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Open Access: Effects on Publishing Behaviour of Scientists, Peer Review and Interrelations with Performance Measures

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1 Introduction

History testifies to two ICT revolutions; we are now in the grip of a third. The first ICT revolution was the development of writing. Beforehand the only vehicle for storing information was the human memory. Transmission relied on speech and signs; if content was not to perish with the individual, replication needed time and personal contact. After the invention of writing, portable storage media decreased the restrictions imposed by time and space. Knowledge became much less vulnerable; more could be stored and passed from generation to generation or carried across long distances; critical thinking was enhanced.

While writing represented a huge advance, scholars in the time of manuscripts knew severe limitations. They tended to travel to manuscripts, which were often in jeopardy: witness the destruction at Alexandria. It was very difficult to determine provenance and authority, and to compare texts. Dissemination by copying tended to corrupt texts.

It is almost impossible for us now to appreciate the scale and impact of the second ICT revolution – printing with movable type – we have spent our lives during its maturity. Scholars in the late 15th and early 16th centuries were, however, under no illusions. We hear of the printer Johann Fust having to flee Paris: its inhabitants believed that only someone in league with the devil could produce so many perfect copies of the bible. Later Fust was conflated with Georg (subsequently known as Johann) Faust, who was, of course, reputed to have sold his soul to the devil in return for knowledge (Eisenstein 1993, 19–20). Particularly telling is the association of a technology, so marvellous that it could only be achieved through necromancy, with the pursuit of that most dangerous commodity – knowledge.

For the scholar the advances represented by printing were marked. The possibilities of *obtaining* texts were hugely enhanced. By 1503 8 million books had been printed, more, it is estimated, than the number of manuscripts produced between 330CE, the founding of Constantinople, and 1453, when it was captured by the Turks; the cost of copying one manuscript equated to the cost of producing over 300 printed books (Eisenstein 1993, 13–14). Provenance and authority were enhanced by the use of title pages; texts became more organised and exploitable through indexes, tables of

contents etc. Later editions *improved* texts through corrections; they did not corrupt them as copying had corrupted manuscript texts.

The speed of production and distribution, the beauty and reliability of the texts, and the low cost must have been as impressive then as the Internet is today.

Looking forward 200 years to 1665 we see one of printing's major outcomes: Oldenburg laying the foundations of scholarly communication with the publication of the *Philosophical Transactions of the Royal Society of London*, a form of communication that has lasted for 350 years.

In today's third (electronic) ICT revolution, we are witnessing the birth of new forms of scholarly communication out of the restrictive chrysalis of print. Just like Johann Fust and others witnessing the birth of printing, we do not know yet what the new patterns will be; but we do know that scholarly communication will be very different in the future, and, as with all disruptive technologies, that the change will be sudden and unpredictable.

2 Open Access: description and definitions

Since its inception the scholarly journal has become recognised as having four functions: registration (providing a time-stamp to establish paternity); certification or validation (peer review to provide a stamp of quality assurance); awareness (distribution) and archiving (preservation) (Suber 2012, 62).

In the print world, a large part of the cost of a scholarly journal of any size arises from its distribution: its physical creation, production and delivery. These and other costs (e.g. marketing, collecting subscriptions, contribution to overheads and surplus or profit in commercial publishers) have generally been met from subscriptions: selling physical copies to individuals and libraries.

In the electronic world the costs of distribution, given the infrastructure of the Internet, are virtually non-existent. This has enabled the rise of the Open Access (OA) movement, which has spawned its own set of definitions and acronyms.

2.1 Open Access

Suber (p4) defines OA literature as “digital, online, free of charge, and free of most copyright and licensing restrictions”. This definition condenses, with somewhat different emphasis, the three main public statements on OA, the Budapest Open Access Initiative (BOAI) of February 2002, the Bethesda Statement on Open Access Publishing of June 2003 and the Berlin Declaration on Open Access to Knowledge of October 2003. The BOAI statement, for instance, says: “By ‘open access’ to this literature, we mean its free availability on the public internet, permitting any users to read, down-

load, 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”.

Suber relaxes the second part of this definition to “free of most copyright and licensing restrictions”, a recognition of the fact that authors, as well as asserting control over integrity and attribution of their work, may wish to restrict re-use to, for instance, educational or non-commercial purposes (see § 11 below on copyright).

Literature that is not OA, such as that published in the subscription journals, is generally referred to as “toll access” (TA), i.e. there is some charge to be met either by the reader or, more generally, by a library.

Two types of OA are generally recognised: Green and Gold. Gold OA is delivered through journals. These may be completely OA or hybrid, where some articles are OA and others TA. Green OA is delivered through self-archiving – authors’ deposit of manuscripts in repositories, which may be institutional (aiming to capture all the articles produced by a particular institution) or disciplinary (aiming to capture all the articles in a particular discipline).

2.2 Green versus Gold OA

The major differences between Green and Gold OA are as follows:

- Articles in OA journals, and, of course, OA articles in hybrid journals, (Gold) are peer-reviewed for publication. Self-archived articles (Green) are generally not peer-reviewed for deposit in a repository; however, they may be, and most often have been, peer-reviewed for publication in TA journals. Gold OA articles therefore incur the same costs for the editorial and peer review process as toll articles. Green OA articles do not incur these costs; they only incur a portion, very small in monetary terms, of the overhead costs of setting up and running the repository.
- OA journals generally obtain rights and permissions direct from the rights-holder (usually the author). For self-archiving in a Green repository, the author must generally obtain the rights from the TA publisher. Many TA publishers offer blanket permission for publication in a Green repository, generally after an embargo period of 6 or 12 months; the policies of individual journals and publishers can be found on the [SHERPA/RoMEO website](#).

Both Green and Gold OA have their different strengths.

Green OA is:

- Easy and cheap: it does not engender the overheads of a peer-reviewed journal, nor does it entail the disruption of switching payments from subscription journals to OA articles. There is also a concern about the administrative burden arising from the granularity of payment at the article level to OA journals, as opposed to TA subscription, which is at the title, collection or Big-Deal level;
- Compatible with TA publishing; scholars are therefore able to publish in TA journals, for instance, where these are of particularly high repute, and, through self-archiving, still make their articles OA, albeit after an embargo period;
- Hospitable to many other types of document, notably pre-prints (which provide the time-stamp noted at the start of this chapter), theses, and research datasets; Gold OA by its nature is confined to post-prints.

Gold OA:

- is always immediate, while Green OA is often subject to time embargoes imposed by TA publishers;
- provides access to the published version of an article, while Green OA generally provides access only to the author's final peer-reviewed manuscript, without the formatting or pagination of the published version.

2.3 Gratis and libre OA

A further distinction is between gratis and libre OA.

To set the context, in many countries, such as the UK and USA, intellectual property (IP) law offers partial “fair dealing” or “fair use” exemptions, typically, to use some of the UK wording, for the purposes of research or private study, or criticism and review; German law recognises Zitatrecht. These exemptions are very limited; furthermore, licences from commercial publishers may be more restrictive than the prevailing IP law.

Gratis OA is free of charge to access. However, anyone wishing to exceed the limits of fair dealing must obtain permission from the copyright holder(s). Gratis OA removes toll barriers but not permission barriers.

Libre OA, on the other hand, is both free of charge and free of at least some legal and licensing restrictions. Users may exceed the legal limits of fair dealing in at least some respects. Libre OA removes toll barriers and at least some permission barriers.

Both Green and Gold OA are gratis. Green OA may be libre, but generally is only gratis: publishers will impose not only embargo periods on self-archived materials, but also the sort of restrictions on use that apply to their TA publications (e.g. “all rights reserved”). Gold OA is not necessarily libre: an author is perfectly entitled to retain all intellectual property rights. However, it is common for Gold OA authors to

lift some of the restrictions of IP law by granting a licence (for further discussion, see § 11 below).

It is important to note that the gratis/libre distinction, which is about rights and permissions, is not the same as the Green/Gold distinction, which is about delivery.

3 Economics¹

3.1 Costs of Green OA

In one sense Green OA (self-archiving in institutional or subject repositories) can be seen as riding on the back of TA publishing. The editorial costs of peer review are borne by the TA journal, or rather its subscribers, leaving institutions to pay only the costs of their repositories.

The costs to Association of Research Libraries (ARL) libraries of setting up and maintaining institutional repositories were surveyed by Bailey et al. in 2006. Respondents reported a range of start-up costs from USD 8,000 (EUR 6,000) to USD 1,800,000 (EUR 1,350,000), with a median of USD 45,000 (EUR 33,700). The range for recurrent maintenance budgets was USD 8,600 (EUR 6,440) to USD 500,000 (EUR 374,500), with a median of USD 41,750 (EUR 31,300). The majority of the recurrent budgets went on staffing. Some may be an underestimate: for instance, where academic rather than repository staff archive materials, the cost of their time may well not be measured; nevertheless it is a real cost.

The median cost for start-up and recurrent budgets over 3 years (start-up costs plus 3 times annual costs) is USD 140,250 (EUR 105,100), on average USD 46,750 (EUR 35,000) *per annum*.

It is difficult to arrive at a cost per article of Green OA. The following calculation is very rough and ready, but gives some sort of estimate. The Ranking Web of Repositories lists 1,438 institutional repositories (IRs) and 82 other (subject) repositories. The midpoint IR in terms of size (Document Server@UHasselt) has 12,916 records. Assuming it has been in operation for 6 years, the average number of submissions *per annum* is 2,153. At the average annual cost of USD 46,750 (EUR 35,000) the cost per submission is USD 21.71 (EUR 16.26) in 2006 prices. Note that this may be exaggerated if there was an element of retrospective up-loading into the repository.

Swan's (2010a) study of costs and benefits for the JISC in 2010 is based on a survey of 4 UK higher education institutions (HEIs) of varying sizes and research intensity. The thoroughness and rigour of the collection and analysis of the underlying data should compensate for the small size of the sample. Swan found (2010a, iv) that:

¹ Currency conversions are at rates prevailing in January 2013.

“Annual operating costs for the institutional repository [writing down start-up costs over 3 years, as Bailey], including the cost of depositing items, range from around 26,000 GBP [EUR 31,100] to almost 210,000 GBP [EUR 251,300]. The cost of depositing a single article varies from around 6.5 GBP [EUR 7.8] to 15.4 GBP [EUR 18.4], with the annual cost of depositing into the repository all articles produced by each university ranging from just over 4,000 GBP [EUR 4800] to over 75,000 GBP [EUR 89700]”.

From these calculations it seems that a high-end cost per article of EUR 18 for Green OA is not unreasonable, while the average cost may be something under EUR 15.

3.2 Costs of Gold OA

Prima facie Gold OA incurs less cost than TA: there is no need for administering and collecting subscriptions (although this is offset by the need to collect other contributions such as article processing charges – APCs) or for digital rights management systems or for legal costs associated with licensing and policing.

Some evidence to support this supposition is provided by Edgar and Willinsky in their 2009 survey of OA journals using Open Journal Systems, an open source online journal management and publishing platform. The survey discovered that 208 (20%) of OA journals recorded *no* cost; the mean annual cost of the remaining 503 journals was USD 16,951 (EUR 12,665). 798 journals (83%) operate under the auspices of academic departments or scholarly societies; only 211 (22%) belonged to non-profit (153 or 16%) or commercial (58 or 6%) publishers (multiple answers to this question allowed). There is unfortunately no analysis by type of publisher.

This survey should perhaps be treated with some caution. First, it is restricted to the users of an open source platform; take-up of this platform may tend to be by small and non-commercial publishers. Second, the majority of these publishers are supported by academic departments or other bodies; reported costs will be lower than actual costs; also the long-term viability of such subsidies must be questionable.

OA publishing is funded from what Suber (2012, 138) calls “author-side” contributions; by contrast, TA publishing is funded mainly from reader-side contributions.

The most obvious, though not the only, contribution to meeting Gold OA costs is the article processing charge (APC). Estimates of APC costs vary widely. Solomon and Björk (2012) studied the APCs and article volumes of journals that were listed in the Directory of Open Access Journals as charging APCs. The average APC was USD 906 (EUR 680). The price range varied from USD 8 (EUR 6) to USD 3,900 (EUR 2,930), with the highest charged by journals with high impact factors from major international publishers. Swan and Houghton (2012, 6) note, however, that the large commercial publishers’ charges are relatively high – in the order of USD 1,000–3,000 (EUR 751–2,250). As these larger publishers shift their business model to Gold OA, a higher average APC is likely.

Other contributions may come from subsidies (e.g. from a university, foundation or scholarly society – this is borne out by Edgar and Willinsky’s study quoted above), advertising, print editions or added-value services.

Some OA publishers, such as BioMed Central, Hindawi, PLOS, offer membership schemes, which typically collect an up-front annual fee from institutions and offer a discount on APCs. The UK’s Royal Society of Chemistry (RSC) is now offering a new model called Gold for Gold. Institutions subscribing to a package that offers all RSC’s online content, receive a number of vouchers, each enabling free OA publication of one article. The number of vouchers is calculated by dividing the subscription the RSC receives from an institution by its APC for making a full paper OA. Once all vouchers have been used, the institution may buy additional vouchers at a discount. It is not clear that this model is sustainable; the RSC itself guarantees it for only one subscription year, 2013. It is, however, an interesting experiment in encouraging the growth of Gold OA in a hybrid environment. The RSC has also committed itself to reducing subscription costs in line with the growth of OA articles in its publications; articles placed under its Gold for Gold scheme are **not** counted as OA.

3.3 Toll access costs

Taking reader-side first, the most obvious contribution to meeting TA costs is subscriptions. According to SCONUL (2012), in 2010/11, UK HEIs spent a total of GBP 160m (EUR 190m) on print and electronic journal subscriptions. A hidden contribution in kind is the provision, chiefly by HEIs, of the expertise of the mainly unpaid editors and peer reviewers. Other sources of revenue to meet costs are advertising and electronic or hard-copy sales of individual articles.

It is often overlooked that there are author-side contributions to TA costs too. Many journals levy page and plate charges. In addition, authors and/or their institutions donate the IP in their articles.

3.4 Economic benefits of OA

In their major study of 2009, *Economic implications of alternative scholarly publishing models: Exploring the costs and benefits*, Houghton et al. (2009) aimed to compare all the costs and benefits associated with alternative publishing and dissemination models, using UK higher education as an example. The study not only compared the cost of publishing UK article output under alternative models, including subscription, but also explored the wider benefits of open access to research in the form of increased returns to research and development (R&D) expenditure. They concluded: “It seems likely that more open access would have substantial net benefits in the longer term and, while net benefits may be lower during a transitional period they are

likely to be positive for both OA publishing and self-archiving alternatives (*i.e.* Gold OA) and for parallel subscription publishing and self-archiving (*i.e.* Green OA). This suggests that there are gains to be realised from moving towards more open access publishing models and that, despite the lag between the costs and the realisation of benefits, the transition would probably be affordable within current system-wide budgetary allocations (Houghton *et al.* 2009, xxii)".

This is, of course, a very theoretical approach – calculating likely but currently intangible benefits to UK R&D over 10 or 20 years. More practically relevant is the subsequent study *Going for Gold?* by Swan and Houghton (2012) and their explanatory comments in Houghton and Swan (2013). *Economic implications of alternative scholarly publishing models* (Houghton *et al.* 2009) addresses the question: “which is the most cost-effective model for scholarly publishing and dissemination (the activity)?” *Going for Gold?* asks: “what are cost implications of the alternative models for key stakeholders, primarily for UK universities and the UK higher education sector as a whole (the actors)?” It is, of course, generally HEIs that will bear any costs, and reap any benefits, from Gold OA.

The main findings of Houghton and Swan (2013) are: “That disseminating research results via OA would be more cost-effective than subscription publishing. If OA were adopted worldwide, the net benefits of Gold OA would exceed those of Green OA. However, we are not in an OA world, nor are we likely to be in such a world in the foreseeable future”.

Indeed, unilateral adoption of Gold OA would see many HEIs, particularly the research-intensive ones, incurring significant additional costs. Unilateral adoption of Green OA, on the other hand, incurs additional but very small costs.

4 Developing policies of funders

Since 2006 funders commonly have been expecting, or mandating, researchers in receipt of their awards to make the articles resulting from that research Green OA by self-archiving in institutional or subject repositories. In January 2013, ROARMAP identified 54 funders worldwide with mandates; 43 were added in the 4 years 2006–2009. In a recent development European funders are starting, in varying degrees, to expect publication of results to be Gold OA.

4.1 United Kingdom

In some ways the UK gave the lead in terms of Gold OA in June 2012 with the publication of the Finch Report (Working Group on Expanding Access to Published Research Findings 2012), comprising publishers as well as funders, academics and librarians.

The Report foreshadows a step-change in moving, albeit unilaterally, to Gold OA for all UK research publications; interestingly, major publishers were well represented in the Working Group, and did not dissent. The main recommendations (Working Group on Expanding Access to Published Research Findings 2012, 7) are:

- a clear policy direction should be set towards support for publication in open access or hybrid – journals, funded by APCs, as the main vehicle for the publication of research, especially when it is publicly funded;
- the Research Councils and other public sector bodies funding research in the UK should ... establish more effective and flexible arrangements to meet the costs of publishing in open access and hybrid journals;
- during the period of transition to open access publishing worldwide, in order to maximise access in the HE and health sectors to journals and articles produced by authors in the UK and from across the world that are not accessible on open access terms, funds should be found to extend and rationalise current licences to cover all the institutions in those sectors;
- the infrastructure of subject and institutional repositories should be developed so that they play a valuable role complementary to formal publishing, particularly in providing access to research data and to grey literature, and in digital preservation.

Finch also takes the further step of suggesting in detail key actions for researchers, policy-makers, funders, university managers, librarians, publishers. Actions (Working Group on Expanding Access to Published Research Findings 2012, 8–10) include:

- Make a clear commitment to support the costs of an innovative and sustainable research communications system, with a clear preference for publication in open access or hybrid journals. (*Government, Research Councils, Funding Councils, universities*)
- Consider how best to fund increases in access during a transition period through all three channels – open access publications, subscriptions, and repositories – and the balance of funding to be provided through additional money from the public purse, by diversion of funds from support of other features of the research process, and by seeking efficiency savings and other reductions in costs from publishers and other intermediaries. (*Government, Research Councils, Funding Councils, universities*)
- Establish effective and flexible mechanisms to enable universities and other research institutions to meet the costs of APCs (*Government, funders*); and efficient arrangements for payment, minimising transaction costs while providing proper accountability (*universities, publishers*).
- Establish publication funds within individual universities to meet the costs of APCs, making use of dedicated moneys provided by funders for that purpose, as well as other available resources. (*universities*)

- Continue to develop the infrastructure of repositories and enhance their interoperability so that they provide effective routes to access for research publications, including reports, working papers and other grey literature, as well as theses and dissertations; a mechanism for enhancing the links between publications and associated research data; and an effective preservation service. (*funders, universities, JISC, publishers*)

Taken together, the recommendations and actions provide a blueprint for moving to full-scale Gold OA, with Green still supported, but seemingly playing a lesser role.

Significantly, the Report received not only a ringing endorsement from the UK Government but also, in September 2012, a fund of GBP 10m (EUR 12m) to be spent by April 2013 by 30 HEIs to support APCs for Gold OA publications. This was followed in November by an announcement by Research Councils UK (RCUK) of the new block grant that it would be making to HEIs over the coming five years to fund APCs at 80 % of full economic cost (RCUK announces block grants for universities to aid drives to open access to research outputs). As can be seen from the following table, RCUK expects that 75 % of peer-reviewed articles that it funds (currently about 26,000 *per annum* in total) will be made available by Gold OA by 2017–18; the remaining 25 % will be made available by Green OA. Financial numbers are as yet not attached to Years 3–5; however, RCUK expects to make over GBP 100m available during the 5-year period.

	Year-1	Year-2	Year-3	Year-4	Year-5
RCUK APC fund	GBP 17m (EUR 20m)	GBP 20m (EUR 24m)	To be determined	To be determined	To be determined
Expected % of papers in Gold OA (number)	45 % (10.5k)	53 % (12.3k)	60 % (14.0k)	67 % (15.6k)	75 % (17.5k)

In short, UK HEIs will be spending upwards of GBP 120m (EUR 143m) on APCs over a six-year period, which equates to about 20 % of their current expenditure on subscriptions.

In addition to this monetary encouragement, it is widely expected that the next research assessment exercise in the UK (which has a major financial impact on HEIs for a period of at least 5 years), expected in 2020, will require submissions to be OA.

4.2 Germany

The Deutsche Forschungsgemeinschaft (DFG) has pursued a strategy of supporting OA, initially with the emphasis on Green OA, since 2007. The subsequent Taking Digital Transformation to the Next Level (Deutsche Forschungsgemeinschaft, Com-

mittee on Scientific Library Services and Information Systems 2012, 11) takes the same overall line as Finch: “Preference should be given to the ‘gold road’ to open access, i.e. the quality-controlled initial publication of scientific articles in an electronic medium that uses an open-access business model”. It differs from Finch in foreseeing and encouraging the wholesale conversion of subscription journals to Gold OA, rather than finding funding for APCs generally. “Funding will not primarily encourage the inception of new open-access journals but rather provide targeted incentives for converting prestigious journals that are currently subscription-based into open-access publications”. These will generally be journals sponsored by scholarly societies.

However, it should be noted that the Deutsche Forschungsgemeinschaft (2010) had already set up a fund to support open access publication by scholars, with the proviso that their institutions contributed 25 % or more of the costs.

4.3 European Union

The European Commission (EC) has stated that all research publications arising from Horizon 2020, the EU’s Research & Innovation programme for 2014–2020 with funding of EUR 80 billion, will have to be Open Access. Both gold and green routes to OA are supported; the green route permits 6- or 12-month embargos. There is not, however, the emphasis on the primacy of and commitment to Gold OA evident in Finch.

The EC has, however, also recommended that member states take a similar approach to the results of research funded under their own domestic programmes. The goal is for 60 % of European publicly funded research articles to be available under open access by 2016. The size of the EU budget for Horizon 2020, and the nudge to national funders in member states, suggest that this policy will have a significant impact.

Moreover, the European Research Council reaffirmed its commitment to OA in June 2012 and has joined Europe PubMed Central.

4.4 Funders

A further indication of the trend towards Gold OA is given by the stance of research funders.

According to SHERPA, in December 2012, worldwide 16 funders (15 % of the total) required (Gold) OA publication; a further 30 % encouraged it. The geographic breakdown, with the percentage for each country, is as follows:

Austria	1 (100 %)
Canada	4 (31 %)
Germany	1 (50 %)
Hungary	2 (100 %)

Netherlands	1 (100 %)
Sweden	5 (100 %)
UK	2 (4 %)

4.5 USA

The strong and gathering impetus towards Gold OA in Europe, and to an extent Canada, has not yet found formal expression in the USA. However, the European funders and their governments are bent on transforming publishing from subscription to OA. The number of funders, the size of budgets and the involvement of governments will surely have a major effect on publishers' OA policies. Even if there is no formal movement by US funders towards Gold OA, the changes in the publishing industry will encourage moves in this direction.

5 Effects of OA publishing on the volume of publications

According to Ware and Mabe (2009, 18–21), there were about 25,400 active scholarly peer-reviewed journals in early 2009, collectively publishing about 1.5 million articles a year. The number of scholarly journals published annually has been growing at the remarkably steady rate of about 3.5% *per annum* since their inception in the 17th century, with an acceleration in the 30 years following World War II. The number of articles had been growing at a slightly lower but constant rate of 3% *per annum*. These rates map closely to the increase in the number of scientific researchers in the USA and the rest of the OECD.

Growth has not, however, been uniform across all regions (Ware and Mabe 2009, 21):

the EU's output [grew] faster than the US and [overtook] it in the late 1990s [...]. The most dramatic growth, however, is in the output from the East Asia region (China, Singapore, South Korea and Taiwan); between 1995 and 2005, China's output grew at 17% and Taiwan's at 16% per year, compared to 0.6% for the USA and 1.8% for the EU, while the UK's output was flat.

Turning to the growth of OA publishing, the rigorous study by Laakso et al. (2011, 8–9) distinguishes three periods: the "Pioneering Years" (1993 to 1999), the "Innovation Years" (2000 to 2004), and the "Consolidation Years" (2005 to 2009).

The Pioneering Years were characterised by innovation by individuals or small groups of scholars, using simple technologies. There was rapid growth from, obviously, a small base: in 1993, it is estimated that 20 open access journals published 247

articles; by 2000, 741 journals are estimated to have published 35,519 articles. Many of these early journals did not survive.

The Innovation Years coincided with the wholesale movement of journal content to electronic delivery. In terms of OA they were characterised by burgeoning advocacy of OA and the development of economic models for Gold OA, notably APCs. BioMed Central and PLOS demonstrated the viability and high quality of Gold OA. There was significant growth of both titles and articles: by 2005, 2,837 journals published 90,720 articles, an increase of 155 % on 2000.

The Consolidation Years saw the growth of infrastructure to support OA, such as open source publishing software, the DOAJ, Creative Commons licences. Discovery was enhanced and enabled by Google and Google Scholar. Growth was not as spectacular, but still very strong: in 2009, 4,767 journals published 191,851 articles, an increase of 111 % on 2005.

It is clear that OA publishing is, unsurprisingly, growing at a much faster rate than publishing as a whole (e.g. 111 % as opposed to 3 % for articles), but from a very low base. A natural question is the proportion of OA articles to TA articles. Laakso *et al.* (2011) note that this question cannot be answered with any certainty. However, from incomplete data they suggest that the percentage of OA articles in 2009 ranged from 5.9 % to 7.7 %.

Turning to the future, Lewis (2012, 496–7), building on the work of Laakso *et al.*, takes this 7.7 % figure and makes straight-line extrapolations to predict the increase in the portion of articles that will be Gold OA. Extrapolating the rate of growth in the period from 2000 to 2009, he suggests that by 2025 the portion of Gold articles would be 19.6 %. Based on 2005 to 2009, where the rate of change increases, the portion of articles in Gold OA journals would be 20.9 % in 2020 and 26.8 % in 2025. Thus over the next 12 years these extrapolations predict that between 20 and 27 % of articles will be Gold OA.

However, Lewis believes that the picture is more complex. He sees Gold OA as having all the characteristics of a disruptive technology, as defined by Christensen (2011, 497):

[D]isruptive innovations generally have two distinct characteristics. First, they bring a new value proposition to the market. This new value proposition is almost always the application of a new technology using a new business model. Second, disruptive innovations usually make it possible for customers who had not been able to access a service or product to acquire it. The fact that the disruptive innovation is inferior does not matter to these new customers, as it is better than what they had before, which was nothing.

Over time the disruptive product improves, and from being a niche offering comes to dominate the market. Examples can be seen in the hard disk market, and in the car and motorcycle market in the USA, where market share has been won by Japanese and Korean firms. A technologically influenced example is Kodak, whose business model was to sell analogue cameras cheaply and to make money from consumables.

In spite of carrying out extensive research into digital cameras, Kodak never developed these, mainly because of middle-management inertia, and from being the dominant supplier of cameras and film shrank to become a supplier solely of printers for PCs, interestingly following the same business model of profiting from sales of consumables (the case of Kodak is discussed by Ball and Spencer (2011) in the context of the wider impact of disruptive technologies on libraries generally).

According to Christensen, the growth in market share of a disruptive technology is not linear, but follows an S-curve. Lewis (2012, 500–501) observes:

The problem is to predict when the curve will flip and the pace of adoption of the disruptive innovation will accelerate rapidly [...]. To take one of Christensen's examples, digital photography spent a decade incubating on the flat part of the S-curve and then in a few short years replaced nearly all film-based photography. But because there was so little market penetration early on, it was hard to see the change coming.

Assuming that the figures produced by Laakso *et al.* (2011) are a good estimate and that the methodology established by Christensen is sound, Lewis provides two estimates of non-linear growth:

[B]ased on the first estimate, using the 2000 to 2009 data, it is likely that Gold OA journals will publish half of all scholarly articles by 2017 and will publish 90% of the articles by 2020. The second estimate, based on 2005 to 2009, shows that 50% of scholarly articles would be Gold OA by 2021 and over 90% by 2025.

These predictions are startling, but Lewis's argument is based on sound figures and methodology. It is not based on intangible factors, such as the likely attitudes of scholars, perceived citation advantage, the growing reputation of OA journals or commitment to the principle of OA. These factors will no doubt play their part in the future growth of OA. A more important, immediate and concrete factor is the switch to direct funding of Gold OA outlined above. This may be the pebble that starts the avalanche.

One area of marked growth is developing countries. As Ware and Mabe (2009) pointed out above, "between 1995 and 2005, China's output [of articles] grew at 17% and Taiwan's at 16% per year, compared to 0.6% for the USA and 1.8% for the EU, while the UK's output was flat". It is not surprising that developing countries should seek the most cost-effective ways of publishing and disseminating this output. The DOAJ at the start of 2013 included the following developing countries (as listed by the International Statistical Institute for 2013) in the top 20 by number of journals:

Rank	Country	No. of OA Journals	No. added 2010/12
2	Brazil	806	407
4	India	472	315
6	Egypt	351	223
9	Romania	253	184
11	Turkey	212	110
12	Colombia	208	111
14	Iran	170	123
16	Chile	142	34
17	Argentina	136	78
19	Mexico	126	48

It will be interesting to see if this trend continues, and the implied increase in academic output mirrors the economic development of countries such as Brazil and India.

6 Research on (possible) citation advantages of OA publications

Since its inception, there has been an assumption by its advocates, and indeed others, that OA would increase citation impact. It seems an obvious conclusion to draw from the very nature of OA, which removes the pay barrier to reading, and hence possibly citing, journal articles. It is important to point out that the assumption was never that OA would increase the citation of all articles whatever their quality or relevance to their fields but rather that the citation impact of works of appropriate relevance and quality would increase by virtue of their being OA.

Swan's synoptic report (2010b, 1–3) summarises the assumptions as follows:

- that a proportion (whose size varies according to discipline or field) of researchers do not have access through subscription journals to all the published papers that are relevant to, and might influence, their own work
- that these people would avail themselves of the opportunity to access and read these otherwise unavailable documents if they were made freely available online
- that some of those documents would be found to be relevant and applicable to the researchers' work and hence citable
- that others would be found to be irrelevant or inapplicable and would not be cited for the usual reasons that work is not cited. (Swan 2010b, 1–2).

Swan (2010b, 2–3) distinguishes four possible citation advantages of OA:

- *General OA Advantage* where OA articles are available to readers who otherwise have no access;
- *Early Advantage* where OA articles are available before similar toll access articles, thus generating more citations over a period of time;
- *Selection Bias* where authors are more inclined to make their better articles Open Access;
- *Quality Advantage* where better articles gain more from the General OA Advantage because they are by definition more citable than poorer articles.

We might add another factor: multiple authorship increases the possibility of self-archiving. According to Wagner (2010), “[p]ublication in an open access journal (Gold OA) apparently is not required to get a significant OA citation advantage.”

Even from this short exposition, it is clear that disentangling and determining any citation advantage for OA articles is fraught with difficulties. What is an appropriate time after publication to measure citations? This differs from discipline to discipline; also it is generally difficult to determine the exact date of an article becoming OA. How reliable, comprehensive and comparable are the sources of citations? Is there a bias, for instance, against developing countries, which may rely more heavily on OA literature? Is like compared with like, and is allowance made for the many variables?

Swan (2010b, 17) summarises her exhaustive analysis of 31 studies published between 2001 and 2010 as follows:

Measure	Result
Studies finding a positive Open Access citation advantage	27
Studies finding no Open Access citation advantage (or an OA citation disadvantage)	4

Size of OA citation advantage when found (and where explicitly stated by discipline)	% increase in citations with OA
Physics/astronomy	170 to 580
Mathematics	35 to 91
Biology	–5 to 36
Electrical engineering	51
Computer science	157
Political science	86
Philosophy	45
Medicine	300 to 450
Communications studies (IT)	200
Agricultural sciences	200 to 600

Even allowing for the difference in methodologies, in sample size, in disciplines, in types of publication, there is a clear indication that there is some citation advantage in OA, although one might conjecture that any advantage will not be at the upper limits suggested by some of the above figures. However, it is not clear whether OA is a factor of causation or a positive correlation.

It should also be noted that a study by Piwowar, Day and Fridsma (2007 quoted by Swan 2010b) established that “publicly-available datasets (open data) are significantly associated with a 69 % increase in citations to articles that the data accompany. This correlation is independent of Journal Impact Factor, country of authors and time since publication”. The trend towards open repositories of research data may therefore also be a significant factor in citations and impact.

7 Effects of OA publishing (especially golden road) on the reputation pyramid of scholarly journals

The main research reflecting the reputation of OA journals was undertaken as part of the Study of Open Access Publishing (SOAP) project (Dallmeier-Tiessen *et al.* 2011, 2–3). About 1.5 million individuals, obtained from the mailing lists of major publishers, were exposed to a survey, which ran for most of 2010. While a respectable total of 54,000 responded to the survey, the analysis was restricted to the 38,358 who had published at least one peer-reviewed research article in the last five years. Respondents were from 162 countries, with a large representation from the research-intensive nations. Respondents were drawn from a wide range of disciplines, with biological and medicine-related subjects making up about 37 %.

This was therefore a large-scale survey of research-active, published scholars from a wide range of countries and disciplines, and can be taken as representative of scholarly opinion towards the end of 2010.

Tellingly, 89 % of respondents believed that journals publishing OA were beneficial to their research field. 20 % cited financial benefits, 18 % the public good, and 10 % benefits to the individual, for instance, enhanced recognition. About 50 % felt that OA was more cost-effective than TA, with about 10 % holding the opposite view. Turning to some commonly held negative opinions of OA, just fewer than 30 % believed that OA penalised research-intensive institutions, with 25 % disagreeing. Fewer than 20 % felt that OA published poor-quality research, with 50 % disagreeing. About 15 % felt that OA undermines peer review, with 60 % disagreeing.

Barriers to publishing OA were seen as financial (39 %) and an absence of quality OA journals (30 %). Only 2 % intended to publish their next article OA. This somewhat contradicts the views just outlined, and shows considerable reluctance among scholars to publish OA themselves, despite the perceived benefits to the research field in the abstract. However, the picture is different in the fields of biological and medi-

cine-related sciences, where there are established OA journals: 50–60 % of researchers in these fields cite funding as the main barrier, and only 20–23 % journal quality. By contrast, in business studies, 37 % cite journal quality and only 12 % funding.

A more detailed view of funding was given by the 52 % of respondents who had published at least one article OA. Of these 50 % had paid no fee; over 75 % of those active in the humanities and social sciences had paid nothing. One can postulate a number of factors for these disciplines: lower costs for copy production; relative newness of foundation; subsidy by academic departments or institutions.

It seems clear from this survey that:

- OA journals are well established and well regarded in some disciplines;
- there remains a reluctance to publish OA; funding is a major issue;
- only a minority perceive OA to be *per se* poor quality and to undermine peer review.

The later (2012) study by Björk and Solomon followed a bibliometric approach, using impact as a proxy for quality of a journal. Taking a 2-year average of citations (impact factors) from the Journal Citation Reports and Scopus, Björk and Solomon (2012, 5–6) found that “OA journals had impact factors that were approximately 76 % and 67 % as high as subscription journals in JCR and Scopus respectively when analyzed by journal and 73 % and 62 % when weighted for articles published”. When categorising by period of launch, they found that newer journals, both TA and OA, tended to have higher impact factors than earlier journals, and that the gap between TA and OA journals narrowed over time, with later TA journals having an impact factor of about 3.8 and OA an impact factor of about 3.6. When analysing by discipline, they found that there was essentially no difference in impact factor between TA and OA journals launched from 2002 onwards in the fields of medicine and health.

Further analysis by method of funding shows that, for journals launched since 2002, OA journals not charging APCs had an impact factor of about 1.25, OA journals charging APCs an impact factor of about 3.2 and TA journals an impact factor of about 3.3.

Björk and Solomon (2012, 9) conclude: “[F]or the newer journals, particularly in medicine and health, our results show that OA journals are performing at about the same level as subscription journals, in fact getting more citations in some subcategories [...] There are large numbers of both subscription and OA journals that are high quality and widely cited [...] [N]ewly founded full OA journals compete on almost equal terms with subscription journals founded in the same period. OA articles published [in] medicine and health by publishers in the four largest publishing countries attract equal numbers of citations compared to subscription journals in these fields”.

From these 2 studies it seems fair to conclude that:

- APC-funded OA and TA journals launched since 2002 are of similar impact and quality;

- there are major differences between disciplines with medicine, health and biological sciences OA journals equalling TA journals and in some subcategories out-performing them, while journals in the humanities and social sciences lag behind.

While OA journals in some areas equal the quality of TA journals, it must be remembered that OA publishing is open to abuse. There are some unscrupulous “publishers” who will accept almost any submissions on payment of a fee and are hence giving OA a bad name. Their existence has prompted Jeffrey Beall to maintain a list of what he terms “predatory publishers”. As Poynder (2013) and others observe, this binary approach (good or bad) has its faults, but as yet “no one has come up with an adequate way of delineating the good from the bad”. Poynder also notes the number of journals in Beall’s list from developing countries. This may be evidence of (unintended) bias; it may simply reflect the large number of new OA journals being produced in these countries (see §5 above).

8 Effects of the different models of OA on peer review practices

Peer review is essentially a product of the print era, developed as a means of rationing the (relatively) rare resource of space in printed journals in favour of high-quality articles.

Wikipedia defines scholarly peer review as:

[T]he process of subjecting an author’s scholarly work, research, or ideas to the scrutiny of others who are experts in the same field, before a paper describing this work is published in a journal. The work may be accepted, considered acceptable with revisions, or rejected. Peer review requires a community of experts in a given (and often narrowly defined) field, who are qualified and able to perform impartial review. Impartial review, especially of work in less narrowly defined or inter-disciplinary fields, may be difficult to accomplish; and the significance (good or bad) of an idea may never be widely appreciated among its contemporaries.²

It is widely regarded as the gold standard of research and scholarly communication, yet, as the definition hints, there are associated problems.

The UK Office of Science and Technology (quoted by Poynder 2013) was a little more blunt, noting that many regard peer review as “an inherently conservative process [...] [that] [...] encourages the emergence of self-serving cliques of reviewers,

² https://en.wikipedia.org/wiki/Peer_review (03.10.2016).

who are more likely to review each others' grant proposals and publications favourably than those submitted by researchers from outside the group".

Even publishers are known to comment unfavourably: in 1997, the then editor of the *British Medical Journal*, Richard Smith (again quoted by Poynder), described peer review as "expensive, slow, prone to bias, open to abuse, possibly anti-innovatory, and unable to detect fraud". He added: "We also know that the published papers that emerge from the process are often grossly deficient".

Some hold that OA is a means of avoiding peer review to publish inferior material. This is not the case: OA *per se* is concerned only with *access*; in this sense it is agnostic as far as peer review is concerned.

The problem arises perhaps from the conflation in TA publishing (printed or electronic) of three of the four functions of the scholarly journal defined at the start of § 2 above: TA publication provides a time stamp, access, and the stamp of quality. Both Green and Gold OA support the functions of the scholarly journal. Green OA provides the means of gaining the earliest time-stamp, through self-archiving of pre-prints. It also provides evidence of quality approval through the self-archiving, with the publisher's permission and after an embargo period, of post-prints, or simply the DOI on the publisher's website. To put it another way, OA provides free access to peer-reviewed research (sometimes *before* peer review), not access to articles free of peer review. Incidentally it also aids preservation through duplication. Gold OA obviously supports all functions of the scholarly journal.

As noted in § 3 above, in one sense one could say that Green OA rides on the back of TA, in that it provides access to peer-reviewed articles without paying the cost of peer review – a significant plank in the argument of those, such as Harnad, championing Green OA over Gold. Otherwise, Green OA does not influence peer review practices. It might be seen as threatening the economic viability of peer-reviewed TA journals, but it is the economic model that it threatens, not peer review.

What OA, however, does do is decouple publication, or access, from the stamp of quality. Moving out of the straitjacket of print, it enables new approaches to establishing quality.

Much OA literature starts life as a pre-print (i.e. a version of an article before peer review, as opposed to a post-print, which follows peer review). While pre-prints predate the Internet, they have become more established with the possibility of online pre-print servers. Perhaps the best known is arXiv, which defines itself as follows:

arXiv is proud to be able to offer such a large collection of scholarly work in a single location, without any fees and with support for users around the world. arXiv supplements the traditional publication system by providing immediate dissemination and open access to scholarly articles (which often later appear in conventional journals). It is important to note, however, that arXiv is not a repository for otherwise unpublishable material, nor is it a refereed publication venue.

The moderation process is essential to ensuring that submissions are of value to the arXiv communities.³

Notably, articles must be of a certain academic standard but they are not peer-reviewed; what arXiv offers is early and immediate dissemination.

There have been numerous experiments with new approaches to peer review, enabled by technology.

PLOS ONE, for instance, uses rigorous peer review, but leaves it to the scientific community to decide on importance:

Too often a journal's decision to publish a paper is dominated by what the Editor/s think is interesting and will gain greater readership – both of which are subjective judgments and lead to decisions which are frustrating and delay the publication of your work. *PLOS ONE* will rigorously peer-review your submissions and publish all papers that are judged to be technically sound. Judgments about the importance of any particular paper are then made after publication by the readership (who are the most qualified to determine what is of interest to them).⁴

A more radical approach was taken by *Philica*. There are no editors or reviewers; submission and access are free of charge; submissions may be on any subject; review takes place after publication by the scholarly community at large. Its peer review process “is both transparent and dynamic. It is transparent as reviews can be seen publicly; it is dynamic because opinions can change over time, and this is reflected in the review process” (Philica o. Jg.). It has not, however, been particularly successful. As of February 2013, only 313 articles and shorter observations have been submitted since 2006. Only 6 articles have been reviewed in the past year; many have never or seldom been reviewed. This hardly represents the wisdom of the crowd.

Frontiers offers traditional Gold OA based on APCs with what it bills as a new approach to peer review:

Frontiers full reviews are made up of two consecutive steps, an independent and an interactive review. In the independent review phase, review editors evaluate independently from each other whether the research is academically sound following a standardized review questionnaire. Then, Frontiers implemented for the first time the real-time Frontiers Interactive Review Forum, in which authors and review editors collaborate online via a discussion forum until convergence of the review is reached.⁵

Frontiers stresses the open involvement of both reviewers (who are named in the published articles) and authors and the involvement of the scholarly community in the assessment phase which analyses views and downloads and produces metrics. The

3 <https://arxiv.org/help/primer> (03.10.2016).

4 <http://journals.plos.org/plosone/s/journal-information> (03.10.2016).

5 <https://blog.frontiersin.org/2013/02/27/frontiers-peer-review/> (03.10.2016)

importance of the approach is characterised as follows: “At Frontiers, it is not the opinion of only 2–3 reviewers, however qualified, that determines the importance of a research work, but the entire academic community. Likewise, it is not the ranking of the journal in which an article is published to determine its impact, but the article itself”.

One can see in these examples that peer review is easing out of the chrysalis of print in response to the new technologies: blogs, wikis and social media as well as OA journals will play a part in scholarly communication. It is no longer space that is scarce, as in the print world; in the Internet age the scarcity is of time and attention.

9 Effects of OA publishing on publication, search and reception practices of scientific literature

9.1 Publication

As we have seen in earlier sections:

- conservative extrapolations predict that between 20 and 27 % of articles will be Gold OA by 2025; more radical estimates are that 50 % of scholarly articles will be Gold OA by 2021 and over 90 % by 2025;
- there are clear indications that there is some citation advantage in OA;
- -APC-funded OA and TA journals launched since 2002 are of similar impact and quality, although there are major differences between disciplines, with the humanities and social sciences lagging behind medicine and biological sciences;
- there is a major expansion of OA journal publishing in developing countries, which, one can assume, will drive up the number and proportion of OA articles.

There is therefore considerable growth in the volume and quality of OA publishing, with 89 % of respondents to the SOAP survey believing that journals publishing OA were beneficial to their research field, although only 2 % intended to publish their next article OA. These effects may be ascribed to the nature and existence of OA publishing.

There has also been considerable advocacy of OA over recent years, notably by people such as Swan, Harnad and Suber. This seems to be having an effect: the SOAP survey found that there was little “agreement of respondents [12–18 %] with a series of ‘myths’ about open access publishing”, such as OA undermines peer review or leads to the publication of poor-quality research (Dallmeier-Tiessen *et al.* 2011, 7–8). A further, extraneous, impetus is being given by funders in Europe starting to insist on, or at least favour, Gold OA.

As noted by Dallmeier-Tiessen *et al.* (2011, 7–8), the main perceived barrier to publishing OA is financial, although there are major differences between the disciplines, with the humanities, social sciences and business studies finding funding much less of a barrier. This may be due to the number of OA journals in these fields charging low or no APCs, which may, of course, change over time as OA journals in these disciplines become more established and expensive to run, losing subsidies from institutions.

This highlights a major, if not the major, obstacle to the development of OA publishing. TA publishing is embedded in the structures of universities: especially in the research-intensive institutions, a large portion of the library budget is devoted to subscriptions and their management. How can the transition from reader-side to author-side payment be made? In the UK there is some funding available from RCUK, but that is tied to specific research grants. Unless there is a major disruption, as predicted by Lewis, it will take several years for Gold OA to expand to the point where it can leverage a decrease in TA subscriptions. During this period universities will be faced with the prospect of funding TA subscriptions at or close to the current level and at the same time finding additional funds to pay APCs. On the part of universities, one option may, of course, be simply to divert money from subscription budgets to APC budgets, which, given the ubiquity of Big Deals, would cause a great deal of angst (for the impact of Big Deals on library budgets, see Ball (2004)). On the part of publishers, an option would be simply to switch from TA to OA; obviously changing economic models like this is very high-risk.

As author-side payment becomes more established, we may well see the development of a competitive market. In the TA market there is some competition amongst publishers and journals for authors. However, generally one can assume there to be an over-supply of articles for publication. Once an article is accepted, the publisher generally is assigned the copyright, and hence has the monopoly on that content and can charge subscriptions at will. With author-side payment OA publishers will have to compete, essentially on the cost-benefit of APCs and impact factors. Unlike the print world, there is no scarcity in terms of space for publication. Similarly, there should be no scarcity of capacity of reviewers, since the author will pay this cost. There is therefore, in theory at least, no limit to the number of articles that an OA publisher could put out.

Turning to Green OA, it was noted in 2005 that some scholars are reluctant to self-archive in repositories: “[a]uch die ... Bereitstellung von entgeltfrei zugänglichen Preprints im Internet ist nach Auskunft der Befragten nicht sehr häufig. Etwas öfter wurden bereits anderweitig publizierte Beiträge sekundär für einen entgeltfreien Zugriff im Internet publiziert” [also the provision of freely available pre-prints in the Internet is, according to the sample, not very common. Contributions already published elsewhere were made available free in the Internet somewhat more often] (Deutsche Forschungsgemeinschaft 2005, 9). This is contradicted somewhat, at least for the social sciences, by Antelman in (2006, 92): “This study finds that social scientists are self-archiving at a significant rate”. Since these surveys we have also seen

mandates becoming more common: ROARMAP shows the number of institutional, funder and other mandates rising from a handful in 2005 to 255 in 2013, with a further 26 proposed. The Open Access Directory in 2013 gives various numbers of Green OA records: 25,000,000 as being harvested by OAIster in February 2013; 38,354,066 as being harvested by Scientific Commons in 2012, although a portion of them will be “dark deposits”, with only the metadata exposed to public view.

9.2 Search and reception practices

It may be argued that OA has not had a great effect on the availability of articles to scholars in the large research-intensive institutions. These have typically subscribed to a large portion of the literature of interest to their scholars, enhanced over recent years by subscription to the Big Deals. Traditional provision has also included subscription to the major abstracting and indexing services, such as *Scopus* and *Web of Knowledge*, enabling discovery, and supply of material not held, by inter-library loan or document delivery.

However, now there is a major search engine freely available: Google Scholar (although many researchers, particularly in the humanities, use plain Google and Google Books at least as a starting point; see Rutner and Schonfeld (2012, 17)). Google Scholar not only indexes full-text journal articles, technical reports, pre-prints, theses, books, and other documents, including selected Web pages, that are deemed to be scholarly; it also provides access to abstracts of articles that have cited the article being viewed. Although different in coverage, Google Scholar has been shown to match *Scopus* and exceed *Web of Science* in the number of citations returned in at least one subject field and “within a year of its introduction, Google Scholar was apparently responsible for bringing far more visitors to the *BMJ* Web site than PubMed” (Kulkarni *et al.* 2009).

A major advantage is that Google Scholar also indexes the content of institutional and subject repositories. It therefore discovers not only TA and Gold OA articles but also self-archived Green OA materials, even dark deposits. These materials are freely available when beyond any embargo periods imposed by publishers; many repositories also provide an email button, enabling scholars without subscriptions to request a copy of an article from the author before the embargo expires.

Many academic libraries now also provide sophisticated search engines, such as the EBSCO Discovery Service. These have the capability to search across a very wide range of resources, tailored to the requirements of individual institutions. They will typically be configured to cover not only TA resources to which the university subscribes, but also OA resources such as OAIster.

In short, there is a huge volume of Green OA materials (25–38 million) in repositories, indexed by a major free search engine, and hence discoverable by and available to anyone with an Internet connection.

10 Interaction of OA with performance measures and other incentives in universities and research institutions

As we have seen in §6 above, there does seem to be at least some citation advantage for OA articles. This is due in part to toll-free availability (more researchers have access, hence there will be more citations), and in part to early appearance, for instance, as pre-prints in repositories, leading to earlier high numbers of citations. In so far as additional citations represent increased impact, an OA article can therefore be expected *prima facie* to outperform a TA article of similar citability.

This outperformance should be an incentive to publish Gold OA, or at least to self-archive. However, as we saw from the SOAP survey above, only 2% of those surveyed intended to publish their next article OA, despite viewing OA favourably. This reluctance may be ascribed to two factors suggested by SOAP: lack of funding (cited by 39%); lack of high quality journals in some disciplines (cited by 30%) (Dallmeier-Tiessen *et al.* 2011, 7–8). There is also an element of conservatism: given a, perceived, choice between publishing Gold OA and publishing in a high-impact-factor TA journal, most academics will choose the latter because of perceived benefits to a career. Also, the citation advantage is by no means proved satisfactorily. However, authors can have the best of both worlds, by publishing in high-impact TA journals and self-archiving in the institutional repository.

The performance measures so important to scholars, in terms of career, and to universities, in terms of research assessment exercises and reputation with funding bodies, may therefore be seen to have acted as a brake on the development of Gold OA. This, of course, as noted in §4 above, is now being eased by the policies of a number of funders, particularly in Europe, which, while not explicitly favouring it, allow and indeed fund Gold OA.

An excellent example of a policy linking deposit of articles to research evaluation is provided by HEFCE (Higher Education Funding Council for England, 2015). The policy insists that “to be eligible for submission to the post-2014 REF [the next research assessment exercise], authors’ outputs must have been deposited in an institutional or subject repository” (<http://www.hefce.ac.uk/pubs/Year/2014/201407/>, p.1). Deposit must also take place on acceptance by a publisher (p.5). There is evidence from individual institutions that this policy is already having the effect of increasing the number and proportion of OA deposits. At UCL (University College London), for instance, the repository contained 10,000 OA outputs in 2011 and 14,000 OA papers in 2013; OA content then sharply increased to 22,500 papers by September 2015 (Ball 2015, 5).

Policies, of both funders and institutions, are therefore contributing to a growth in the deposit of OA resources. Important work on policies has been done by the European project PASTEUR4OA, which “aims to support the European Commission’s

Recommendation to Member States of July 2012 that they develop and implement policies to ensure Open Access to all outputs from publicly-funded research”. As part of the work of PASTEUR4OA, the database of Open Access policies, ROARMAP, was extended and elaborated. It now records, and links to, every known policy’s conditions under an exhaustive set of categories, and is fully searchable. This database as a whole provides a rich source of data to analyse when studying policy effectiveness.

The project also looked at the mandatory policies in place at over 120 universities around the world and assessed the effectiveness of each policy. This was measured in terms of the percentage of Open Access material available from each institution compared to the total number of articles published from those institutions each year. Using regression analysis, the project determined that the critical elements of a policy, whether of a funder or an institution, are as follows (Swan 2015, 9):

The policy requires that research articles be deposited in an Open Access repository; In addition, the policy must state that this deposit step cannot be waived; The policy links deposit with research assessment (performance evaluation). These are important results for the continuing development of Open Access”.

11 Copyright

As we noted above in § 2, the original OA statements of 2002–3 aimed at freedom from virtually all copyright restrictions. However, OA is agnostic as regards copyright: permissions may be as restricted as with TA publishing, or the author may reserve some rights, for instance, of commercial use, or there may be no restrictions at all.

The **Creative Commons** initiative provides a range of common licences that allow various degrees of permission. There are 6 gradations in the generally used licences from the freest, CC-BY, which “lets others distribute, remix, tweak, and build upon your work, even commercially, as long as they credit you for the original creation”, through CC-BY-NC, which “lets others remix, tweak, and build upon your work non-commercially, ... although their new works must also acknowledge you and be non-commercial”, to the most restrictive, CC-BY-NC-ND, “only allowing others to download your works and share them with others as long as they credit you, but they can’t change them in any way or use them commercially”. There is also the ultimate OA licence (CC-Zero or CCO) for copyright-holders who wish to place their work entirely in the public domain.

The self-archived versions of articles published in TA journals will carry the same restrictions imposed by the publishers as the published articles themselves. However, over time the existence, and awareness, of the Creative Commons licences should enhance the usability as well as the availability of Gold OA articles.

It should also be remembered that authors, or their institutions, are the first holders of the copyright in articles, whether Green, Gold or TA. As such they are at

liberty to assign or reserve rights in their work. The position of individual authors *vis-à-vis* publishers can be strengthened by institutional mandates or policies insisting on the reservation of rights.

12 Conclusion

It is clear from the foregoing that OA is only about toll-free access: of itself it does not affect any other aspect of scholarly communication, except perhaps in increasing or bringing about earlier citations. However, it does open the door to changing, developing, or at least experimenting with, many aspects of scholarly communication.

We have just seen that copyright in OA materials can be as restrictive as the TA norm of “all rights reserved”; however, through the new infrastructure of Creative Commons licences, it enables materials to be as free as CC-BY or even CC-Zero.

Turning to quality assurance, many OA journals operate peer review in just the same way as the traditional TA journals; in some disciplines they are matching or even exceeding the quality and impact of concurrent TA journals. In the TA world, publication amalgamates access, a time stamp and the stamp of quality; Gold OA enables their separation and opens the possibility of different forms of peer review. Author-side payments also make possible a theoretically unlimited increase in content published.

12.1 The future

Like the protagonists of the last ICT revolution, we cannot predict how scholarly communication will develop under OA. There are some pointers, however.

We have seen the new possibilities of changing peer review from the closed and somewhat discredited system operating under TA. One emerging model is for a short initial review and collaborative enhancement of the technical quality of articles to be undertaken; this is followed by publication, with the expectation that the scholarly community at large will engage with the content, and assess and develop the importance of the ideas.

This process will be fostered and enhanced by the current move towards open access to the data sets of publicly funded research. The article and associated data form the nucleus of an organic corpus of scholarly debate, open to any scholar with access to the Internet. While the STM community has led the way in the move to OA, this form of debate may foster a rebirth of the humanities monograph, which has always suffered under the economics of TA print.

Another development is the overlay journal. In its purest form the overlay journal selects Green pre-prints from OA repositories, reviews their quality and has the journal

title (i.e. the quality stamp) added to the metadata of approved articles (for an early exposition of this idea, see Ball and Spice 1996). In other manifestations the overlay journal will provide links to (generally OA) articles published in other journals; it therefore acts as a kind of alerting service, drawing together articles on a particular topic and hence saving the time of the reader.

12.2 Challenges

It seems from the evidence cited here that OA is becoming embedded in the research process, initially as Green but increasingly as Gold OA, latterly given impetus by the actions of research funders. There are three main challenges:

- Given that OA is neutral regarding most elements of the scholarly communication process, but has the potential to enable radical change, the onus is on the research community to develop, test and implement new models for scholarly communication.
- Despite the advocacy around OA, there is still a need to inform scholars, funders and administrators of its possibilities and implications.
- At a practical level, the transition from TA to Gold OA seems problematic and, according to Houghton *et al.*, costly, for both universities and TA publishers; means need to be developed to ease the transition without large additional costs and without destroying the richness of existing provision. Some concrete steps are recommended in the Finch Report (see §4 above).

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Acronyms

- APC – article processing charge
- BOAI – Budapest Open Access Initiative
- DFG – Deutsche Forschungsgemeinschaft
- HEI – higher education institution
- IP – intellectual property
- IR – institutional repository
- OA – open access
- R&D – research and development
- SOAP – Study of Open Access Publishing
- TA – toll access