Access Repository) (Johnson and Fosci 2016). Guedon (2017) also argues for the necessity of a fully networked, interoperable system of repositories. He has high hopes for the OpenAIRE project supported by the European Commission, which links the repositories in all the countries of the EU as well as a number of associated countries.

Scholarly communication is still transitioning to a new era. The problem of the serials crisis will not be easily solved, but new OAMJs and the like have potentially redrawn the map of scholarly communication.

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