

From Oligopoly to Open Science: DeSci

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Abstract

This article discusses the issues with traditional scientific publishing and the solutions offered by DeSci. It covers problems caused by oligopoly in scientific publishing, author-reviewer-editor triangulation, predatory journals, and funding and resource allocation. These issues result in gated publishing, peer review bias, publish or perish culture, centralized funding, poor publication quality, low accessibility, low transparency, and low reproducibility. This study discusses DeSci's solutions to the aforementioned problems through blockchain technologies, including DAO, DBDAO, NFT, Zero-Knowledge Proofs, IP-NFT, and IPFS. Sample applications and projects are provided to illustrate these solutions. DeSci's solutions represent a transition from oligopoly in scientific production to the true Open Science era.

Keywords: DeSci, Oligopoly in scientific publication, open science

Background of Traditional Science Problems

The origins of academic journals date back to the 17th century, beginning with the *Philosophical Transactions of the Royal Society* by Henry Oldenburg in 1665, quickly followed by the *Mémoires de l'Académie des Sciences*, and culminating in the first fully peer-reviewed journal, *Medical Essays and Observations* in 1733. The methods of producing and disseminating knowledge have remained largely unchanged over this time. International publishing organizations have been the hub of knowledge flow and scientific debate for centuries. In recent decades, the scientific publishing industry has come under the control of a few giant publishers. (Larivière Haustein and Mongeon 2015). While these structures have contributed to the quality of scientific publications, they have also led to high access fees, information monopolies, bias, and research cartels (Bauer 2004).

The process of scientific publishing and its peer review mechanism predominantly depend on a limited number of key industry entities that dominate the majority of journals (like Elsevier), databases (such as Scopus), and evaluation metrics (for instance, the JCR Impact Factor), while maintaining restricted access to most articles through paywalls (Tenorio-Fornés et al. 2021). As a result of highly centralized scientific practices, several issues have arisen. Monopolization, problems in author-referee-editor interactions, predatory journals, and the 'publish or perish' mentality (Firat 2020) are among the most significant issues in academic publishing today. Monopolization takes the form of large publishers exerting excessive control over information and limiting access through high subscription fees. Problems in author-referee-editor interactions can result in bias, delays, and unjustified rejections (Ross-Hellauer, Deppe, and Schmidt, 2017). Biased comments by anonymous reviewers or conflicts of interest by editors can lead to valuable scientific contributions being ignored. Problematic manuscript handling systems also contribute to these problems. In the neo-liberal world, the commercialization of science can be traced back to the general pattern of capitalism, which is similar in many areas (Buğra Ağartan and Irzik 2007).

Oligopoly can lead to the production of counterfeit copies. This phenomenon is also present in the current scientific publishing oligopoly. Predatory journals have emerged rapidly as a result of dominant companies in the scientific publishing industry publishing paid articles under the guise of open access or article processing charges in order to increase profits

(Camargo 2014; Zepetnek and Jia 2014). Predatory journals sell scientific articles that are already in the public domain to the public for money (Firat 2020). They use low-quality or bogus peer-review processes to lure researchers with the promise of fast publication in exchange for high fees. By undermining the integrity of the scientific community, these journals can lead to the dissemination of poorly produced or misleading work in the literature. The pressure to publish frequently, known as the 'publish or perish' mentality, can lead researchers to prioritize quantity over quality (Parchomovsky 2000). This can result in the overemphasis of less significant findings in order to safeguard their careers. These factors, each a significant issue on its own, combine to create structural challenges that undermine the foundation of the scientific community.

In addition to these significant issues, scientists and scientific research funding often rely on the outcomes of these unconventional scientific processes. National and international funding agencies frequently evaluate research and projects based on the number of publications, the prestige of the journal, and the impact factor. This means that scientific work is often evaluated based on the criteria of monopolistic publishing organizations. Even Nobel laureate Peter Higgs published fewer than ten papers after his groundbreaking work in 1964; his work was only truly appreciated after he won the Nobel (Jandrić 2021). As a result, research agendas may become narrow and innovation may be limited, as resources are often directed only to research published in certain journals or approved by certain indexes.

Moreover, the integrity of funding decisions is at risk due to predatory journals and a literature filled with low-quality publications. Articles published in these journals can influence funding and promotion decisions without adequate evaluation by the scientific community. This structure can lead to a cycle based on quantity and vanity rather than quality and innovation, not only for scientific publications but also for funding scientific research. The hindrance of social and technological progress is one of the biggest obstacles caused by the negative impact of funding on the advancement of science.

These difficulties are further exacerbated by the problems inherent in funding itself. Intermediary institutions and organizations significantly cut back funds allocated to research, which results in their erosion before reaching the researchers and research itself. Institutions often deduct a significant portion of the funding for administrative costs, transaction fees, and other charges (Walwyn 2016). This can result in valuable resources earmarked for scientific discoveries and societal advances not being utilized to their full capacity, and researchers not receiving the full funding necessary to pursue their projects. Limiting the creativity and innovative ideas of scientists, as well as slowing down the research process, ultimately hinders scientific progress and affects society as a whole. Therefore, it is urgent and important to make more effective and efficient adjustments to the delivery of funds for research in the scientific world.

The scientific publishing industry faces several fundamental problems, including oligopoly, author-reviewer-editor triangulation issues, predatory journals, and funding and resource allocation problems. In addition, there are secondary problems such as gated publishing, peer review bias, publish or perish culture, centralized funding, poor publication quality, and low accessibility, transparency, and reproducibility. These issues are illustrated in Figure 1.

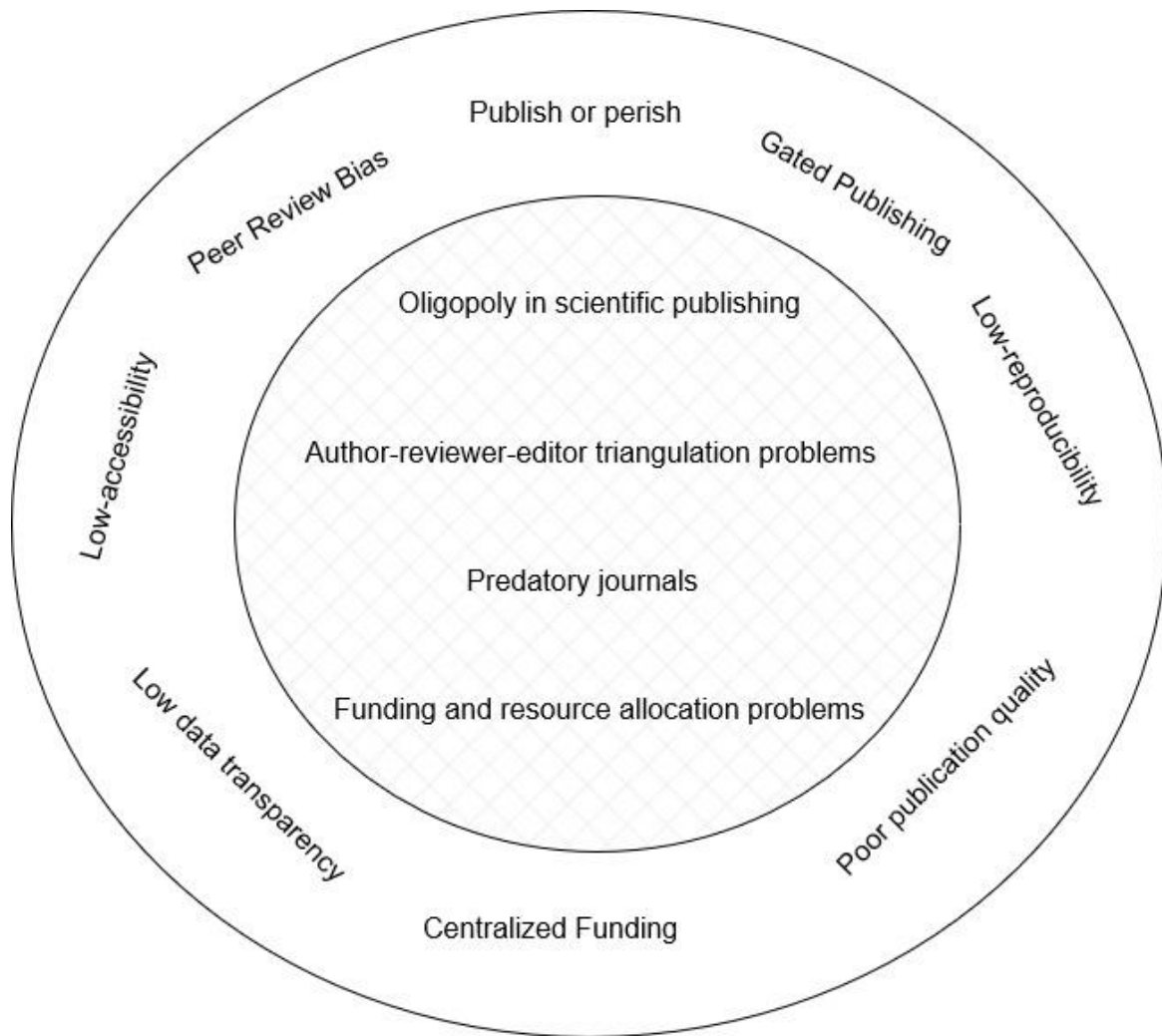


Figure 1. Problems in traditional scientific research

The scientific community is increasingly recognizing the need for a profound and comprehensive transformation in the way science is conducted and disseminated. This transformation aims to democratize access to knowledge, accelerate research processes, and reduce centralization. DeSci is one of the candidates that can lead this transformation.

DeSci - Decentralized Science

DeSci is a new concept and movement that uses blockchain technologies to address the challenges of modern science (Weidener 2024). It leverages the principles of decentralization associated with blockchain technology and Web3 innovations to create a more open, transparent, and accessible scientific ecosystem (Hamburg, 2021). DeSci aims to address the fundamental problems of traditional scientific processes by reducing gatekeeping, minimizing bias, and fostering collaboration across the global scientific community (Tenorio-Fornés et al. 2021). DeSci achieves this by using decentralized networks, smart contracts, and tokenomics to facilitate peer review, funding, and publication processes that are less dependent on traditional, centralized authorities and more focused on community governance and merit-based recognition (Ducrée et al. 2022). This paradigm shift can promote a more efficient, inclusive, and equitable distribution of resources and recognition in the scientific community.

DeSci aims to democratize science by facilitating open and transparent research, collaboration, and data sharing through the use of blockchain technology. The use of blockchain technologies ensures the authenticity, security, transparency and reproducibility of scientific

data, making it a valuable tool for open science (Janowicz et al. 2018). Smart contracts automate peer review and funding distribution, creating a merit-based and unbiased environment. DeSci integrates decentralized storage and computing platforms, providing a robust infrastructure for researchers to collaborate worldwide without the gatekeeping and monopolies of traditional scientific institutions. This accelerates scientific discovery and ensures a more equitable distribution of knowledge and resources.

DeSci is inspired by the concept of DeFi (decentralized finance). However, due to the new scientific paradigm shift that DeSci represents, it requires a more diverse and rich technological infrastructure. Figure 2 illustrates the 8 key technologies that DeSci leverages.

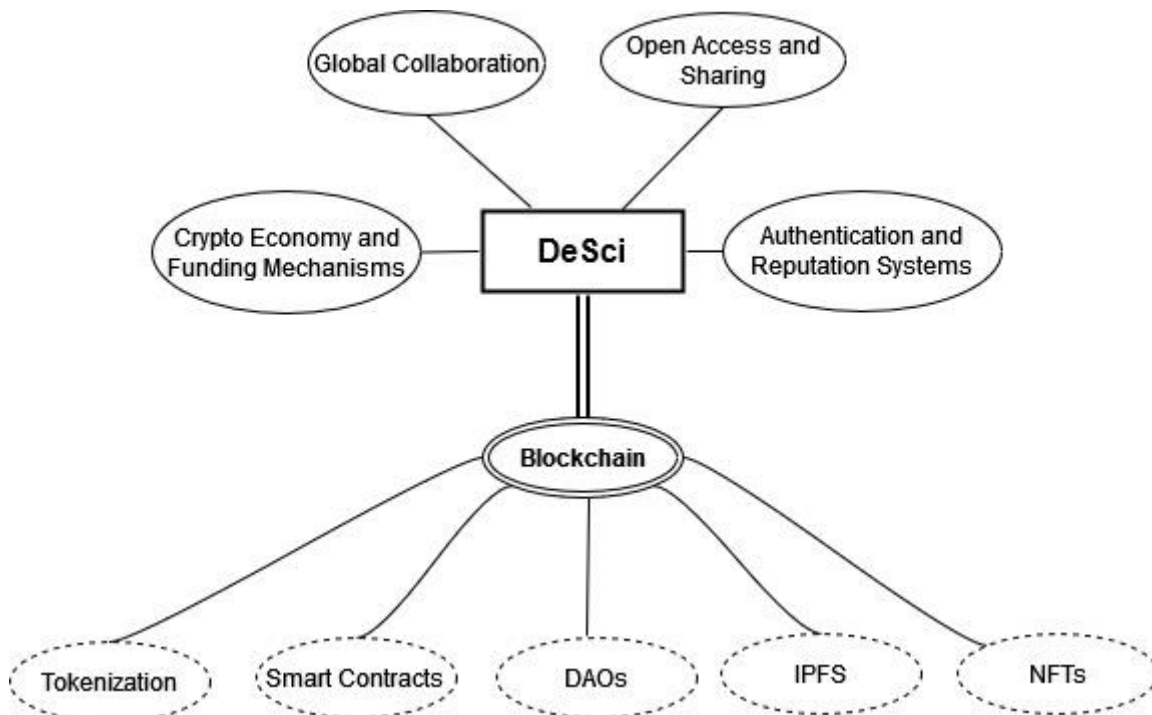


Figure 2. DeSci technologies

Blockchain is a technology that is designed to store data in an immutable and transparent manner. Every transaction is cryptographically added to the chain and cannot be altered. Scientific data, results, and peer reviews are stored on the blockchain, which enhances the transparency and reliability of the process. The use of Ethereum blockchain and advanced scaling solutions (Optimistic Rollups, zkSync) enables performance and cost optimization. Smart Contracts are protocols that run on the blockchain and are automatically executed under predetermined conditions. They automate processes such as funding scientists, rewarding reviewers, and managing intellectual property rights. IP-NFTs play an important role in these processes by facilitating ownership and transfer of intellectual property.

DeSci ecosystems incentivize participants to contribute to research using various crypto-economic models. DAOs and IPFS are important technologies in this process. DAOs, or decentralized autonomous organizations, determine project direction and funding through blockchain-based voting mechanisms of community members. IPFS stores files on a decentralized network, ensuring durable and accessible scientific data and publications.

DeSci platforms use blockchain technology to securely and verifiably store the identities and contributions of scientists and reviewers, enhancing their reputation and credibility. This promotes and sustains global collaboration in science by making research results and scientific outputs accessible to a wider audience.

DeSci Solutions for Open Science Era

Open science is an approach that promotes scientific knowledge and data, research processes, and results to be easily accessible and usable by all interested parties (Foster and Deardorff, 2017). By encouraging the sharing of knowledge, open science increases the speed and impact of scientific discoveries (Fecher and Friesike 2014). Transparency and accountability of scientific processes are at the center of scientific publications in open science. In this paradigm, scientific knowledge is not limited to academic circles but reaches a wide audience, enabling society to participate in and benefit from scientific developments. Open science fosters global and interdisciplinary collaborations, which are especially critical for addressing global challenges (Firat, 2020).

The open science and DeSci movements complement each other in shaping the future of scientific research (Tenorio-Fornés et al. 2021). Open science promotes transparency and accessibility of research processes by promoting knowledge sharing and collaboration. DeSci innovates in areas such as funding and management of scientific research through blockchain and other decentralized technologies (Weidener 2024). Open science and DeSci can transform the management and sharing of scientific research, contributing to a more democratic and effective advancement of science. At this point, we can consider DeSci's solutions in the context of problems faced by traditional science publishing. Table 1 below presents DeSci's solutions to these problems along with project examples.

Table 1. DeSci's solutions and projects to modern science problems

Problems	DeSci Solution	Aim	Projects
Oligopoly in scientific publishing	Decentralized and open publishing platforms	Providing platforms for scientists to share their work, get free peer review and win prizes.	ResearchHub, Ocean Protocol, GenomesDAO
Gated publishing			
Author-reviewer-editor triangulation problems	Decentralized identity and reputation systems	Create transparent reputation systems by tracking users' interactions, publications and comments.	Ants Review, ResearchHub
Predatory journals	Decentralized platforms for publishing and peer review	To increase the reliability of scientific publications through quality control mechanisms and open peer review processes.	LabDAO, ResearchHub
Funding and resource allocation problems	Community-based decision making through daos	Enabling direct contributions to research and community-based decision-making processes in resource allocation.	Gitcoin, SCINET Molecule, VitaDAO, AthenaDAO, ValleyDAO
Peer review bias	Transparent peer review mechanisms	Reduce bias by making the peer review process transparent and controlled by a wider range of the scientific community.	CerebrumDAO, Ants Review, LabDAO
Publish or perish	Reward systems for quality over quantity	Reduce publication pressure by promoting quality content, thus alleviating stress on researchers.	AthenaDAO, ResearchHub

Centralized Funding	Decentralized Funding Platforms	Enable a wider and more diverse range of funding opportunities by providing direct financial support to researchers and projects.	Bitcoin, Bio.xyz, BeakerDAO, Molecule
Poor Publication Quality	Quality Control via Decentralized Tools	Providing a variety of tools and methods to improve research quality.	LabDAO, Molecule, ResearchHub
Low-Accessibility and Transparency	IPFS for Data Storage	Provide a decentralized storage solution by ensuring that data is stored in a secure, accessible and transparent way.	Filecoin, Ocean Protocol, GenomesDAO
Low-Reproducibility	Data Marketplaces	Facilitating data sharing to increase the reproducibility of research and pave the way for new discoveries.	Fleming Protocol, Sci2sci, GenomesDAO

The table presents DeSci solutions and example projects that rely on important blockchain technologies. Ethereum blockchain provides a robust infrastructure for many DeSci projects. Storage protocols, such as Arweave, offer significant advantages over traditional centralized systems in terms of security, reliability, and censorship resistance. DBDAO, as an intermediary layer, converts databases into DAOs, turning each row of data into an NFT. Contributors can share in the database revenues through DBDAO. DBDAO and the Fleming Protocol help researchers overcome limitations in data sources by providing better access to data. The use of Zero-Knowledge technology allows for the recognition of the database's value while ensuring data protection. Zero-Knowledge Proofs promote transparency and collaboration while safeguarding the confidentiality of research data. IP-NFTs serve as proof of ownership of intellectual property in science, increasing accountability and reducing fraud. The concept that NFTs can aid in funding science by treating significant scientific discoveries as valuable art, akin to how historical manuscripts and artworks are highly prized, has begun to gain traction.

DeSci offers comprehensive solutions, even at this early stage, that provide innovative and effective approaches to structural and functional problems within the scientific community. The goal is to make the scientific community more open, collaborative, and accessible. As an example, Ants Review is a privacy-oriented protocol of smart contracts that allows authors to issue a bounty for open anonymous peer reviews (Trovò and Massari 2021).

Conclusion

DeSci provides a robust framework with technologies that have the potential to revolutionize the world of science and technology. However, the adoption of this new approach presents several challenges, including regulatory, data security, and quality issues. The scientific community is continuously engaged in research and development to gain a better understanding of these technologies and their potential. If research institutions and governing bodies can benefit from the early momentum generated by the DeSci movement, they can transparently and coordinately put in place a future-proof research funding chain that values the general welfare across an already financially challenged academy (Sicard 2022). However, a literature review reveals that current publications on DeSci primarily focus on its basic level and the necessity for its implementation. Despite this, DeSci projects and practices are rapidly evolving. Therefore, it is recommended that further research be conducted to examine the effects of these projects and practices. Additionally, there is a growing need for research on the challenges encountered during DeSci adaptation.

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