A Study on Open Access Practices of Academic Publishers in the Context of Open Science

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Abstract

[Objective] To analyze the open access practices of academic publishers in the context of the evolving open science movement and to explore the development trends of open access for scholarly publications. [Methods] Using two methods—web-based survey and literature review—to outline the evolution of open access for scholarly publications and the practical initiatives undertaken by academic publishers to promote open access development within the open science context. [Results] Academic publishers primarily promote open access to scholarly publications through five dimensions: transformative agreements, academic journal subscriptions, open research monographs, scientific data sharing, and open peer review. [Conclusion] Through practices such as accelerating the publication cycle of scholarly outputs, shifting toward author-attracting operational strategies, and constructing integrated platforms, publishers actively respond to open science initiatives, thereby advancing progress and innovation in scientific research.

Full Text

A Study of Open Access Practices of Academic Publishers in the Context of Open Science

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Abstract

[Objective] To analyze the open access practices of academic publishers against the backdrop of the open science movement and to explore the development

trends of open access in scholarly publications. [**Methods**] We employed web surveys and literature research to examine the evolution of open access for scholarly publications and the practical activities undertaken by academic publishers to promote open access within the open science context. [**Results**] Academic publishers primarily advance open access through five key avenues: transformative agreements, scholarly journal subscriptions, open access to research monographs, scientific data sharing, and open peer review. [**Conclusion**] Publishers actively respond to open science initiatives by accelerating publication cycles, shifting toward author-centric operational strategies, and building integrated platforms, thereby fostering scientific progress and innovation.

Keywords: open science; open access; open publishing; publishers

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Open science posits that interdisciplinary exchange and dialogue drive innovative knowledge development, and its practices aim to facilitate multi-stakeholder participation in knowledge creation, processing, and dissemination, making scientific information, data, and outputs more broadly and readily accessible to diverse audiences. In 2021, UNESCO's 41st General Conference unanimously adopted the UNESCO Recommendation on Open Science[1], marking a global consensus that the era of open sharing of scientific knowledge has arrived and that open science has entered a new phase of development. The Recommendation outlines four key pillars of open science: open scientific knowledge, open science infrastructures, open science communication, open engagement of societal actors, and open dialogue with other knowledge systems. As a quintessential representative of open scientific knowledge, scholarly publications constitute the core of open science initiatives, which seek to advance the public's right to immediate open access to academic publications through open science practices.

During the implementation of open science practices, different stakeholders—including governments, universities, research institutions, and academic publishers—have exhibited varying priorities based on their respective interests. Academic publishers, whose commercial interests are directly impacted by the principle of free access to scientific knowledge, have engaged in years of negotiation with entities such as governments and research institutions that actively promote open access. Consequently, publishers' attitudes toward open access have undergone a transformation from resistance and opposition to active embrace.

1. The Evolution of Open Access for Scholarly Publications

As crucial participants in the dissemination of scientific knowledge, academic publishers maintain quality control over scholarly outputs through mechanisms such as peer review, thereby ensuring the credibility of scientific communication. To this day, academic journals remain one of the most important channels for researchers to exchange research findings. Since Syracuse University launched the world's first open access journal, *New Horizons in Adult Education*, in 1987[2],

open access for scholarly publications has evolved over several decades and plays an increasingly significant role in scientific research and scholarly communication. Based on different developmental practices, the evolution of open access can be divided into four main stages.

1.1 1980–2000: Emergence of Open Access Journals and Platforms

During this stage, early open access journals and platforms began to emerge. On August 14, 1991, the arXiv repository for physics research papers was established at Los Alamos National Laboratory in the United States[3], providing free preprint services for physics researchers. In June 1997, PubMed was officially opened to the public[4], offering free online access to medical literature through its web-based retrieval system. By 2000, BioMed Central had become the first commercial open access publisher[5]. Simultaneously, PLOS garnered widespread attention in the academic community by promoting free online access to medical research findings. In 2002, PLOS launched its first batch of open access journals, *PLoS Biology* and *PLoS Medicine*[6].

1.2 2001–2003: Release of Open Access Initiatives and Declarations

This stage witnessed the emergence of declarations and initiatives that played crucial roles in advancing the open access movement and represented milestone achievements. The Budapest Open Access Initiative, released in 2002[7], proposed two pathways to achieve free access to scholarly resources: self-archiving in open access repositories and open access journals. In the same year, the non-profit organization Creative Commons was established[8], providing various copyright licenses to the public. In 2003, the Bethesda Statement on Open Access Publishing encouraged the biomedical community to rapidly advance open access, while the Berlin Declaration called for support for open access to scientific and humanities resources and urged a reevaluation of the promotional and usage value of publications[8].

1.3 2004–2017: Commercialization of Open Access Publishing

During this period, academic publishers gradually explored business models for open access publishing, striving to balance economic benefits with the open access trend. In 2004, Springer became the first publisher to offer hybrid open access options for journals[9]. In the same year, *PLOS ONE* was officially launched as a peer-reviewed open access journal and became one of the most prominent open access journals at the time. BioMed Central[5] demonstrated the successful operation of a commercial open access model based on author fees in 2005 and was acquired by Springer in 2008, becoming Springer Open, the largest commercial open access publisher at that time. From 2007 to 2011, *PLOS ONE* published over 12,000 papers, establishing itself as one of the world's largest peer-reviewed journals and laying a solid foundation for open access to scholarly publications[10].

In addition to commercial publishers, non-profit organizations also contributed to advancing open publishing. In 2008, the Open Access Scholarly Publishers Association (OASPA) was formally established[11], representing the interests of open access journals and further strengthening the dissemination and recognition of open access principles. Following this stage of development, the pathways to achieving open publishing became increasingly clear, primarily comprising open repositories (Green OA) led by institutions or non-profit organizations and open publishing (Gold OA) led by publishers.

In 2012, the academic community protested against excessive subscription fee increases by scholarly publishers. A website called "The Cost of Knowledge" was launched[12], with organizers calling on researchers and scholars to boycott Elsevier by refusing to submit manuscripts, conduct peer reviews, or serve as editors. One of the primary reasons for this protest was to urge publishers to reduce journal subscription prices and pay attention to the open access trend in scholarly publications. Following this boycott, academic attention to publishers' journal subscription pricing and open access for scholarly publications continued to grow, further promoting the development of open publishing. Subsequently, publishers began exploring new models for scholarly publishing. In 2014, Springer Nature began exploring open access publishing transformative agreements[13] to expand open access coverage to more scholarly publications. In 2017, Springer Nature and Jisc (the UK Joint Information Systems Committee) explored "offsetting agreements" for open publishing[14], which stipulated that Jisc's journal subscription fees could be used to offset article processing charges (APCs) for its researchers publishing open access articles in Springer Nature's hybrid journals. Both transformative agreements and offsetting agreements represent positive attempts by publishers to balance subscription costs with the demand for open access.

1.4 2018–Present: Rapid Development of Open Access Practices

During this stage, research funding agencies and governments, as key stakeholders, introduced more radical open access policies, accelerating the pace of open access practices in response to the changing policy environment. In September 2018, several national research funding agencies jointly established cOAlition S[15] and launched Plan S, an initiative to accelerate the transition to full and immediate open access to research publications. Plan S principles require that scholarly articles resulting from research projects funded by cOAlition S members must be published in open access journals or platforms or made available without embargo through open repositories. The launch of Plan S challenged the traditional publisher model, which relies on high APCs to sustain operations.

Beginning in 2019, major academic publishers actively pursued transformative agreements with research institutions, making such agreements the primary mechanism for publishers to engage in open access practices. Wiley signed Germany's first open access transformative agreement with the Projekt DEAL consortium in 2019[16]. Cambridge University Press (CUP) signed the first open

publishing transformative agreement in the United States with the University of California in 2019[17]. Oxford University Press (OUP) signed China's first open publishing transformative agreement with the National Science Library, Chinese Academy of Sciences in 2020[18]. Elsevier signed its first transformative agreement in the Asia-Pacific region with Japan in 2020.

Beyond signing transformative agreements, other open publishing methods for scholarly publications have also evolved. Starting in 2020, eLife announced a new pathway for peer review and article publication[19]. Under this new model, eLife no longer makes acceptance or rejection decisions after peer review but instead publishes peer-reviewed papers as preprints on its website. Furthermore, to meet growing open access demands, publishers have begun exploring open access for backfile content. For example, in 2022, Elsevier partnered with the NorthEast Research Libraries consortium (NERL) to pilot retrospective open access[20], with plans to gradually open access to historical literature.

2. Open Access Practices of Academic Publishers

2.1 Actively Promoting Transformative Agreements

Transformative agreements represent a transition mechanism from subscription-based access to fully open access for scientific publications, wherein publishers and subscribing institutions negotiate a fee that covers both subscription and open access components. Under these agreements, institutions gain access to publishers' content while their researchers can publish articles in journals without paying APCs. Transformative agreements enable sustainable scientific publishing services while enhancing transparency in public fund utilization and controlling publishing costs.

In the open science environment, actively promoting transformative agreements has become a crucial initiative for publishers. Research from the SPA-OPS project conducted by UK-based Information Power indicates that transformative agreements are considered one of the most widely accepted open publishing models in academia[21], with their primary advantage being the establishment of stable funding sources. Under the transformative agreement framework, major expenses continue to be borne by traditional subscribing institutions, reducing the publication cost burden on authors themselves. Subscribing institutions not only retain journal reading rights but also gain publishing rights within the agreement framework, achieving dual benefits of reading and publishing. During the promotion of transformative agreements, some leading publishers have made varying degrees of concessions as open access principles have gained traction. For instance, Elsevier signed a transformative agreement with Jisc in 2022, agreeing to include its top-tier journals within the open access scope. Publishers' gradual waiver of exemptions for top-tier journals during transformative agreement negotiations reflects their growing emphasis on open access. Springer Nature signed three agreements in 2022, with open access coverage including *Nature* journal[22].

2.2 Exploring Diverse Open Access Journal Models

Among the open access publishing services provided by publishers, the most common model is "author pays, reader free," supported by APCs to cover publishing service costs. However, this model has not fundamentally changed the reality that research institutions must pay substantial fees to access research outputs, and publishers' profit-seeking has led to divergences between publishers and research institution systems or library consortia in promoting open access practices. Research institutions are seeking to significantly reduce costs and negotiate special open access terms that enable their authors to publish open access articles without paying APCs. In response, academic publishers are actively exploring alternative subscription publishing models, including community action publishing, flat fee agreements, and membership subscription models.

(1) Community Action Publishing Model
Community Action Publishing (CAP) is a commercial subscription model launched by PLOS in 2020[23]. Its core concept shifts the cost of open access articles to research institutions through fixed annual fees, replacing high APCs paid by individual authors. Based on the community principle that entities working together can achieve better outcomes than individuals, the CAP model involves research institutions signing agreements with PLOS and paying annual fees, after which their researchers can publish papers in relevant PLOS journals free of charge. The CAP model encourages institutional participation in collective action, while authors from non-member institutions must pay additional fees that increase annually to incentivize institutional membership.

Unlike subscription models, CAP aims for sustainable selective publishing rather than maximizing revenue profits. When institutions meet revenue targets, CAP returns excess income to community members, with PLOS not retaining surplus revenue beyond the target.

(2) Flat Fee Agreements
PLOS also offers flat fee agreements that provide institutions with unlimited open access journal article publishing rights for a fixed annual fee[24]. This model encourages institutions to more actively support open access and provides more publishing opportunities for their members. The difference from subscription publishing models is that flat fees cover both author publishing costs and reader access costs. While the payment mechanism resembles CAP (i.e., annual unified fees), the journals involved and cost calculation mechanisms differ. Flat fees currently apply to six PLOS journals and are calculated based on APC rates at the time of negotiation, historical publishing activity, waiver rates, and corresponding author expenditures. CAP fees, by contrast, are based on total journal publishing costs and consider corresponding author and contributor activities.

(3) Membership Subscription Model
Membership models represent a popular option among publishers' open publishing offerings. Publishers such as PeerJ and PLOS have launched membership

models enabling authors and institutions to choose different payment methods, including one-time payments, institutional plans, and lifetime memberships. For example, PeerJ[25] employs a one-time payment model for lifetime free publishing, where authors pay a single membership fee to enjoy lifetime rights to publish papers free of charge. BioMed Central and SpringerOpen offer institutional membership models[26] that provide APC discounts, with three specific institutional membership types: supporting members receive discounts through annual fee payments, prepaid members enjoy different discounts based on prepaid deposit amounts, and shared supporting members enable cost-sharing between institutional prepaid deposits and authors for article processing fees.

2.3 Promoting Concurrent Development of Monograph Open Access

Open access has achieved considerable development not only in scholarly journal publishing but also in monograph publishing, with publishers adopting various innovative models to advance monograph open access. In 2005, North American university presses began experimenting with open access for scholarly monographs[27], collaborating with libraries to establish scholarly digital offices. These presses adopted multiple innovative models, including open electronic versions plus paid print versions, paid electronic-only versions, open access, and emerging digital publishing projects. This diversified approach aims to meet the varying needs of authors and readers while providing more choices and possibilities for monograph open access. In 2011, Springer Nature piloted open access book publishing based on its existing open access journal foundation[28], serving as a key driver among commercial publishers experimenting with open publishing for scholarly monographs and stimulating the development of open access book publishing.

Current major monograph open publishing models include: Book Processing Charges (BPC) model, post-embargo open access model, free open access model supported by financial subsidies, post-embargo free open access model supported by financial subsidies, membership publishing model, library consortium model, subscribe-to-open model, and crowdfunding model[29,30]. Beyond these models, some publishers continue exploring new possibilities for monograph open publishing. For instance, Taylor & Francis partnered with F1000 in 2022 to launch the Open Plus Books innovative solution[31], which combines open research publishing models with book publishing to enable book works to be published as open access in individual chapters through open peer review. This approach transforms books from traditional static formats into dynamic models, allowing authors to continuously update or add new chapters using a “version update” function, with changes recorded in both print and open access versions.

2.4 Optimizing Scientific Data Open Access Workflows

Open access to scientific data is crucial for promoting research reproducibility and advancing scientific progress. As direct recipients of scientific data, publishers aggregate vast amounts of data and play a key role in promoting

scientific data open access. Publishers have developed comprehensive journal data policies that standardize data submission, review, and usage to facilitate open sharing and reproducibility of scientific data.

First, publishers establish requirements for data submission intensity, formats, and methods. Some journals require authors to submit data supporting their papers upon manuscript submission. For example, *Nature*, *Science*, and PLOS journals require authors to disclose all data necessary to replicate their research results upon publication. Springer Nature requires authors to promptly provide materials, data, code, and related protocols to readers during the submission process[32]. The data and materials provided by authors must comply with journal transparency requirements and FAIR utilization principles. Cell Press requires authors to archive all unprocessed data related to their papers and may request raw data[33].

Second, publishers actively collaborate with data platforms to provide one-stop data sharing services, encompassing both facilitating authors' data publication and enabling readers' data access. Initially, publishers encouraged authors to upload data to public repositories to achieve open sharing. Sharing data through public repositories facilitates structured and standardized data identification and management while saving time and resources that would otherwise be spent on data management and platform development. As data sharing practices have evolved, publishers have integrated data sharing into the author submission workflow through partnerships with third-party data platforms, providing researchers with more convenient pathways to share scientific data. For example, Springer Nature's BioMed Central partnered with Figshare[34] to launch publishing services that seamlessly integrate data sharing with manuscript submission for medical journals, allowing authors to participate in data sharing through Figshare. Springer Nature subsequently expanded this service to all its journals and partnered with the computational science platform Code Ocean[35] to integrate code storage, review, and submission processes. Springer Nature journals and Wolters Kluwer's Lippincott journals have also collaborated with Figshare to integrate data sharing into the author submission workflow, making data sharing an integral part of the submission process. Simultaneously, publishers have improved data access methods by providing visual cues to help researchers quickly locate accessible data, thereby saving time and promoting the discovery and reuse of open data. For instance, PLOS announced in March 2022[36] that it would provide article linking to OSF, Figshare, or Dryad repositories, with uploaded research data displaying an "accessible data" feature in the reading interface to help researchers rapidly identify available data.

2.5 Innovating Open Peer Review Practices

Open peer review represents a significant development trend in scholarly publishing, with major publishers actively exploring innovative models to promote transparency, enhance review quality, and facilitate scholarly communication. Since *Nature* attempted to implement open peer review in 2006, an increasing

number of publishers and journals have adopted this model. Surveys indicate that most authors support open peer review and believe it improves paper quality and transparency. Publishers including PLOS, BioMed Central[37], Frontiers, PeerJ, and F1000 Research[38] have launched open peer review initiatives, with some journals disclosing reviewer names, review reports, and author responses after publication, achieving maximum transparency.

Publishers are also actively innovating open peer review models to enhance reviewer motivation and review quality. For example, Publons introduced innovative models such as review credits[39], converting reviewers' contributions into academic reputation points to incentivize participation and contribution. Additionally, innovative peer review services like Select Crowd Review[40] employ social media-like communication mechanisms to enhance reviewer enthusiasm and speed while maintaining review quality. PLOS allows reviewers to choose whether to sign their reviews[38] and has received numerous signed review reports. This approach acknowledges reviewers' contributions and enriches the scientific record, with recognition and incentives for reviewers' work helping to improve their motivation and engagement.

Building on these efforts, publishers have further attempted to optimize the transparency and citability of open peer review comments. For instance, SAGE Publishers publicly discloses review reports for its journals through Web of Science[41], enabling readers to understand the complete review process. Science Open publishes review reports on its website with DOI numbers attached, promoting the role of review comments in subsequent scholarly communication. PLOS's open peer review mechanism achieves transparency and accountability by publishing peer review histories and key documents[38], such as editorial decision letters, peer review comments, and author responses. eLife[42] publishes papers in the form of "preprints with review reports," incorporating both public comments and authors' responses to evaluations.

3. Trends in Academic Publishers' Open Access Practices

3.1 Accelerated Open Publishing Cycles for Scholarly Outputs

Rapid access to researchers' latest findings represents a key orientation of open science initiatives. To meet public demand for immediate knowledge dissemination, publishers are actively implementing measures to shorten the open access publishing cycle for scholarly outputs. First, publishers are accelerating peer review processes to improve the speed of research output processing. While traditional peer review may take months or even longer, publishers in the open science context tend to adopt more efficient models, such as rapid peer review or preprint publication, to expedite the release of research findings. This ensures that researchers' latest results can be evaluated by peers and the public as quickly as possible.

Second, publishers are optimizing publishing workflows by adopting more efficient technologies and platforms to accelerate scholarly output publication.

Advances in digital technology enable publishers to process, edit, and publish scholarly outputs more rapidly. They invest in advanced publishing systems and online platforms that provide fast manuscript processing and publication workflows, reducing the time costs associated with traditional print publishing. For example, some publishers have adopted online review systems[43] that make manuscript processing faster and more efficient. Publishers also provide self-service publishing tools[44] that enable researchers to more conveniently manage and publish their research outputs independently.

Furthermore, the global COVID-19 pandemic has intensified public demand for rapid dissemination of research findings by publishers[45]. During the pandemic, research outputs from researchers and medical experts received widespread attention and played crucial roles in prevention and treatment. Publishers responded rapidly by developing fast-track publishing strategies for pandemic-related research, substantially increasing the number of open access journals and accelerating review and publication workflows to ensure that COVID-19-related research could be promptly accessed and utilized by the scientific community and the public.

3.2 Platformization of Scholarly Output Publication and Access

To better respond to open science initiatives and reduce barriers to scholarly output publication and utilization, the publication and access of scholarly outputs are trending toward platformization. Publishers have implemented various measures to build and launch integrated platforms that enhance the efficiency of research output publication, storage, sharing, and dissemination. Regarding integrated research output publication, F1000 Research collaborated with the European Commission to develop an open access publishing platform called Open Research Europe[46], designed to provide researchers with a free, transparent, and high-quality publication mechanism that optimizes operational experience. Launched in early 2021, Open Research Europe employs an immediate publication model, with published articles undergoing transparent, open peer review procedures. The platform also supports authors in publishing various research outputs and FAIR-compliant underlying data, enabling authors to actively participate in the publishing process.

Regarding one-stop access to scholarly outputs, Elsevier, in partnership with the American Chemical Society (ACS), the Royal Society of Chemistry (RSC), Taylor & Francis Group (T&F), and Wiley, aggregated 70,000 papers from 35 organic chemistry and transportation journals on the ScienceDirect platform in January 2022[47] for reader access. The development of integrated platforms helps reduce the inconvenience of researchers switching between different publishers and improves the accessibility and discoverability of research outputs.

3.3 Transition from "Attracting Readers" to "Attracting Authors"

In the open science context, publishers are shifting their operational strategies from "attracting readers" to "attracting authors," a transition driven by publishers' profit models. Under the traditional "subscription-publishing" model, publishers focused on providing better reader services, with reader subscription fees representing their primary revenue source. As publishers continuously explore and refine subscription models for open access publishing, open access publishing revenue has become an important component of publishers' profit structures. According to Simba Information's report *Open Access Journal Publishing 2018-2022*[48], revenue from open access scientific journals has become a rapidly growing income source. Between 2015 and 2017, academic journal sales grew at an average annual rate of over 1%, while open access journal growth reached double digits. Consequently, the "author pays, reader free" open publishing model determines that publishers will invest more effort in attracting authors to publish open access outputs to generate higher profits.

On one hand, publishers are launching more open access journals to attract authors and generate APC revenue. By offering high-quality open access journals, excellent publishing services, and strong reputations, publishers attract authors to choose their platforms for article publication. On the other hand, publishers are committed to providing more author services to attract researchers to publish on their platforms, including high-quality peer review services, editorial support, fast publication workflows, and global visibility.

Open science initiatives have driven publishers' transition from traditional "subscription-publishing" models to open access models. By accelerating peer review and optimizing publishing workflows, publishers actively shorten open access publishing cycles, enabling researchers' latest findings to be more quickly accessed by peers and the public, thereby facilitating rapid knowledge dissemination and scientific progress. Simultaneously, scholarly output publication and access are developing toward platformization. Publishers actively build and launch integrated platforms to improve the efficiency of research output publication, storage, sharing, and dissemination. Platformization measures—including identity verification and service tools, academic impact visualization tools, mobile publishing and content promotion tools, and transformative agreement management and settlement tools—not only enhance the accessibility and visibility of research outputs but also improve researchers' work efficiency and the accuracy of academic impact evaluation. Furthermore, publishers' operational strategies are shifting from "attracting readers" to "attracting authors." In traditional subscription models, reader subscription fees constituted the primary revenue source. With the rise of open access models, publishers' profit structures have changed. By building integrated platforms, implementing flexible publishing policies, and providing author support services, publishers attract researchers to choose open access channels for publishing their research outputs. This transformation reflects changes in publishers' profit models and addresses researchers' needs in the open science

environment.

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Note: Figure translations are in progress. See original paper for figures.