“Gold” Open Access Has Harmed Science and Should Be Abandoned

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The discovery that many published results in the social, behavioral, and medical sciences cannot be reproduced marked the start of the “replication crisis”. Recognizing that the scientific process was flawed, researchers proposed multiple reforms. Pre-registration and measures to increase the publication of null results specifically aimed to increase replicability. Open Access (henceforth “OA”) reforms aimed to increase the accessibility of scientific findings by making publications freely available. This was intended to benefit researchers from underfunded institutions and the public, whose taxes fund most research.

OA policies have been extremely popular and more than 20,000 OA journals now exist whose content is freely available to all. Despite these good intentions, pay-as-you-publish OA policies have also had a number of unintended negative consequences that undermine and potentially exceed their benefits. As such, it is time to abandon author-paid OA publishing and seek less harmful alternatives.

The economics of publishing

Although the internet and the advent of purely online journals have dramatically reduced the cost of publishing, it is nevertheless expensive to run a journal. Journals need money to pay for typesetters, proofreaders, and editors. They pay to host digital publications online and some print physical editions as well. How journals secure funding creates an incentive structure that affects their publication strategies.

Prior to OA, most journals were funded through reader subscriptions, often paid by institutions. The subscription model incentivizes journals to publish content that readers are willing to pay to read, which, in theory, is high quality work. The replication crisis also highlighted that readers are especially interested in shocking or surprising results, which are disproportionately likely to be incorrect; as such, the subscription model likely produces an excessively high false positive rate.

The most typical OA format is “gold” OA in which journals are funded through “article processing costs” (APCs) paid by researchers (or their institutions) upon publication of their work. Other forms exist. For instance, “diamond” OA journals are free to both authors and readers, being reliant on external donations and volunteers. Although numerous, diamond OA

journals are typically quite small in terms of both their readership and output. Hybrid journals are those that still rely on subscription fees and so do not charge authors to publish, but allow them to pay APCs in order to make their articles available to readers without a subscription. A final alternative to journals making their content freely available is author self-archiving, so-called “green” OA. In this case, authors simply post a copy of their article (often without the journal’s official formatting) on their website or an online repository or preprint server. As gold is the most common OA policy, it is the focus of our critique.

The hidden costs of gold Open Access

Making content freely available clearly has benefits. However, by altering how journals make money, gold OA shapes their publication strategies. In particular it creates an incentive for journals to publish low-interest papers that don’t attract readers, as they generate income regardless. Moreover, it encourages the publication of as many papers as possible, as income is generated on a per-paper basis. Examination of the 50 most productive journals (31 of which are gold OA, the other 19 hybrid OA) supports this[1]. Gold OA journals produce more papers than hybrid journals (an average of 18,613 over 3 years, versus 11,707, $p=0.033$), but these papers receive fewer citations (average of 4.9 over two years, versus 8.6, $p<0.001$). Moreover, despite their greater productivity, gold OA journals have lower *h*-indices than hybrid journals (average of 207 versus 367, $p=0.007$).

The publication of low-interest work has the potential to harm the reputation of prominent journals and so many publishers have instead launched new lower-prestige gold OA journals to collect APCs from less newsworthy publications. These emphasize technical soundness over perceived importance, but may deliver neither.

Over time, gold OA journals have begun to compete to attract authors with increasingly quick and easy routes to publication. A steady flow of invitations to guest edit OA special issues, including expeditious publication of one’s own work, is now a feature of many scientists' inboxes. This bidding for authors has enabled researchers to pursue a quantity-over-quality research strategy, especially when research communities perceive publishing open access itself to be a signal of quality. As some researchers have dropped the quality of their work, new OA journals with lower standards have appeared to provide an outlet. Thus, OA engenders a coevolutionary process between researchers and publishers in which both parties sacrifice quality for quantity. This process has been sufficiently rapid that when journals are ranked by papers published per year, 18 of the top 30, and *all* of the top five are gold OA.

The more extreme negative effects this has had on science can already be seen in recent cases of mass retractions, the rise of predatory journals and paper mills, and the publication of AI-generated papers (and even AI-generated peer review!). These clearly harm the ability of science to advance our understanding, but they also harm the public perception of science. Less dramatically, but perhaps more importantly, the proliferation of low-quality work muddies literatures, generating confusion that slows scientific progress. In addition, the increasing volume of publications puts further strain on an already creaking peer review process. Finally, the guarantee of publishing low-interest work means researchers may be discouraged from pursuing high-risk high-reward projects that could lead to significant advances.

Can diamond, green or hybrid Open Access help?

Hybrid OA journals make use of APCs and so are subject to some of the same corrosive incentives as gold OA journals. As such, it is critical that the extent to which their funding depends on APCs is clearly stated and, ideally, limited. For instance, it could be required that APCs generate less than 50% of the amount generated through subscriptions. Even then, it is important to note that hybrid policies do not meet the inclusivity goals of the OA movement because many of their papers are not free to read. Moreover, within hybrid journals, publishing OA produces a citation boost[2] and so reduces the relative prominence of work by underfunded researchers. Across journals, APCs correlate with impact factor (*Nature*, for instance, charges over $12,000 to publish OA) meaning that this penalty is most pronounced in the most prestigious venues.

Diamond and green OA publishing do not involve APCs and so are not affected by the incentives that APCs create. Instead, they face logistical concerns. Diamond OA journals are financially insecure and typically cannot scale up to the size of widely read journals – in order to do so many to switch to gold OA policies. Green OA policies are similarly reliant on outside funding for preprint servers, while individual hosting is unreliable and not standardized. A possible solution for these issues is for funding bodies to switch from supporting gold OA, by mandating OA publication and providing funds for APCs, to mandating green or diamond OA and funding green and/or diamond initiatives directly.

A potential risk of green OA is that institutions could simply stop paying for subscriptions and rely entirely on preprints, at which point the green OA system would collapse. Nonetheless, the potential long-term success of green OA can be seen in repositories such as the arXiv which has been consistently maintained since 1991. Moreover, in the fields in which posting preprints has been normative for many years—including physics, computer science, and economics—journals still play an important role for vetting and curation while preprints guarantee access.

Future directions

Science is a complex process. Its success requires policies that incentivize researchers and journals to behave in ways that maximize its societal benefit. The number of professional scientists is higher today than at any time in history. As such, the quantity of work being produced is not a limiting factor. Instead, we should seek out policies that improve its quality.

It is clear that gold OA policies have failed in this regard. In hindsight, reliance on reader subscriptions incentivizes journals to robustly check the quality of the work they publish, and, in turn, incentivizes scientists to conduct high-quality work in the first place. As such, subscriptions should be seen as valuable safeguards to the scientific process. Where they hinder access, we should look into measures that subsidize subscription costs for underfunded researchers without replacing them with author fees or enabling publishers to exploit readers, authors, or institutions with exorbitant fees. Green OA, in particular, may be a viable alternative to gold OA.

A recent development is the replacement of APCs with institutional agreements to waive APCs for their employees. Where they break the *pay-as-you-publish* model, these

agreements may be an improvement on gold OA. However, attention needs to be given to the new incentives they create as publishers may simply switch from bidding for authors to bidding for institutions. Moreover, to incentivize quality research, institutions should avoid reaching such agreements with low quality journals. However, institutions span many fields and so are often poorly positioned to distinguish quality from quantity, while publishers are likely to bundle many journals together into packages preventing such selectivity. Finally, such policies do not benefit researchers from underfunded institutions.

A longer-term measure we suggest is a re-consideration of the relationship between researchers and journals. The proliferation of society-less OA journals means that too often researchers publish in, review for, and serve as editors for journals they are not invested in. This engenders a low-effort approach. We should seek out alternative systems where incentives align to favor quality instead. A renewed emphasis on society journals may help. With fewer alternative journals bidding for work, editors and reviewers may be more able to demand major improvements or extensions to submitted work, though this would have to be balanced by the need for diverse outlets. Journals could even require a history of thorough reviews as a prerequisite for submitting one's own work, thereby incentivizing high-quality reviews. In the long-term, research communities should aim to go beyond mere enumeration of journal articles as a productivity metric and instead develop holistic assessments that account for the diverse ways in which individuals can contribute to research and scholarship.

We suggest that gold open access should be abandoned. While we have proposed alternative paths, we encourage readers to be skeptical: Green OA may not be stable in the long term; seemingly useful quality metrics may simply distort publishing in other ways; society journals may be vulnerable to corruption and abuse. Rather than adopting new policies and hoping for the best, proposals should be examined through formal modeling of the scientific process. Existing work shows that this can be done, with models generating concrete predictions that could be tested through experimentation. This sort of vetting is critical to avoid policy blunders; there is too much at stake to proceed blindly.

[1] https://www.scimagojr.com/journalrank.php?type=j&order=titem&ord=desc

[2]Tang, M., J. D. Bever, and F.-H. Yu. 2017. Open access increases citations of papers in ecology. Ecosphere 8(7):e01887. 10.1002/ecs2.1887