



POLICY FORUM

SCIENCE COMMUNICATION

Open access is shaping scientific communication

Funders and publishers should roll out policies in ways to support their evaluation

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Recognizing the importance of ensuring access to taxpayer-funded scientific knowledge and underlying data, many national governments and supranational institutions have been supporting the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities as far back as 2003. More recently, they have been implementing mandates to establish open access (OA) to scientific publications and underlying data. In this work, we examine the effects of related OA mandates and agreements on scientific communication for both the broader scientific community as well as the science communication and science policy communities. We outline key contemporary unknowns and avenues for continued research. We also explore the effects of OA “big deals” (where one or more universities and a single publisher negotiate the fees for publishing in any of the latter’s journals) and the bundling of publishing and data contracts on prices and market structure.

An important policy example in the global context is the international consortium cOAlition S, which was launched in 2018 and supported by the European Commission and European Research Council to implement OA for scientific publications that result from research funded by public and private grants. More recently, in 2022, the White House Office of Science and Technology Policy (OSTP) directed all US federal agencies to make taxpayer-supported publications and underlying research data immediately accessible to the public, without embargo or cost, no later than 31 December 2025.

SCIENTIFIC COMMUNITY

For career reasons, researchers are focused on the quality of the journals in which they publish (measured by impact factor) and the citation impact of their publications.

Up until the 2000s, the economic or business side of providing access to the scientific literature was delegated to researchers’ employers and, specifically, institutional libraries. Scientists were generally unaware of the subscription prices for the journals they read and published in. University libraries, however, were keenly aware of journal price inflation (the term “serials crisis” dates back to at least the 1980s). Yet they did not fully understand its causes.

The 2016 Pay It Forward Project surveyed graduate students, postdocs, and faculty from all disciplines at several major US research universities about their attitudes regarding “gold” OA, where journals make all scientific articles freely available to readers while authors (or their universities) are paying to publish, for instance, under the common article-processing charge (APC)-based funding model (1). By then, OA had been growing in importance for more than a decade, owing to OA mandates [e.g., research funded by the National Institutes of Health (NIH) or Horizon 2020], the emergence of new OA publishers (e.g., PLOS), and the introduction of hybrid OA by traditional publishers, that is, subscription journals in which some of the articles are published as OA against payment of an APC.

The survey revealed some concerns that the average quality of research might decline given that the APC structure might tempt publishers to increase revenues by accepting articles of lower quality. Although the literature has mainly focused on the effect of OA on low-quality journals and the emergence of so-called predatory journals, empirical literature that examines the impact of APC-based revenue on the quality of research in high-caliber journals is relatively underdeveloped (2). Nevertheless, dividing author fees into submission and acceptance fees is a solution to solve this problem (if it exists).

The survey reflected some confidence that OA would generate a positive citation impact. There is extensive literature exam-

ining the impact of OA on citations, with widely varying results (3). Only a small subset of these papers reflect appropriate experimental conditions and robust empirical analysis. In those instances, there is, at most, a small positive citation impact associated with OA (<10%) (4), and no OA citation impact for journal articles if OA preprints are available (5). This is far less than early studies that reported effects as large as ~300% (3) but failed to control for article quality. By contrast, the impact of OA on downloads and the number of unique visitors is considerable (6). The real beneficiaries of OA may not be the scientific author community, who traditionally have excellent access to the research literature (and face powerful incentives to comprehensively cite that literature), but rather communities that consume, but rarely contribute to, the corpus of literature (e.g., students, educators, physicians, patients).

According to the survey, authors’ willingness to pay an APC varied by source of funding, that is, it is highest for library OA funds and less for all other preexisting sources of research funding. The introduction of so-called transformative agreements (TAs) over the past decade, in which (consortia of) universities negotiate with individual publishers to replace subscriptions with OA to the scientific literature, provides an opportunity to slow, if not completely halt, the cost spiral experienced by institutions.

However, TAs differ in their (incentive) structure. We analyzed data for 1006 TAs between 65 publishers and 184 universities or consortia in more than 50 countries from 2014 to 2024 that we obtained from the Efficiency and Standards for Article Charges (ESAC) TA Registry (see the figure and supplementary materials). The most common TA is a publisher OA big-deal contract in which universities pay a fixed charge for each accepted article (reflecting a discount to the typical APC) and affiliated authors usually face almost no incentives to cost minimize (e.g., Germany’s

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Projekt DEAL with Springer Nature, Elsevier, and Wiley). By contrast, the so-called multipayer model provides a cost-minimizing incentive mechanism to combine funding from libraries with research funds of authors [e.g., University of California (UC) with Springer Nature, Elsevier, and Wiley].

COMMUNICATION AND POLICY COMMUNITIES

By 2019, the fraction of journal articles published without any paywall restrictions had grown to around 50% (7). The most notable factors contributing to this shift are (i) rapid increases in (for-profit) publisher journal subscription prices before and after the introduction of the internet, (ii) low distribution costs associated with digital content, and (iii) OA mandates of research funders, for example, NIH, Wellcome Trust, German Research Foundation (DFG), or UK Research Councils. Although most of these funders will typically fund the cost of APCs in fully OA journals but not in hybrid OA journals, Wellcome also funds APCs in cOAlition S-approved transformative journals. By contrast, research funders typically do not allow grantees to use grants to pay for journal subscriptions because their content is more general in nature and cannot be directly linked to funded research projects.

Although mergers contributed to price increases, the primary factor was almost certainly the behavior of readers who demand free access to the scientific literature. In response, (research) libraries strove to provide access to all journals that were read by their respective user communities. This “multihoming behavior” (where most users access multiple journals) dampened competition between journals, and therefore publishers. Demand is very inelastic (because articles are not easily substituted), so subscription pricing was immune to competition.

The resulting market conditions generated enormous incentives for buyers of peer-reviewed content (mainly libraries) to seek alternative platform model(s) for delivery of this content, that is, OA in its myriad forms (8). However, in its most comprehensive form—the TAs—the resulting menu of APCs and library subsidies faced by authors can induce price competition between journal platforms seeking author submissions. This is due to the transition from multihoming on the reader side, where demand is inelastic, to single-homing on the author side, where competition between journals for an author’s submission is manifest. Be-

cause authors may only submit an article to one journal at a time, each submission involves a choice among multiple journals. In the reader-pays environment, submission fees are typically zero (or nearly zero). So, the decision criteria are noneconomic in nature, for example, journal quality, and so on. In an OA big-deal context, the decision criteria are unchanged: The author does not face an APC. But in a multipayer TA context, authors must consider APC levels when selecting among their preferred journals. Those with lower APCs will attract more submissions. APC competition should increase if the average journal choice set faced by authors reflects more rather than fewer different publishers.

Creating a mechanism to exploit the

idly with widespread adoption of OA big deals. The OSTP acknowledges the need for tracking expenditures on APC fees and TAs (9); the same is true for subscription expenditures (9). The OSTP’s 2023 report includes several economic appendices, including one that considers platform economics (9). However, the report never applies these concepts to explain that TAs can be used to facilitate competition through single-homing or that OA may be welfare-reducing in certain cases (10). The intuition is that the aggregate willingness of readers to pay for access may exceed the willingness of authors to pay to publish.

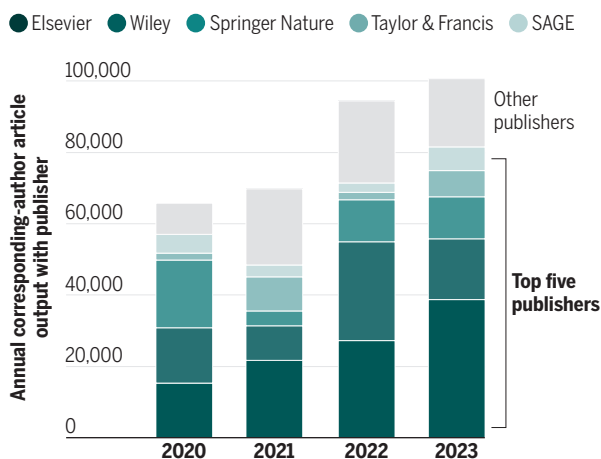
Consider the case of a high-impact journal such as the *New England Journal of Medicine (NEJM)*. It is published weekly; it has a 2022 journal impact factor of 158.5, making it a top-ranking medical journal; and its global readership is more than 1 million medical professionals (11). The annual individual online subscription price is \$179. Although there is no hybrid OA option, *NEJM* provides free access to its weekly research articles (4 or 5 per week) after 6 months dating back to 1990. *NEJM* also now allows authors to post accepted manuscripts submitted after 1 February 2024 in noncommercial repositories [satisfying the OSTP mandate (12)]. This is known as green open access. Research articles are supplemented by a vast set of complementary policy and practice commentaries, multimedia content, and so on, many of which are authored by *NEJM* journalists. Clearly, the costs for such a platform far exceed those of a standard scientific journal (that published a similar number of research articles).

What are the implications for adoption of an APC-based OA business model by *NEJM*? Suppose that there were 1 million individual subscriptions and thus an annual revenue of \$179 million. To replicate this with APCs, authors would be charged \$688,000 for each of the 260 annual research articles. If we allow for the possibility that the average access price per reader is lower owing to institutional subscriptions, for example, \$50, the corresponding APC is then \$192,000, which still far exceeds the highest APCs now observed (~\$10,000). APCs of this magnitude would almost certainly reduce the number and quality of article submissions, likely lowering overall welfare. Not surprisingly, *NEJM* will continue to operate on a subscription basis.

It seems likely that OA and traditional reader-pay journals will coexist in the im-

Growth in size of TAs

Shown are data on the size of 808 transformative agreements (TAs) as approximated by the range of annual corresponding-author publications from universities with a given publisher. Articles are eligible to publish under a TA only when the corresponding author is supported under the TA (see supplementary materials).



competition between journal publishers for single-homing authors’ submissions has the potential to slow down the trend of ever-increasing university-specific costs associated with scientific publishing [see (1) for a discussion of publisher APC competition]. However, our review of many of the extant TAs in North America and Europe that we obtained from the ESAC TA Registry reveals that, except for the UC TAs, none incorporate incentives for authors to minimize costs. Of course, publishers know this, and are likely to behave accordingly, that is, less competitively.

Most institutions couldn’t credibly say no to the original big deal, which contributed to the serials crisis. This begs the question of whether the cost of scientific publishing will continue to increase rap-

mediate future, and probably should in the long run. In this context, the OSTP OA mandate will neither undermine the gatekeeping role of scientific journals nor much perturb the future evolution of scientific communication. The widespread adoption of TAs was already underway; if anything, the mandate reinforces that path. In an environment where both readers pay and OA journals operate alongside preprint platforms, it is natural to ask whether preprints might constrain subscription prices and APCs. If preprints and their peer-reviewed counterparts were close substitutes, then APCs for most OA journals would decline considerably. Subscription prices for pure research journals would approach zero. In the case of *NEJM*-type journals, subscription prices would decline but remain positive. Instead, we observe large positive values, implying that peer-reviewed papers are higher quality than their corresponding preprints. The OSTP OA mandate injects free peer-reviewed papers into this mix. But because the global share of published papers with US federal funding is less than 10%, readers' willingness to pay for access to traditional journals should be largely unaffected (13).

BUNDLING OF PUBLISHING AND DATA

Over the past decade, large scientific publishers, such as Elsevier and Holtzbrinck (owner of Springer Nature), began developing data analytics capabilities to complement their journal publication businesses. Given the potential value of data harvested from their journal portfolios, citation databases, and so on, both firms created and/or acquired research networking tools that automatically harvest data on grants, publications, and researchers. This information can inform research strategies and accelerate research discovery at the author, group, and department levels, as well as beyond. This information can also help identify emerging areas of research, allowing the firms to target those segments with new, dedicated journals ahead of other publishers.

There are concerns that the bundling of publishing and data analytics contracts might foreclose stand-alone analytics firms, leading to greater market concentration [e.g., consider the 2020 data and TA contract between Elsevier and Dutch universities (14)]. For example, in negotiating new TAs, Elsevier might offer greater APC discounts in exchange for an exclusive data analytics contract. In turn, these lower APCs might harm revenue growth for pure journal publishers. Greater adoption of multipayer TAs would place further downward pressure on APC levels. In this environment, and absent antitrust inter-

vention, integrated firms such as Elsevier and Holtzbrinck would likely find it profitable to acquire the largest stand-alone pure publishers. As the number of independent publishers declines, so does potential competition between the journals seeking APCs from single-homing authors.

Although theoretically possible, anecdotal evidence regarding (i) the rapid evolution of the research networking tool space and (ii) the proliferation of non-cost-minimizing TAs suggests that these concerns are unwarranted for now. Regarding (i), the emergence of open research databases, for example, OurResearch's OpenAlex, encourages institutions to perform many data analytics tasks themselves. For example, in December 2023, Sorbonne University announced that it will discontinue its subscription to the Web of Science database and Clarivate bibliometric tools in 2024 (15). The Sorbonne will be partnering with OpenAlex.

Regarding (ii), aside from the UC System's adoption of multipayer incentive-based TAs, it appears that all other negotiated TAs (for which data are reported) shield authors from the costs associated with their article submissions (OA big deals). Indeed, when negotiating OA big deals, libraries know that each researcher expects to have the freedom to select a journal to which they will submit an article, ideally from the set of all relevant journals. Knowing this, no (pure) journal publisher has an incentive to undercut the APCs previously negotiated (but not faced by a submitting author) in that library's other TAs. If anything, the negotiated APCs should increase over time, replicating what occurred with traditional subscription big-deal contracts. This begs the question of whether researchers' institutions or libraries, acting alone, can efficiently negotiate competitive APC levels for thousands of journal titles over time and across multiple publishers.

POLICY EXPERIMENTS

Research funders and publishers that are about to roll out policies in response to the 2022 OSTP memorandum (12) could take the opportunity to do so by supporting experimental research designs and evidence collection. To illustrate, prior research exploited hybrid OA pilot agreements between Springer Nature and several universities and research institutes as the basis for a quasi-experimental research design (5). Under these hybrid OA agreements, OA status was exogenously assigned to all articles of authors affiliated with hybrid OA pilot institutions. This mitigated concerns related to author-driven selection bias when considering hybrid OA and closed-access articles.

Recent TA pilot agreements offer opportunities to conduct (quasi-)experiments studying, for instance, the incentive effects of the multipayer model. UC's pilot TA with Wiley charges APCs under the multipayer model only for articles by authors affiliated with the five participating campuses. By contrast, the five nonparticipating UC campuses are not eligible for participation in the multipayer model. Both groups, however, enjoy 15% APC discounts. Experimental research design and evidence collection supported by research funders and publishers are important elements for rigorous evidence-based policy advice on OA and the future of scientific communication. ■

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SUPPLEMENTARY MATERIALS

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