Title: Total Availability of Journal Articles to Internet Users

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Abstract:

Purpose - To determine the outcome of the different measures taken towards open access to peer-reviewed research by measuring aggregate availability of a sample of journal articles. This sample was then used to examine the factors contributing to the availability or non-availability of types of article.

Design/methodology/approach - A sample of articles was taken from the Scopus database based on a search by surname. This minimised any skew that would result from a dataset based on subject or source. The results were analysed to determine availability by subject and differences in availability based on source.

Findings - Less than 30% of articles are available in their year of publication, rising to nearly 40% in following years. Repositories are responsible for slightly less than 50% of available articles. Substantial differences exist between the practices of scholarly societies and commercial publishers.

Practical implications - Aggregate availability is dependent on a range of activities and current efforts need to be maintained to ensure its continuance. Moves towards open access by commercial publishers are not a major factor.

Originality/value - This study differs from similar work by looking at access from the users' viewpoint. Rather than looking at the total amount of material to which access is provided, it looks at the proportion of high-value information which is available.

Keywords: Information democracy, Open access, Institutional repositories, Access to information, Scholarly publishing, Learned society publishing

Introduction

Recent policy developments in the United Kingdom, Australia and the United States towards the mandating of open access to publicly funded research documents have highlighted the increasing normalisation of freely available access to research that had previously been restricted to a privileged minority The transition to Open Access (OA) for peer-reviewed journal article publishing has developed into a complex and interlocking system of fully OA journals, hybrid titles offering an author-funded OA option among their subscriber-access-only articles (the Gold options), journals that provide delayed free access to their articles after periods of embargo, institutional and subject-based digital repositories in which authors are able to archive their own works (the Green option), and a significant fringe of social networks and miscellaneous websites on which scholarly articles can be found. Overlaying and regulating this system is a framework of rules and allowances concerning the availability of copyrighted documents and a set of mandates on the part of employing institutions and research funders requiring the archiving of documents that they have funded, either directly or through author salaries. Conventional subscription-model journal publishing continues to be dominated by a set of major commercial publishers (the number of which has shrunk over time as a result of amalgamations) and scholarly societies, and the concerns of libraries over the affordability of the literature continue even as "big deal" subscriptions take much of the effort out of selecting individual titles. High-value author-funded OA publishing has also tended to be concentrated in the hands of a few major players.

Seen from the point of view of the user of research documents, none of this complexity matters. If the typical user of an OA document is an individual lacking affiliation with a university or other subscription-paying institution, all that this person cares about is getting hold of the document immediately and with as little fuss as possible. From this perspective what is most important is the likelihood that a given document will be available, rather than the totality of documents that are theoretically available (except insofar as this contributes to availability of the desired document). The purpose of this study is to determine this likelihood for a given cross-section of the literature, and only once this has been done work back and to look at questions of provenance with relation to those documents that were available. Were they available to the user because they were fully OA "born free" documents, were the journals they were published in fully or partially OA titles, were the documents available because they had been archived in a formal Repository or had they been placed in a scholarly social network or informal document collection on the web? To what extent, if any, did subject area affect the availability of documents and did availability change over time? By beginning with effect – availability – and working back to this complex set of causes the study is intended to cast light on the comparative efficacy of the various contributors to OA and specifically to identify the comparative importance of archiving documents in repositories.

The following questions are addressed by the study –

1. What was the total proportion of peer-reviewed articles readily available to non-affiliated Internet users for each of the years 2011, 2012 and 2013?

2. What proportions of articles were primarily available directly from their publishers, from formal repositories and from other sources?

3. Was there a difference between primarily commercial publishers and scholarly society publishers in respect to availability of articles?

4. Were there significant differences between subjects in the availability of articles?

The Research

On the whole the growth in open access to research documents is proving to be remarkably successful and earlier concerns about the maintenance of scholarly standards and robust peer-review systems have by and large turned out to be unfounded (Laakso et al., 2011; Solomon, 2013; Suber, 2012). The slow uptake by authors themselves of the opportunity to self-archive their work in institutional repositories, even where evidence exists that to do so may result in increased readership and a consequently greater likelihood that it will be cited by other scholars, has been a cause of some disappointment (Björk, Laakso, & Welling, 2013; Cullen & Chawner, 2011; Morris & Thorn, 2009; Nicholas, Rowlands, Watkinson, Brown, & Jamali, 2012) and mandates appear to have been a more effective means than persuasion of recruiting author participation (Cochrane & Callan, 2007; English & Joseph, 2008). While OA may have exerted some downward pressure on journal prices it has not yet reduced the dependence of libraries on paid subscriptions (Hoskins, 2013; Jubb, Cook, Hulls, Jones, & Ware, 2011; Lewis, 2012). As far as research institutions are concerned the payment of publication fees will have added another expense item to the overall cost of carrying out research, with a very limited trade-off, if any, in subscription costs. In addition to fully OA journals, publishers also make a contribution to the aggregate total of available documents through delayed access and hybrid publishing. While hybrid publishing may have fallen short of earlier expectations (Björk, 2012), delayed OA of subscription journal articles, particularly from the scholarly society sector, is a significant factor in overall availability despite the apparent weakness of financial incentives for this model (Jubb, 2011; Laakso & Björk, 2013; Thorn, Morris, & Fraser, 2009). Overlaying this complex blend of factors are variations between disciplines in terms of both author and publisher behaviour with regard to OA that result in widely varying outcomes for Internet users (Björk et al., 2013).

Various attempts have been made to examine the outcome of all of this activity by estimating "the ratio of open access papers to the overall number of papers" (Björk, Roos, & Lauri, 2009) but this has generally been done by examining inputs from a provider perspective, determining the amount of material made accessible through the various green and gold channels (Björk et al., 2010; Laakso & Björk, 2012; Miguel, Chinchilla-Rodriguez, & De Moya-Anegón, 2011) rather than directly measuring the aggregate proportion of available documents. Two recent studies (Gargouri, Larivière, Gingras, Carr, & Harnad, 2012; Kurata, Morioka, Yokoi, & Matsubayashi, 2013) have looked at total availability of articles but these are both based on pre-selected subject groups and use a data-mining approach that makes replication difficult. If a truly random sample of the literature could be taken this would be a more reliable guide to the total availability of peer-reviewed articles than any attempt to estimate the amount that had been made available through various channels.

To create a sample it was important to select from a substantial body of scholarly literature, and one that would be more or less neutral in terms of the OA issue; to this end the Scopus database was selected as a broad-ranging source of peer-reviewed journal literature with excellent coverage of those articles likely to be of interest to, and sought by, non-affiliated researchers. Although there have been questions around the database's coverage in recent years of low value titles seeking to cash in on gold option authors' fees, (Beall, 2013; White, 2013), the overall effect of these anomalies would be minor, and in the bigger picture Scopus could reasonably serve as a proxy for the total scholarly journal literature. To create a dataset that would be representative of this literature as a whole without being unmanageably large, author surnames were chosen as the sampling element. If it can be assumed that common surnames are distributed widely enough through the international population to rule out a skew in terms of subject, then their use would provide the cross section needed. There is a potential national/historical/cultural issue here, as surnames tend to represent specific genealogical inheritances and the use of an Anglophone surname would impart an English-heritage bias, but this was already inherent in the choice of the Scopus database and was unlikely to distort the results.

After some experimentation the surname *Robinson* was selected as being likely to produce a manageable sample without any obvious further bias in terms of class or ethnicity. Scopus was searched for all journal articles with a first author named Robinson for the years 2011 to 2013 and then, in order to preserve the integrity of the data no further selection or elimination of results was undertaken at that point. As there is no reason to believe that people named Robinson are more likely to be physicists or veterinarians than, say, philosophers or social psychologists, then we can assume that all of those categories would be represented in the sample in roughly the proportion that they were present in the database. Obviously a larger sample would have provided a higher degree of granularity, but as the primary aim of the research was to estimate the overall availability of OA articles this was not considered to be an insurmountable drawback. The definition of an article had been left to Scopus and the documents returned from the searches ranged from short opinion pieces to major pieces of research, all of them potentially of interest to Internet users, and because the study aimed to give a comprehensive account of the availability of articles, individual items were not excluded once they had been located. An exception was made in the case of a set of 29 brief pieces in *PLOS Biology* by Richard Robinson, a "freelance science writer". These were short summaries of other articles in Public Library of Science journals and due to their number in relation to the size of the sample their inclusion would have tended to overstate the prevalence of full-text availability and of the significance of PLOS.

In order to test the hypotheses articles were the classified into three groups according to the following schema -

Publisher Open Access - these were articles in fully OA journals, OA articles in hybrid subscription journals, or articles in issues of journals that had come out of embargo and were now freely available. By including post-embargo articles this category is broader than what is traditionally referred to as "gold open access".

Repositories - articles held in digital repositories, either institutional or disciplinary. The distinction between a repository and a web page was easy to make in most cases, repositories being defined as substantial collections of documents hosted by institutions or major

organisations for the purposes of long-term preservation and access. Articles placed in institutional or disciplinary repository generally adhere to the copyright allowances of publishers as defined by the Sherpa/ROMEO project (University of Nottingham, 2013).

Web pages and social networking sites – any article not clearly falling into the previous two categories was placed in this group. Those sourced through Researchgate and Academia are archived by members of these services and were, at the time of the study, accessible to all Internet users through Google Scholar. It should be noted that only a relatively small proportion of the articles held within Researchgate appear to be captured by Google Scholar searches so that the totality of documents available through that channel could be much greater than indicated, but as registration is required to use the service these potentially accessible documents did not meet the requirement for availability. Individual documents were included in this category when the web context in which they were located fell short of the definition of a repository. These were often commercial, organisational or personal websites, although a few of them appeared to be held in collections of documents on websites of unknown provenance.

Only the "primary instance" of each article being made publicly available was recorded - where an article was available directly from the publisher this version took priority over another iteration of it appearing in a repository or a social networking site or web page. This means that the study may not indicate the extent of repository holdings in their entirety, but it does accurately reflect those instances where the repository was responsible for making the article available, in other words where it *made a critical contribution to access*. No attempt was made to distinguish between fully OA articles and those that become accessible through the expiration of embargoes, and to do so would have required considerable extra work. However, this temporal limitation in no way invalidates the conclusions that can be drawn from the data because its purpose is to describe the extent of the material actually available to the Internet user, not the totality that may become so at a future date; now that data exist about the state of those articles in December 2013 it will be possible to track changes in their availability status over the next two years.

In order to test for differences between the "scholarly-society" and "commercial" sectors with relation to availability a further sub-sampling was undertaken on the basis of publisher names. Attaching publishers to specific journals is not an entirely straightforward matter, but although the source list of Scopus journals (Elsevier Inc, 2013) is not absolutely current it was possible to use it in order to assign a publisher to each title in the study. Most of the inaccuracies relate to the fact that the list has not been updated to reflect changes of ownership, with 742 titles still listing Blackwell as their publisher despite the acquisition of that company by Wiley, and a number of Elsevier titles still listed as Academic Press and Pergamon. Although it was decided that the sample was too small to draw any conclusions on individual publishers, it could still be used to arrive at valid conclusions about the comparative behaviour of commercial and scholarly-society publishers. While the major changes of ownership were known and could be accounted for, transfers of single titles from one commercial publisher to another are relatively uncommon and would not significantly affect any generalisations made about the behaviour of classes of titles. A subset of commercially published titles extracted from the data using the following publishers - Elsevier, Pergamon, Academic Press, Springer, Taylor & Francis, Oxford, Sage, Nature, Lippincott, Wiley, Blackwell and Emerald. A contrasting subset of scholarly society

publishers was then made by identifying those publishers with either of the words *society* or *association* in their names, and a further visual verification was made of the validity of this approach.

Testing for variations by discipline needs to be approached with caution, particularly as subject schemata vary widely and individual journals may cover a variety of topics. For the purposes of this study, Scopus searches on first-author *Robinson* were repeated with each of the four top-level subject limits selected in turn – Life Sciences, Health Sciences, Physical Sciences, and Social Sciences and Humanities. These were then cross-referenced with the results to provide a broad picture of availability by discipline. While this approach may lack the specificity of some other studies (Björk et al., 2013; Gargouri et al., 2012; Kurata et al., 2013) any more specific analysis would not be justified on a sample of this size.

Methodology

A search were carried out in the Scopus database for journal articles with first-author and the outputs captured in spreadsheet format. In order to determine whether the full articles themselves were available to Internet users they were then searched for by title on Google Scholar using scripted searches. A very high proportion of "hits" (i.e. references on Google Scholar, not full documents) was obtained directly but when necessary slight adjustments were made to the titles as recorded in Scopus to find the correct references. When the reference was found the presence of freely available full text was indicated by a link immediately to the right of the title indicating the presence of either a PDF or HTML version of the article. A simple "Yes" or "No" indicated whether a document was available. Google Scholar indicates this with a very high degree of accuracy, and no cases were found where this link was absent but full text was still available under one of the "Other versions", while the small number of false positives all appeared to come from Project Muse which Google Scholar wrongly interpreted as being OA.

In all cases where availability was indicated the link was followed in order to verify that full text was indeed present and to determine whether or not it was the definitive version of record or an author post-print or preprint, although that information has not been used in the present account. The primary source of the document was recorded as being either the publisher, a repository or a social networking site (Researchgate or Academia) or a web page. Considerable detail was also captured regarding these sources which has been aggregated for the purposes of this paper but which could form the basis of further analysis.

Once the data had been fully recorded the list of Scopus journal sources (with publishers) was downloaded and added to the spreadsheet. A lookup formula were then used to assign a publisher to each article against which to determine availability and source of articles for the following publishers - Elsevier, Pergamon, Academic Press, Springer, Taylor & Francis, Oxford, Sage, Nature, Lippincott, Wiley, Blackwell and Emerald – and these data were aggregated. A secondary lookup was done within the publishers' names for the words "society" or "association" and availability and source data for these were aggregated as well. In order to allow categorisation into the four subject divisions, four additional first-author-Robinson Scopus searches were carried out and mapped onto the results in order to identify which categories the articles in the sample belonged to.

The data were collected in November and December 2013 and the study represents a snapshot of the OA availability of the documents at that point in time. Post-capture reinterpretation was not carried out as the status of documents could have changed, with the exception of the 29 articles in *PLOS Biology* which were removed from the sample.

Results

Table 1 Availability of Articles to Internet Users

	2011	2012	2013	Total
Total Available	170	181	120	471
Total Articles	485	489	489	1463
% of articles available	35%	37%	25%	32%

A total sample of 1463 articles was examined and as can be seen in Table 1 they were spread more or less evenly over the three years of the study. This near-parity was coincidental and as the research was carried out in December 2013 the final figure for that year will increase as further articles are published and captured by Scopus. For articles published during those three years slightly less than one in three (32%) would have been available to users of Google Scholar, and fewer articles were available in the year of publication. While the difference in availability percentages for articles published in 2011 and 2012 was not significant, the 2012 percentage is 50% higher than the 2013 figure which is statistically significant.

Table 2 Availability of Articles by Primary Source

	2011	2012	2013	Total
Publisher	76 (16%)	76 (16%)	65 (13%)	217 (15%)
Repository	79 (16%)	72 (15%)	33 (7%)	184 (13%)
Social Networking Sites and Web Pages	15 (3%)	33 (7%)	22 (4%)	70 (5%)
Total Articles	485	489	489	1463

There are broadly speaking three channels through which journal articles can become openly available - either through their publishers, by being archived in repositories, or by being placed on web pages or social networking sites, namely Academia or Researchgate. Many articles are accessible through more than one of these channels but, as noted already, priority was given to publisher access in order to identify within the Repository group only those articles that would not have been accessible had they not been archived in repositories. Likewise, lesser priority was given to articles found on web pages and social networks, which are less likely to be permanent but which nevertheless needed to be included in order to arrive at a comprehensive picture of availability. Overall, 15% of articles in the sample were available directly from their publishers, and this figure declined only slightly for availability in the year of publication. By contrast, 13% of articles in the sample were available from Repositories but the operation of embargoes and the necessity for author initiative in archiving means that only 7% were available in the year of publication, while within two years repositories had become as significant a source of articles as publishers. Web pages and the two social networks accounted for a further 5% of articles from the sample being available.

Table 3 Comparison of Availability of Articles from Commercial and Scholarly Society Publishers

Sample of Commercial Publishers	2011	2012	2013
Total in sample	180	180	207
Total available full text	54 (30%)	63 (35%)	34 (16%)
Direct from Publisher	9 (5%)	17 (9%)	11 (5%)
Repositories	38 (21%)	31 (17%)	10 (5%)
Social Networking Sites and Web Pages	7 (4%)	15 (8%)	13 (6%)
Sample of Society Publishers	2011	2012	2013
Total in sample	87	94	85
Total available full text	43 (49%)	34 (36%)	24 (28%)
Direct from Publisher	27 (31%)	16 (17%)	10 (12%)
Repositories	16 (18%)	13 (14%)	9 (11%)
Social Networking Sites and Web Pages	0 (0%)	5 (5%)	5 (6%)

Compared to articles appearing in the sample of subscription journals from commercial publishers, those from the scholarly society journals sample were twice as likely to be directly available from the publishers in the year of publication, and this difference increased over time, possibly due to the expiry of embargo periods. On top of this the higher proportion of these articles archived in repositories means that 75% more of them were openly available to Internet users in the year of publication, and after the passage of two further years nearly half of the articles from scholarly society publications were available compared to less than a third of those commercially published. The part played by repositories in ensuring availability is particular evident in the figures for commercial publishers – for 2011 and 2012 a total of 26 articles were directly available from their publishers, whereas 69 were held in repositories.

Table 4 Availability of Articles by Broad Subject Divisions

	2011		2012		2013	
	Category Total	Available	Category Total	Available	Category Total	Available
Life Sciences	135	74 (55%)	133	73 (55%)	146	46 (32%)
Health Sciences	195	74 (38%)	188	67 (36%)	194	48 (25%)
Physical Sciences	115	34 (30%)	147	57 (39%)	141	44 (31%)
Social Sciences and Humanities	135	32 (24%)	143	38 (27%)	156	30 (19%)

Overlaying the four overlapping Scopus subject divisions onto the data reveals a striking difference in availability between life sciences articles at the one extreme and social sciences/humanities articles at the other, with more than twice as many 2011articles from the first category being available. Articles from the life sciences and health sciences also show a marked tendency to increase in availability after the first year whereas this trend is less discernible in the figures from the other two categories.

Discussion

What this study reveals is that for the casual Internet user or non-affiliated researcher around 35% of the peer-reviewed literature is freely available, with this figure falling to less than 30% for recently published work. The major variations are by discipline and by publisher-type and these two factors are to an extent interrelated - publishing in the life sciences is more likely to be undertaken by scholarly societies with a tradition of making articles freely available after an embargo period, whereas this is almost never the case for commercial publishers. Repositories also play a major role in ensuring availability and without their ongoing participation the pool of documents available on a long-term basis would be only half its current size. The overall figure of 13% for green OA is very close to the 12% recently reported by Björk, Laakso and Welling (2013) working on the same definition, in their words "copies of articles not already available in gold, delayed or hybrid journals".

While it is hard to draw any firm conclusions about future trends from a snapshot of this kind, the results of this study suggest that repositories continue to play an important role in making the peer-reviewed journal literature available to non-affiliated Internet users. The role played by scholarly societies is another important factor and their continued financial health will be critically important if present rates of access are to be maintained. Researchgate is the major new player and now that a dataset exists showing the situation as at December 2013 it may be possible to track changes to its coverage at regular future intervals. Channels of this sort, however, which by-pass the contractual and copyright aspects of scholarly publishing, and which do not have an obvious financial model, are inherently at risk of legal action or sale to the highest bidder (Dobbs, 2013; Solon, 2013), so while it may be tempting to see them as a "solution" to the access question the risk that disruptive technologies may themselves be disrupted is relatively high. At best the current state of OA represents the fruits of the uneasy alliance of publishers, research funders, research institutions and libraries while scholars themselves are still largely insulated from the effects of their publishing decisions. While the voluntary uptake of the self-archiving opportunities offered by institutional repositories may be disappointing, the effort is well justified in terms of both public service and information democracy.

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