Research on the Major Development Trends of International Preprint Platforms

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Abstract

Under the influence of major trends such as open access and open science, preprints and academic exchange based on preprint platforms have garnered significant attention from the scientific community. This paper systematically reviews the international development of preprint platform construction since 2013 and proposes seven major trends in the current international development of preprints. Research demonstrates that traditional preprint platforms, represented by arXiv and SSRN, have achieved substantial development through exploring sustainable development models; new preprint platforms, represented by BioRXiv and ChemRXiv, have emerged proliferatively, bringing great prosperity to preprint platforms; and within the scientific community, the preprint exchange model based on scholarly manuscripts has gained widespread recognition from academic societies, associations, scientific management institutions, funding organizations, and even traditional publishers, indicating that the preprint-based academic communication model grounded in scholarly self-governance is transforming the traditional journal-centered academic communication model.

Full Text

Study on the Main Development Trends of International Preprint Platforms

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Abstract

Influenced by the Open Access and Open Science movements, preprints and preprint-based scholarly communication have garnered significant attention from the scientific community. This paper summarizes the development of international preprint platforms since 2013 and identifies seven major trends in the current international preprint landscape. The study reveals that traditional preprint platforms such as arXiv and SSRN have achieved substantial growth through exploring sustainable development models. Meanwhile, new preprint platforms including BioRxiv and ChemRxiv have emerged rapidly, bringing unprecedented prosperity to the preprint ecosystem. Furthermore, the manuscript-based preprint communication model has gained widespread recognition from academic societies, scientific associations, research management institutions, funding agencies, and even traditional publishers, indicating that community-governed preprint-based scholarly communication is transforming the traditional journal-centric 学术交流模式.

Keywords: Preprint Platform; Scholarly Communication; arXiv; SSRN; Development Trend

1. arXiv Achieves Sustainable Development Model and Enters a Period of Major Growth

arXiv is currently the most internationally renowned preprint platform. In 1998, it was transferred to Cornell University Library for operation. Before 2010, although arXiv had become an important academic infrastructure in fields such as high-energy physics, its development was constrained by funding limitations as it received support only from Cornell University Library.

Beginning in January 2010, Cornell University Library initiated a three-year exploration of a sustainable development model for arXiv, transitioning it from a model solely managed by Cornell to a membership-based governance structure with multi-institutional collaboration and multi-stakeholder support. On August 28, 2012, the sustainability model proposed by Cornell University Library received funding from the Simons Foundation. Under this grant, the Simons Foundation provided Cornell University Library with $300,000 annually from 2013 to 2017, plus an unconditional annual gift of $50,000 to support arXiv' s operations and management. Currently, arXiv has established a long-term sustainable development model supported by Cornell University Library, the Simons Foundation, and member institutions worldwide. In recent years, arXiv has continued to receive support from the Heising-Simons Foundation and the Sloan Foundation to improve its infrastructure and develop new service models, thereby achieving the goals outlined in the Next Generation arXiv (arXiv-NG) initiative [**?**].

In recent years, the number of papers posted on arXiv has achieved multiple breakthroughs. In October 2012, arXiv hosted approximately 790,000 research

papers; by January 12, 2015, this number exceeded 1 million [?]; and by October 2017, the total had reached 1.31 million, representing an increase of over 520,000 papers in five years. Correspondingly, monthly submission rates have grown substantially. In 2011, arXiv added 76,578 new papers, averaging fewer than 6,400 per month. Since arXiv' s article identifiers follow a "year-month + serial number" format (arXiv:YYMM.number) with four-digit serial numbers, this was sufficient to accommodate monthly submissions. By the end of 2014, arXiv predicted that monthly submissions would soon exceed 10,000, prompting the expansion of serial numbers from four to five digits starting in 2015 [?]. In October 2016, new submissions to arXiv reached 10,100, marking the first time monthly submissions surpassed 10,000 [?].

In 2017, arXiv expanded its subject domain coverage in two phases. Previously, arXiv accepted preprints in only six disciplines: physics, mathematics, computer science, quantitative biology, quantitative finance, and statistics. Following requests from academic communities (such as the IEEE Signal Processing Society) and domain experts, and after review by the arXiv Scientific Advisory Board, arXiv expanded to include electrical engineering and systems science on September 18, 2017 [?], and economics on September 26, 2017 [?].

2. SSRN Acquired by Elsevier and Expanding into Multiple Key Domains

Although SSRN' s influence in the preprint platform space has not yet reached arXiv' s level, its development model in recent years has been exceptionally innovative, in some respects surpassing even arXiv.

On May 17, 2016, Elsevier acquired the preprint platform SSRN, an event that attracted considerable industry attention. Two major questions emerged: Why would a publishing giant like Elsevier acquire SSRN, a preprint platform serving the social sciences? And how would SSRN develop post-acquisition?

Regarding the first question, Elsevier' s press release provided clarification [?]. As stated, Elsevier actively adapted to the Open Access trend and recognized the value of open sharing in academic research. The acquisition aimed to build an open science network supporting scholarly communication. As part of this strategy, Elsevier sought to leverage its content resources, the Mendeley technology platform and its user community, and SSRN' s preprint communication channel to construct a comprehensive network supporting researcher communication. Clearly, Elsevier' s acquisition of SSRN reflected a long-term vision, recognizing the changing landscape of traditional scholarly communication.

Regarding the second question, the answer has become clear one year later. In 2017, SSRN emerged with a new orientation under Elsevier' s ownership. While significantly improving its user interface, SSRN ceased confining itself to social sciences and humanities, instead actively expanding into additional key research domains [?]. In May 2017, SSRN launched the Biology Research Network (BioRN) [?], followed by the Chemistry Research Network (ChemRN)

in August 2017 [**?**]. Additional research networks were planned for expansion by the end of 2017. SSRN' s domain expansion signals that competition among preprint communication channels has begun.

3. BioRxiv Emerges Strongly, Establishing Itself as a Premier Brand in Biology Preprint Services

In recent years, biologists have actively drawn from arXiv's experience in physics to promote preprint adoption in their field. In 2013, Cold Spring Harbor Laboratory launched BioRxiv, a preprint platform for biology [**?**]. That year, the platform received 824 preprint submissions, and by February 2016, BioRxiv hosted approximately 3,100 papers [**?**], indicating modest growth during its initial three years.

In February 2016, the organization ASAPbio (Accelerating Science and Publication in biology) emerged, catalyzing BioRxiv' s rapid development. ASAPbio is a grassroots organization initiated by scientists dedicated to promoting preprint-based scholarly communication in biology [**?**]. By organizing multiple workshops on preprint development, ASAPbio actively fostered support from scientists, research management institutions, scientific societies, publishers, and funding agencies for biology preprint platforms. Under ASAPbio' s influence, BioRxiv' s submission rate increased rapidly, with over 5,000 new papers added in 2016 alone. By October 2017, BioRxiv' s collection had reached 16,000 papers, with monthly submissions exceeding 1,000, establishing it as an important research infrastructure in biology.

BioRxiv received support from the Lourie Foundation at its inception and has attracted considerable attention from additional funders in recent years. In February 2017, ASAPbio issued a call for funding support to build a centralized biology preprint platform, including BioRxiv, to accelerate research communication. This call received positive responses from the National Institutes of Health (NIH), the Wellcome Trust, and other funders. On April 26, 2017, BioRxiv received a multi-year grant from the Chan Zuckerberg Initiative (CZI) to cover staff salaries, technical development, and infrastructure improvements [**?**].

4. ACS Promotes ChemRxiv, Building an International Chemistry Preprint Platform

Among the major disciplines of mathematics, physics, chemistry, and biology, chemistry has traditionally been relatively conservative and resistant to openness because its research results have direct economic applications. However, since 2016, the chemistry community, led by the American Chemical Society (ACS), has actively promoted preprint platform development to serve the international chemistry community.

On August 10, 2016, ACS announced the creation of ChemRxiv, an international preprint platform for chemistry, as a key initiative to promote open collabora-

tion in the global chemistry community and facilitate rapid dissemination and application of important scientific discoveries [**?**]. ACS envisioned ChemRxiv following the arXiv model in physics and the bioRxiv model in life sciences, enabling chemistry researchers to share early research results and data across disciplinary boundaries before formal peer review and publication. On August 14, 2017, ACS announced the beta release of ChemRxiv for global use and testing by the chemistry research community.

The ChemRxiv beta version is powered by the digital repository platform Figshare. Before public release, the beta was extensively tested and reviewed by ACS, the Royal Society of Chemistry, the German Chemical Society, and relevant non-profit organizations, scientific publishers, and preprint platforms [**?**]. ChemRxiv maintains free submission and access services, allowing users to access textual content and harvest data through open APIs or OAI-PMH protocols.

ChemRxiv is positioned as a community-driven, internationally-oriented preprint platform for chemistry, enabling global chemists to share research findings promptly and gain early recognition for their discoveries. During development, ACS collaborated with the Royal Society of Chemistry, the German Chemical Society, and non-profit organizations to ensure ChemRxiv' s neutrality and international character. Currently, ACS manages the platform on behalf of the international chemistry community, with plans to establish management and scientific committees to oversee strategic direction.

5. Proliferation of "Xiv" Platforms Marks Unprecedented Prosperity in Preprint Development

Beyond the aforementioned platforms, numerous academic organizations and knowledge service groups have launched new domain-specific preprint platforms in recent years, creating unprecedented prosperity in preprint development.

In April 2013, PeerJ launched PeerJ Preprints, providing preprint deposit services in biology, medicine, health sciences, and computer science, having now collected 3,350 research papers with growing influence. In June 2016, the Multidisciplinary Digital Publishing Institute (MDPI) in Basel, Switzerland, launched a multidisciplinary preprint platform serving all disciplines, which has published 2,200 manuscript papers. In April 2017, the engineering preprint service engrXiv officially launched, initiated by the Center for Open Science in 2016 and managed by the University of Wisconsin.

Additionally, domain-specific preprint platforms continue to emerge. Examples include PsyArXiv for psychology (2016), SocArXiv for social sciences (December 2016), Therapoid for medical preprints launched by Open Therapeutics (2017), LISSA for library and archival science (2017), AgrXiv for agriculture (February 2017), PaleorXiv for archaeology (early 2017), SportRxiv for sports (April 2017), LawArXiv for law (May 2017), INArxiv for Indonesian disciplines (August 2017),

Thesis Commons for student thesis preprints (August 2017), and MedArXiv for medicine and health (September 2017).

Several additional platforms are under development. The American Geophysical Union's ESSOAr is expected to launch in November 2017; EarthArXiv will serve the geosciences; and MarXiv for marine conservation and climate science is also scheduled for November 2017.

Domestic preprint platforms have also developed rapidly. On June 13, 2016, the Chinese Academy of Sciences launched ChinaXiv, aiming to build a preprint platform operating according to international standards.

6. Funding Organizations Support Preprints as Basis for Grant Applications and Reporting

To encourage innovation and promote timely dissemination and application of research results for socioeconomic benefit, funding organizations generally maintain positive attitudes toward preprints, encouraging grant applicants and recipients to release findings through preprint platforms promptly. Many funding agencies believe that preprint publication enables broader readership and commentary, enhancing research rigor, while timely dissemination increases the impact of funded projects.

Currently, numerous research funding organizations accept preprints as evidence in grant applications and reports, establishing standards for citing preprints. The National Institutes of Health (NIH) has been a key leader in this area. In October 2016, NIH issued a Request for Information to explore including preprints and interim research products in grant applications and reports, and to develop citation standards [**?**]. After extensive consultation, NIH announced in March 2017 that preprints and other interim research products could be cited in NIH grant applications and Research Performance Progress Reports (RPPR) effective May 25, 2017 [**?**]. In this announcement, NIH encouraged researchers to utilize preprint communication to rapidly disseminate findings while enhancing research rigor. The notice also specified requirements for acknowledging NIH support when citing interim products.

Generally, NIH clarified that preprints and interim research products can be cited like formally published papers in relevant sections of applications and reports, including bibliographies, biosketches, planned outputs, and major outcomes in progress reports. NIH further specified that to promote standardized citation, applicants and recipients must include the preprint's digital object identifier, clearly identify the document type as a preprint, list version information (including last modification date), and indicate the citation date.

To maximize the impact of NIH-funded preprints, NIH encourages that they be made openly accessible under CC-BY licenses whenever possible, include acknowledgments of NIH support in the text, clearly state that the work has not undergone peer review, and disclose any competing interests. Regarding

platform selection, NIH guidance includes requirements that preprint platforms ensure content is findable, accessible, interoperable, and reusable; that metadata (including usage statistics) is openly and readily accessible; and that long-term preservation strategies are in place.

Beyond NIH, numerous other funding and research organizations support preprints. The UK Medical Research Council announced support for preprints starting April 2017; the Wellcome Trust stated in January 2017 that it would accept preprints for grant applications and reporting; Cancer Research UK announced acceptance of preprints in grant applications on May 30, 2017; and the Howard Hughes Medical Institute, Helmsley Trust, and Simons Foundation have also expressed support.

7. The Ingelfinger Rule Is Being Broken as More Journals Support Preprint Communication

The Ingelfinger Rule, proposed by Ingelfinger in 1969, requires that manuscripts submitted to a journal must not have been submitted elsewhere or published previously [**?**]. While intended to prevent duplicate submission and ensure originality, this rule also prevented authors from posting manuscripts to preprint platforms.

In recent years, the Ingelfinger Rule is being broken in the publishing domain, with increasing numbers of journals allowing authors to post manuscripts on preprint platforms before submission (e.g., *Nature*, *Science*). Some journals adopt a case-by-case approach, requiring authors to contact editors to discuss preprint posting (e.g., *Cell*).

Although some journals continue to enforce the Ingelfinger Rule, they face opposition from the scientific community, with many scientific societies actively organizing to break the rule. The American Chemical Society exemplifies this trend. Following its August 2016 announcement supporting preprint communication, ACS journals have successively implemented preprint policies, allowing authors to varying degrees to post manuscripts on preprint platforms before journal submission. For instance, *ACS Chemical Biology* and *Nano Letters* treat submissions with and without preprint posting equally, merely requiring authors to inform editors at submission.

8. Summary and Analysis

Recent years, particularly since 2016, have witnessed unprecedented prosperity in preprint platform development. In the scientific community, manuscript-based preprint communication has gained broad recognition from academic societies, scientific associations, research management institutions, funding agencies, and even traditional publishers. Specifically, traditional preprint platforms such as arXiv and SSRN have achieved major growth through sustainable development model exploration; new domain-specific preprint platforms like BioRxiv

and ChemRxiv continue to emerge, with some establishing themselves as new service brands, bringing great prosperity to preprint platforms; funding organizations actively support preprint communication, increasingly accepting preprints as basis for grant applications and reports while establishing citation standards; and in publishing, the Ingelfinger Rule is being broken as more journals allow preprint posting before submission. These trends demonstrate that community-governed preprint-based scholarly communication is transforming the traditional journal-centric 学术交流模式.

Facing this unprecedentedly prosperous international preprint landscape, five aspects warrant particular attention:

(1) **Open Science is the dominant driver of preprint platform development.** The full-cycle transparent research model advocated by Open Science is becoming mainstream, with preprint platforms and preprint-based communication serving as essential tools for researchers, academic societies, publishers, and funders to adapt to Open Science requirements.

(2) **Academic community autonomy is the primary motivation for supporting preprint platforms.** The principle that scientific matters should be handled by the scientific community has long been a fundamental requirement for many research groups. Recognizing the over-reliance on journals for research evaluation, academic societies increasingly appreciate that research assessment and communication require community governance. Preprint platforms independent of publishing institutions better embody this community autonomy.

(3) **Active funding agency support is a major driver of preprint platform development.** As research funders, funding organizations desire rapid, high-quality research output and its swift dissemination to generate impact and benefit—goals that align perfectly with preprint platforms' mission of timely research communication.

(4) **Competition among preprint platforms incentivizes development.** Behind the proliferation of preprint platforms lies intense competition for research communication channels and academic discourse power. This is particularly evident in chemistry, where ACS launched ChemRxiv just one week after SSRN introduced its Chemistry Research Network.

(5) **Changing scholarly communication models are the inevitable result of preprint platform development.** Preprint platform development will inevitably transform traditional scholarly communication. Chinese institutions should actively organize the construction of a national scientific preprint platform to lead new communication models aligned with international trends and enhance China' s leadership and voice in scholarly communication.

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