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Measuring the Impact of Gold and Green Open Access

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ABSTRACT

Using data from Web of Science, this research investigates how physical science researchers funded by the Canadian Institutes of Health Research complied with its open access policy, and compares the citation counts of articles published through gold and green models.

It was found that, for articles published between 2008 and 2015, 9% were available through gold open access routes and 13% were available through green routes; most were not openly accessible. Citation rates were comparable for green open access and non-open access articles, but citation rates for gold open access articles were lower. After controlling for publication year, citation rates of gold, green, and non-open access articles were comparable. Among gold open access articles, citation rates were highest for open access journals with article processing charges, but after controlling for publication year, articles published in hybrid journals, followed by those in open access journals with article processing charges, achieved the highest citation rates. Articles published in free open access journals had the lowest citation rates. The results suggest that green open access is the most economical approach to comply with open access policies, and that it provides researchers with at least as much research impact as gold open access.

Introduction

Over the past decade, funding agencies around the world have adopted open access policies. At the time of writing this article, 71 funding agencies¹ require that journal articles resulting from agency-funded research be made openly accessible within a set amount of time (ROARMAP: Registry of Open Access Mandates and Policies, 2017). Among these agencies, health sciences funding agencies were early implementers of such policies; both the U.S. National Institutes of Health (NIH) and the Canadian Institutes of Health Research (CIHR) instituted open access policies in 2008, and were among only 23 funding agencies that had done so at that time.

There are, however, two ways to achieve open access: gold open access and green open access. “Gold open access” is achieved through publishing in one of three groups of journals. One group charges its authors no article processing fees, generally because the costs of publishing are borne by a sponsoring society or association. Thus, authors can publish in these journals for free. We call them “free open access journals” in this study. A second group of journals collects article processing charges (APC) from authors to publish their articles. We call this group “open access journals with APC.” The third group is composed of

traditional subscription-based journals that offer authors the opportunity to make their individual article openly accessible upon payment of article processing charges. We call this group “hybrid journals.” All gold open access articles are freely available to readers immediately upon publication.

Under the “green open access” model, authors publish their articles in traditional subscription-only journals. Then, after a publisher-specified embargo period has elapsed, they “self-archive” their works by depositing them in institutional or subject-specific repositories. Green open access is permitted by most publishers; at the time of writing this article, SHERPA RoMEO, which provides information on publisher copyright and archiving policies, states that 74% of the publishers listed on their site allow self-archiving of “post prints” (articles that have completed the peer review process) (SHERPA/RoMEO, 2016).

The possible “citation advantage” of open access publishing, that is, the possibility that articles made freely available to readers are cited more often than those behind a paywall, has been studied for more than a decade (Harnad & Brody, 2004). Many studies have been done, and results have varied. However, in 2015, the various studies on this topic were summarized, and it was found that of the 70 studies conducted till that point, 46 showed a citation advantage, while 17 found no

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E-mail addresses: li.zhang@usask.ca (L. Zhang), e.watson@usask.ca (E.M. Watson).¹ The 71 funding agencies include both funders and research organizations that are also funders (e.g. NIH, CIHR).<http://dx.doi.org/10.1016/j.acalib.2017.06.004>Received 10 February 2017; Received in revised form 9 June 2017; Accepted 13 June 2017
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advantage, and 7 were “inconclusive, found non-significant data, or measured other things than citation advantage for articles” (SPARC Europe). Interestingly, even though nearly a quarter of studies (17/70) found no citation advantage for open access articles, the conclusion reached by SPARC Europe was that it was no longer necessary to update the site, since “the citation advantage evidence” had “become far more common knowledge.”

Of the many studies on citation advantage of open access, one stream has focused on that of green open access, and again the results have been mixed. For example, two early studies showed that making a subscription-only article available in a repository increased the citation rate by 36–200%, and that the amount of increase varied by discipline, with physics articles being the greatest beneficiaries of green open access (Hajjem, Harnad, & Gingras, 2005; Harnad & Brody, 2004).

However, some have argued that much of the citation advantage experienced by green open access articles might be the result of other factors. Kurtz et al. (2005) concluded from their study of astronomy journals that the openly accessible articles were cited more often, but that this was the result of two factors. First, the openly accessible articles were all available through ArXiv, a site that allows authors to post preprints, articles that have not yet undergone peer review. Other researchers therefore had greater opportunity (a longer time period) to cite them than they did to cite articles that became available only at the time of publication in a journal. This first factor is called the “early access” or “early view” effect. Second, Kurtz et al. (2005) concluded that authors chose to make only their best work openly accessible, and that because this was higher quality work, it was cited more often – this is called the “self-selection effect” or “quality bias.” Like Kurtz et al. (2005), Moed (2007) found that openly accessible journal articles were cited more often; he also attributed this to the selection bias and the early access effect. Davis and Fromerth (2007), however, found that selection bias alone, and not early access, explained the higher citation rates of the openly accessible articles in their study. On the other hand, when Gargouri et al. (2010) compared the articles deposited in a repository (either through author choice or because of a funder or institutional mandate) with non-open access articles, they found that the citation advantage of open access was “real, independent and causal”. However, the citation advantage was not due to authors choosing to make only their best work open access (quality bias), but due instead to what Gargouri et al. (2010) call a “quality advantage.” They claim that open access does not improve citation rates of all articles, but that it does increase citation rates of high-quality articles, because they are more easily accessible and thus more easily citable.

Another stream of research on the citation advantage of open access articles has concentrated on gold open access. Using data from the Directory of Open Access Journals, Journal Citation Reports, and Scopus, Björk and Solomon (2012) compared the citation rates of open access and subscription journals from a wide variety of disciplines, including sciences, medicine, social sciences, and humanities. They found that the average citation rate of subscription journals was about 30% higher than that of open access journals. However, when they controlled for discipline, journal age, and publisher location, the difference in citation rates of the two types of journals almost disappeared. They also found that free open access journals had much lower citation rates than did open access journals with APC or subscription journals. Björk and Solomon (2012) concluded that open access journals with APC achieved equal citation impact to subscription journals launched in the same period. In another study, McCabe and Snyder used citation data from 100 journals in ecology and related fields (McCabe & Snyder, 2014). They found that journals that moved from a subscription-based model to an open access one experienced an 8% increase in citation rate. However, it was for the most part the top-ranked journals that experienced the increase, while the lowest-ranked journals experienced a significant reduction in citation rate. The authors speculate that open access not only enhances readers' ability to find the full-text of articles but also gives them more choices of what to read, i.e., readers might not

actually read articles from the lower-ranked journals. Open access, then, might actually intensify the competition for readership, creating both winners and losers.

Over the last few years, more and more traditional subscription-based journals have started to offer authors the option to make their article openly available upon payment of APC. A few studies have therefore focused specifically on the citation advantage of hybrid journals. Studying the open access and non-open access articles in journals published by Springer and Elsevier, Sotudeh and colleagues found that open access articles had a citation advantage ranging from 21% to 49%, depending on the year of publication (Sotudeh, Ghasempour, & Yaghtin, 2015). They also found that the citation advantage varied by discipline, with the advantage for natural sciences journals being the highest (35%) and for social sciences and humanities journals the lowest (3%). It was noted that, in their study, they did not differentiate between open access journals with APC and hybrid journals, though the former accounted for fewer than 10% of the total open access articles. Because Springer and Elsevier are both prestigious publishers, it is unclear whether the publishers' reputations increased the citation advantage of the open access papers. Therefore, the results might not be generalizable to less-known publishers. Mueller-Langer and Watt (2014) examined the open access articles and non-open access articles published in the same hybrid journals in economics. The data used in their study were from a Hybrid Open Access Pilot Agreement, under which articles of authors from the participating institutions were automatically published as open access in the piloting hybrid journals, thus reducing the self-selection/quality bias. They found that hybrid open access increased the citation rate by 22% to 26%. However, after institution quality (based on the ranking of the authors' institution in the Academic Ranking of World Universities) and early view (because some of these articles were made available as preprints through the RePEc preprint server) effects were taken into account, the hybrid open access citation advantage was reduced to an insignificant 0.4%. They concluded that paying to make an article hybrid open access did not represent a worthwhile investment if researchers' motivation for publishing in a hybrid open access journal was to receive more citations.

While many studies have looked at whether open access publishing (either gold or green) leads to greater numbers of citations, relatively few have directly compared the citation counts of gold and green open access. Studying the types of open access papers at the European and world level from 1996 to 2013, Archambault and colleagues found that green open access articles had the greatest citation advantage, being cited 53% more than the average of all papers in the study (Archambault et al., 2014). In contrast, gold open access articles (which in their study included articles published in free open access journals and open access journals with APC, but not hybrid journals) had a citation disadvantage of 35% compared to that of all papers. Gold open access journals had a citation rate even lower than that of non-open access articles. They concluded that green open access articles have a huge citation advantage over other types of open access models, and advocated that green open access be the preferred route for open access. Miguel, Chinchilla-Rodriguez, and de Moya-Anegón (2011) explored the average number of citations per document for articles published in open access journals, subscription journals allowing self-archiving, and subscription journals not allowing self-archiving. Their findings were similar to Archambault's: the subscription journals allowing self-archiving achieved the highest citation rates per document, followed by subscription journals not allowing self-archiving. Open access journals had the lowest citation rate. Once again, hybrid journals were not considered separately.

Research objectives

In the current academic climate, obtaining research funding has become increasingly competitive, and so it is important for researchers to both use their funds to their best advantage and maximize the

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