CENTER FOR GLOBAL DEVELOPMENT

inasp

Research Publishing Is an Under-Recognised Global Challenge

Opportunities for the G20 to Act

TOM DRAKE, SOPHIE GULLIVER, JON HARLE

Abstract

Global systems for research dissemination, dominated by a few major publishers, continue to restrict access to significant amounts of new research, and many cannot afford to pay often high publishing charges. Decades of initiatives to improve access to research have yielded only modest successes. In 2023, the research landscape is shifting. Emerging economies are producing ever more of the world's research, and some are pioneering alternative models for research publishing. Without significant reform, research publishing—and wider research systems—risk fracturing into regional silos, thereby entrenching inequities and undermining our collective ability to face global challenges. Ahead of the 2023 G20 Summit in India, this paper argues that the G20 is well placed to provide the leadership needed to ensure that research is a global public good by elevating the discourse on research publishing reform and acknowledging that this is not merely a niche concern for researchers but an important global challenge that underpins human progress. It also argues that by advocating for effective policy change vehicles, championing equitable funding mechanisms, and driving policy harmonisation, the G20 can help to dismantle the barriers to research access created by the current publishing system.

POLICY PAPER 306 • SEPTEMBER 2023

Research Publishing Is an Under-Recognised Global Challenge: Opportunities for the G20 to Act

Tom Drake
Center for Global Development

Sophie Gulliver
Independent consultant

Jon Harle
INASP

The authors are grateful to Elizabeth Marincola, Rob Johnson, Javier Guzman, and Masood Ahmed for comments on a draft of the paper.

The work was funded by the UK Foreign Commonwealth and Development Office (FCDO). The analysis and associated interpretation do not necessarily represent the views of FCDO or the UK government.

Tom Drake, Sophie Gulliver, Jon Harle. 2023. "Research Publishing Is an Under-Recognised Global Challenge: Opportunities for the G20 to Act." CGD Policy Paper 306. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/research-publishing-under-recognised-global-challenge-opportunities-g20-act

CENTER FOR GLOBAL DEVELOPMENT

2055 L Street, NW Fifth Floor
Washington, DC 20036
202.416.4000

1 Abbey Gardens
Great College Street
London
SW1P 3SE

www.cgdev.org

Contents

Executive summary

This paper presents an analysis of the research publishing sector, the current state of initiatives towards research publishing reform, and opportunities for the G20.

Global systems for research publishing are in bad shape. In 2022, the five biggest publishers had a combined revenue of US$7.7 billion, with profit margins of up to 38 percent. They made only 31 percent of their articles Open Access (without paywall) and only 25 percent of their journals were fully Open Access. The median publication charge was $2,860 but could be as high as $11,690. This means taxpayer-funded public research is too often locked behind paywalls, and researchers without the funds to publish are too often prevented from doing so. These issues manifest as a systemic global challenge comprising five elements:

1. Research does not yield the benefits to understanding the natural world and our changing ecosystems, managing our societies and economies, or facilitating technological innovation that it would if freely and openly accessible.
2. The generation of research itself is impaired through inaccessibility of previous research.
3. Unnecessarily high costs of publishing research, paid by research funders, have an opportunity cost in other research foregone.
4. Participation in global research systems is inequitable.
5. A closed research publication system separates the research sector from the general public, undermining public trust in research and creating space for misinformation.

Efforts to reform research publishing have yielded some successes—principally modest increases in the proportion of new research available without a paywall—but barriers to participation persist and costs remain high. European-led initiatives have failed to pay sufficient attention to alternative publishing models from emerging economies. cOAlition S, the leading vehicle for reforming the sector, have accelerated a transition towards pay-to-publish solutions that improve access to read but reduce ability to participate for those without deep pockets.

The research landscape is shifting and has been for some time. Emerging economies are producing an ever-greater share of the world's research output (China now produces more research articles per year than any other country) and many have pioneered alternative research publishing models. Without significant reform, research publishing—and wider research systems—risk fracturing into regional silos, thereby entrenching inequities. Research is a global public good and effective, international research collaboration is necessary to meet the global challenges of our time.

High-level leadership is needed and the G20 is well placed to provide it. G20 countries represent the full spectrum of research investment, encompassing leading research producers, countries with small but growing research sectors, countries pioneering new models for research publishing, and includes the countries of the big five publishers. The G20 can elevate the discourse on research publishing reform and offer a vision for radical change. Leaders could recognise that the issue is not

merely a niche concern for researchers but an important global challenge that underpins human progress. It could acknowledge that switching the locks from pay-to-read to pay-to-publish is not a viable solution for much of the world, and it could agree that, in the 21st century, digital technology means that curation of the most important research can be separated from its publication. In addition, there are three more specific issues that could be taken up by the G20: i) consider endorsing cOAlition S, ii) champion equitable funding mechanisms, and iii) pursue policy harmonisation.

India, which currently holds the G20 presidency has already put research publishing on the agenda of several G20 engagement groups. G20 leaders can seize the moment and harness the influence of the G20 to light a path towards effective, efficient, and equitable research publishing.

The landscape of research publishing

In 2020 an estimated US$1 trillion of public funding was spent on research worldwide (1). This research is wide-ranging, but all resulting knowledge products have the potential to be public goods; anyone could, potentially, draw benefit without this benefit being diminished for someone else. However, markets are typically poor at the provision of public goods and the research publishing market is no exception. Once research is complete and published in peer reviewed journals it often ceases to be a public good. Instead, it becomes a private good to be monetised, trapped behind paywalls, excluding many, and significantly hindering the global dissemination and advancement of knowledge. Indeed, in 2018 it was estimated that nearly 70 percent of current and historical publicly-funded research was locked behind publisher paywalls[1] (2).

Research publishing is a booming business. The International Association of Scientific, Technical, and Medical Publishers (STM) (3), estimates that the global research publishing industry was worth around $26.5 billion in 2020 with revenues from journals approximately US$10.8 billion. Over 50 percent of that revenue is distributed between five major publishing companies all headquartered in the US, UK, and Europe—Elsevier, Springer Nature, Wiley Blackwell, Taylor and Francis, and Sage Publications. According to their annual filings, in 2022 the big five publishers had a combined revenue of US$7.7 billion, with operating profit margins from 19 percent (Sage Publications) up to 38 percent (Elsevier)— making Elsevier more profitable than Apple (4). In 2020 the big five publishers controlled more than 50 percent of journals on Web of Science (5), including many of the most prestigious and high-impact journal tiles like The Lancet and Nature. They are also steadily acquiring smaller players in the market who had threatened to disrupt their dominance (see table 1). These publishers also own the means to discover and access content through researcher-serving platforms like Scopus and Mendeley (Elsevier), or publishing platforms like F1000 (Taylor & Francis) and Atypon (Wiley), giving them increasing control of the market.

Part of the reason research publishing is so lucrative is that, in addition to conducting and writing up the research, researchers provide free peer-review and editing services to journals—meaning publishers do not pay for labour that is essential to the process. Once their research is published, and despite the sizeable inputs researchers have provided, researchers or their institutions must then pay an annual journal subscription fee of up to seven figures to the publishers and often pay thousands of dollars in publishing fees to remove the paywall and make their article Open Access (freely accessible online without a paywall). Formal analysis of the research publishing market has been undertaken using the "Five Forces" of: Competitive Rivalry, Threat of New Entrants, Threat of Substitute Products or Services, Bargaining Power of Suppliers, and Bargaining Power of Buyers (6). Significant barriers were identified under all of the five domains. For example, the disconnect between who chooses the journal (the researcher) and who pays the publishing fee (typically the funder) breaks the classical economic link between price and demand.

1 In some cases non-publisher copies may be obtainable through workarounds.

TABLE 1: Characteristics of the big five research publishers in 2022

	Journals	Revenue (US$)	Profit Margin	APC (US$) Median (Maximum)	Miscellany
Elsevier Owned by Relx, with HQ in UK. Owns Scopus and Science Direct.	2,970	3.7bn (up 9% on previous year)	38%	2,990 (10,100)	40 leading scientists resign editorial board of top science journal in protest of Elsevier's "greed" (9).
Springer Nature HQ in London and Berlin. Owns Nature and Biomed Central.	3,069	2bn (up 6%)	27%	2,840 (11,690)	Recent years have seen outcry over the unprecedented high article processing charges levied for top tier journals, including Nature (10).
Wiley HQ in USA.	1,917	1.1bn (up 9%)	26%	2,270 (5,740)	In 2021 Wiley, a major low-cost Open Access publishing platform based in London, UK, for $298m (11).
Taylor and Francis Owned by Informa. HQ in UK.	2,700	0.8bn (up 3%)	35%	2,860 (6,540)	In 2020 Taylor and Francis bought F1000, also a low-cost publishing platform that many expected to become an alternative to the traditional publishers (12).
Sage HQ in UK and USA.	1,165	0.2bn (up 8%)	19%	3,250 (5,000)	In 2021, control of SAGE moved to a trust (13).

*APC = Article Processing Charge or an Open Access publication fee. Revenues are total revenues and may include revenue streams from databases, tools, and electronic references. Number of journals and APC charges were sourced from journal and pricing lists on the publisher's website or the publisher's 2022 annual report. Revenue and profit margins were taken and calculated from 2022 annual reports.

Outside of the big five publishers, the European and North American publishing industry comprises a large number of smaller publishing actors including other for-profit publishers like De Gruyter, university presses, and academic and scientific societies which publish their own journals. The historic importance of Europe and North America means researchers from other parts of the world commonly publish with platforms based in these regions, however there are also flourishing alternatives. Not-for-profit publishing platforms like the Brazil-based, SciELO (Scientific Electronic Library Online), or Mexico-based Redalyc hold a significant place in the landscape, especially in Latin America. China has a growing domestic publishing industry, with 36 percent of almost 5,000 officially listed journals publishing Open Access (7). For over two decades African Journals Online has provided a platform for individual African journals to publish, often owned by research

institutions and academic societies, while Open Research Africa has emerged to offer rapid pre-review publication and AfricArXiv as a discovery mechanism for African content published across a range of open platforms (see following sections and appendix for further detail on initiatives from emerging economies). Globally nearly 6,000 Open Access public repositories maintained by research institutions and communities, provide spaces where researchers can also deposit or publish their work—often to ensure that their work isn't blocked by paywalls (8). Yet the proliferation of alternative publishing platforms has not been able to challenge the dominance of the big five and the global research system is fragmented, ineffective, inequitable and inefficient. This should be a concern beyond the scientific community.

Research publishing is a fundamental global challenge

Research is vital to all aspects of human and planetary life. From understanding the natural world and our changing ecosystems, to managing our societies and economies, and facilitating technological innovation. Yet the current system for publishing and communicating the results of research is failing in five ways.

Firstly, it means that what should be **global public goods—the ideas, evidence and data resulting from publicly-funded research—are ineffectively distributed**. This significantly reduces the ability of policy makers, public officials, entrepreneurs, professionals, businesses, and indeed citizens and communities of all countries, to make use of knowledge and evidence to make better decisions or devise new solutions to critical problems. In short, the benefits of research are much lower than they should be, and subtly, but fundamentally, this global lack of access undermines the flourishing of societies and economies across the globe. It is particularly acute for lower-income and emerging economies, whose access to research is more limited than in wealthier countries, and whose researchers and research users must rely on temporary and charitable solutions (14).

Secondly, **the ability to generate high-quality *new* research is fundamentally constrained**. Restricted access to existing data and research findings hampers the production of new research. When researchers can't access the latest evidence or historical studies they are unable to build on these in their own work. The result is methodologically weaker, repetitive, or even unnecessary studies. And although more research is now published Open Access this has largely been achieved by a "switch in the locks" from reader to author. This excludes many researchers—those who can't afford to publish in the top fully-open journals in their fields—from participation in global scientific discourse. It exacerbates existing inequalities in science, making diverse thinking and new ideas less visible. Research behind paywalls, or research that is openly published but with more restrictive licenses, is also likely to obstruct the application of machine reading and artificial intelligence that could synthesise knowledge and data across disciplines, an issue that will become increasingly important in the coming years.

Thirdly, the **current system is not only ineffective but inefficient**. It is expensive for funders, who must pay not only for the costs of undertaking research, but also for the costs of publishing or accessing the peer-reviewed results. While the costs of research publication are a core part of the research process, and should be included in research budgets, the fact that this system is largely controlled by a small group of commercial publishers who are able to generate very substantial profit margins (see table 1) indicates that public funders are securing poor value for this part of their investment. Experienced and professional publishing firms can offer sophisticated digital platforms to manage and disseminate research findings, but digital advances mean that technically sophisticated services can be run at much lower costs and at much better value to those who pay, with the potential for a more diverse system.

Fourthly, the current system **fundamentally prevents equitable global research participation** and exacerbates inequities between and within national research systems. The most prestigious and wealthiest institutions and their staff have access to global science, and can contribute to it through publication, while others don't. This continues to entrench advantage, prestige, and wealth. A lack of equity is both an ethical and a practical issue. By denying opportunity to researchers and research users based on where they are and what they can pay, we are starving the world as a whole from the talent of individuals who could help shape planetary progress and improve human wellbeing and prosperity. This is especially critical when global challenges require localised solutions that respond to specific contexts and needs, and when intractable problems need ideas from new perspectives and new combinations of scientific and social knowledge.

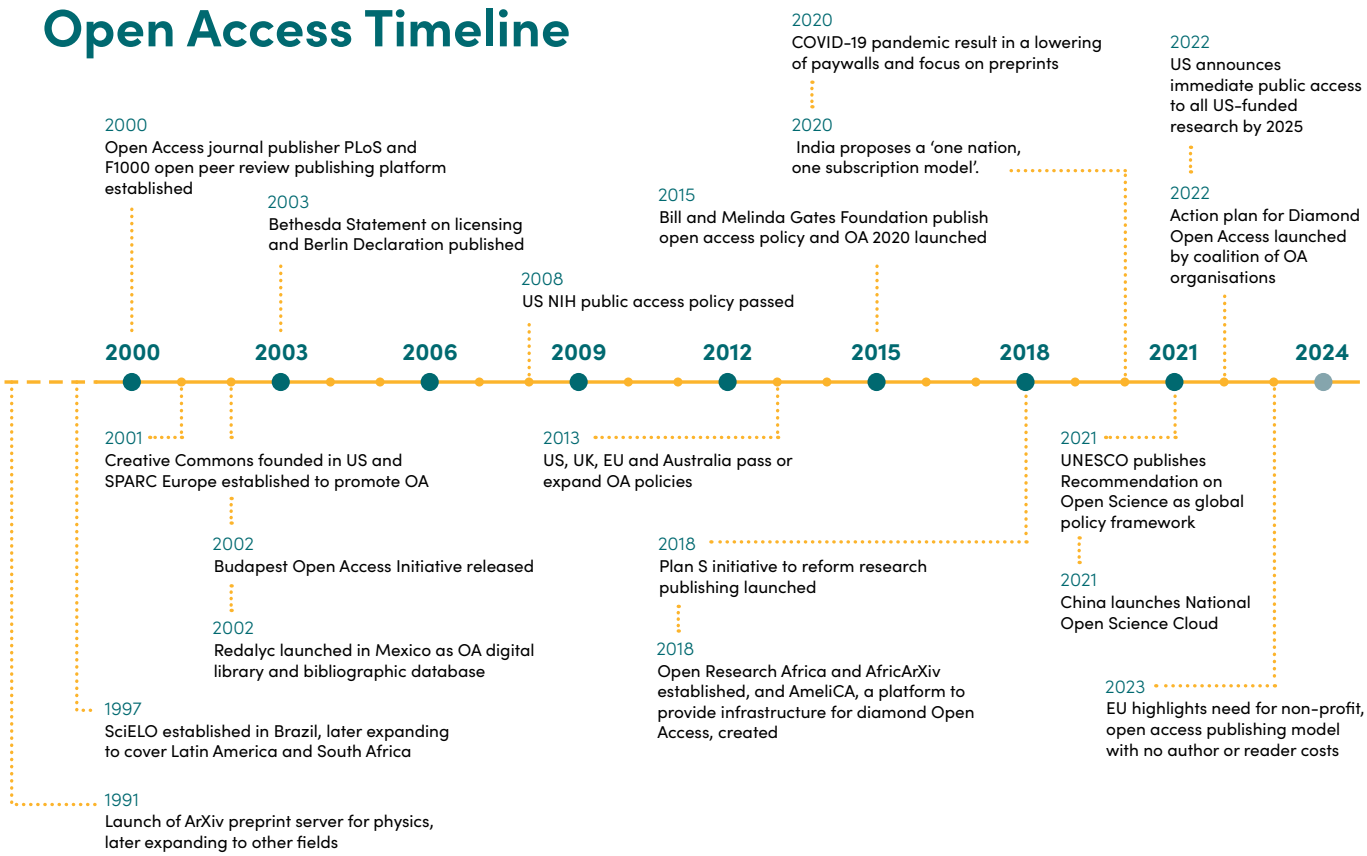
Lastly, **there is a wider case, which turns on the critical issue of public trust in science and experts**. That trust has already proved fragile in recent years and as scientific evidence becomes more critical and more visible in navigating global policy issues—from pandemics to climate crises—that trust becomes ever more important. If science remains a closed enterprise, with its knowledge and ideas restricted to a small minority, it loses a vital opportunity to build public support for greater investments in research and scientific enterprise, and perhaps more importantly, societal trust in the policies and decisions that are taken as a result. The rapid growth in the use of artificial intelligence—both generally and specifically in research and publishing—makes the issue of societal trust in scientific knowledge all the more important (15).

The COVID-19 pandemic brought the importance of science—and public trust in science—into sharp relief. It also proved what is possible in acute crises—that we can rapidly organise to remove paywalls and barriers and make critical science rapidly available to all with a minimum of digital access. If such a response is important in moments of acute need, it is equally vital when we face multiple, unfolding and intersecting crises of weak healthcare systems, global hunger and malnutrition, the global learning gap, and growing inequality. With a rapidly warming climate we have entered a period of persistent, intersecting crises, demanding new and complex scientific and policy responses. Failures in research communication will undermine human progress and resilience.

Open Access and the changing business models of research publishing

Open Access refers to the free, unrestricted access, reuse, and distribution of research articles and publications on the internet. By allowing anyone to read, download, and distribute research without cost barriers, Open Access aims to democratise knowledge dissemination. This approach challenges traditional publishing models and holds the potential to accelerate scientific advancement and foster greater global collaboration. Open Access is sometimes framed in terms of a wider movement towards Open Science, which includes data, code, physical samples, software, and so on. However, Open Access to research findings is a separable issue worthy of focused attention.

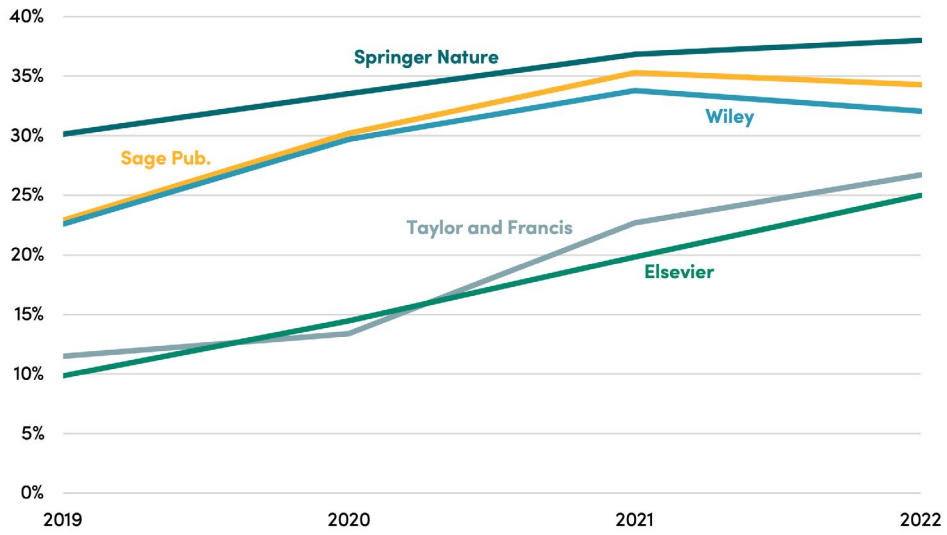
FIGURE 1: Timeline of key Open Access moments



Efforts to reform research publishing extend back two decades. The launch of the physics pre-print server arxiv in the early 1990s is often cited as the origin point, but the possibilities created by digital publishing had started to suggest alternatives. The Berlin, Bethesda and Budapest conferences and resulting manifestos in 2002 and 2003 were major milestones in the Open Access movement. In the intervening years there have been efforts to create national policy positions, with many public and philanthropic funding agencies introducing Open Access publication mandates and initiatives to develop new infrastructure emerging amongst the research community. The business models and publishing routes offered by the commercial publishing sector began to change in response. The result has been a steady growth in Open Access publication (2). Non-profit Open Access publishers like the Public Library of Science (PLOS) and commercial Open Access publishers like BioMed Central, MDPI, Hindawi, and Frontiers have emerged to disrupt the established publishing order. In parallel, pre-review platforms like F1000 or pre-print servers like medRvix have driven further change to the mode and process of publishing. Nevertheless, BioMed Central, Hindawi, and F1000 have all been acquired by one of the big five, bringing innovative platforms into the commercial mainstream.

As Open Access principles have gained traction, especially with the rise of cOAlition S (discussed in detail below), the big five publishing companies have adapted. Open Access mandates put pressure on subscription-based publication models which could adversely affect their financial position. As such, these companies are slowly transitioning towards more Open Access offerings on their terms to keep up with changing requirements as well as shifting public sentiment, while also developing alternate revenue streams, especially transformative agreements (see below).

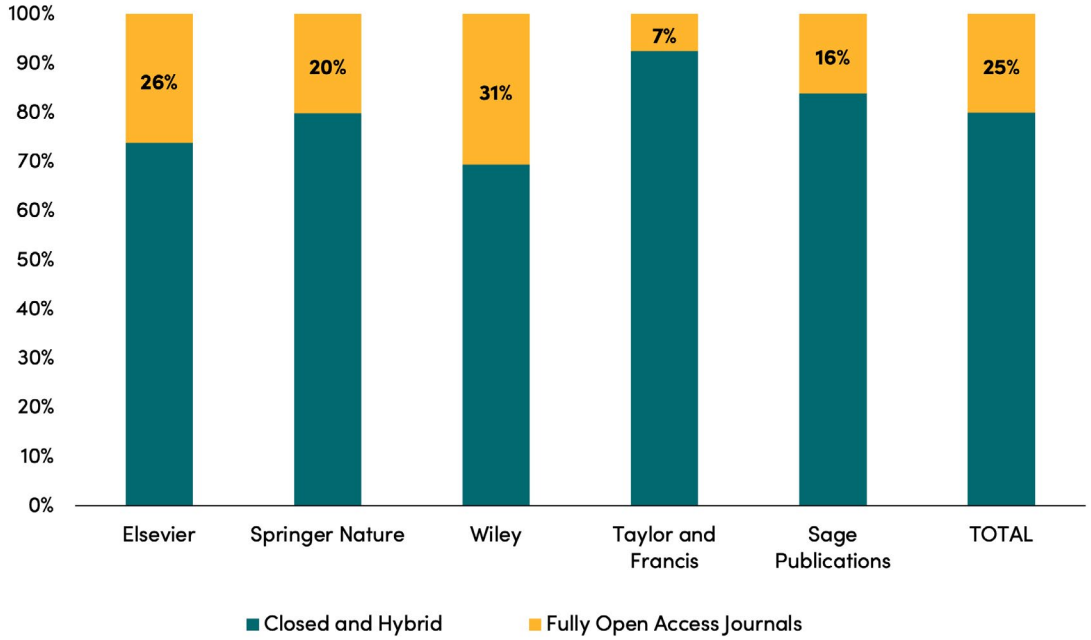
FIGURE 2: Trends in the proportion of articles from the big five publishers published Open Access, 2019–2022



* Refers to articles available Open Access from the publisher. Some publishers allow pre-prints or author manuscripts to be made available elsewhere, under the so-called "green" Open Access route

Sources: Publisher reports, Wordsrated, ESAC registry

FIGURE 3: Proportion of fully Open Access journals for the big five publishers, 2022



Sources: Publisher journal lists, publisher annual reports, publisher websites.

The proportion of articles published Open Access has been rising slowly but consistently over the past decade and accelerated during the COVID-19 pandemic. In 2019, Delta Think (16) estimated that around 30 percent of all articles were published as paid-for Open Access and by 2021 this had risen to around 45 percent (17). Data from the big five publishers from 2019 to 2022 illustrates a similar consistent, but slow trend, with the average proportion of Open Access articles each year rising from 19 percent up to 31 percent but with differences in the pace amongst publishers (figure 2). However, while this trend is promising, as of 2022, only a quarter of journals managed by big five publishers were classified as fully Open Access (figure 3) (compared to an estimated 47 percent of all journals) (18). This means that many articles are being published in hybrid journals where only select content is Open Access and where there is a risk of double dipping; charging both Open Access publishing fees and institutional subscriptions.

Publishing business models have undergone significant transformation since the explosion of the digital era in the late 1990s and early 2000s and the rise of the Open Access movement. Models have shifted from a mainly subscription-based pay-to-read model, towards a pay-to-publish model and more recently towards hybridised, transformative agreements incorporating both read and publication costs which, according to the ESAC registry (19), have risen from only two signed agreements in 2014 to 214 recorded in 2022. The main models of for research publishing are:

- **Pay to read.** Initially, most publishers made money by charging institutions and individuals to read their articles and journals. This practice persists today. For example, single access fees for one article outside of a subscription plan can vary by journal but are typically around US$30-50. Annual institutional subscriptions for journals vary hugely depending on the prestige of the journal, ranging from $28 to an astounding $86,085 with a median subscription cost of $1,445 amongst the big five publishers according to their subscription list pricing. Ironically, even research funders often pay journal subscription fees, collectively paying to access the results of the research they funded in the first place. As prices can rise year-on-year by percentages over and above inflation, this can quickly lock out resource-constrained institutions, especially those in emerging economies from accessing research. While it is theoretically possible to subscribe to journals this way, the common practice is to bundle journals together in larger subscriptions at the institutional or national consortium level, making the pricing system more opaque.

- **Pay to publish (the gold route).** Unaffordable subscription costs and a focus on Open Access principles led to changes in financial models in the early to mid-2000s. As a result, pay-to-publish models emerged (the so-called 'gold route' for Open Access publishing, see box 1). Article processing charges range from US$200–$11,100 with a median charge across the big five publishers of US$2,860. This is a high price, especially considering estimates of the true direct cost of publishing for the average article come in around US$400 (20). These charges keep publication out of reach for many researchers, especially those in lower-resourced institutions or without funders willing to pay up. This especially impacts low- and middle-income (LMIC) researchers and research institutions who struggle to afford the costs of publishing in gold or hybrid journals yet need to do so to reach peers internationally, have their work valued through its association with higher prestige titles, and ultimately to progress their careers (21). While some publishers offer waivers of 50–100 percent to researchers in poorer countries on the Research4Life priority lists, these waivers are often not sufficient to make publication affordable or are onerous to apply for, which continues to deter publication (22). This type of concession is also not a sustainable, long-term solution as it props up publishing platforms from high-income countries while reducing the incentives and ability to invest in local, Open Access research infrastructure.

- **Transformative agreements (read and publish).** Since 2014 a hybridised model has been gaining ground that encompasses both read and publish fees, acknowledging the difficulty of navigating subscription and publication costs simultaneously and at a time of transition. Under transformative agreements an institution, or a consortium of institutions, can negotiate with journal publishers to secure multi-year contracts that include both publishing charges and subscription costs, allowing researchers to publish and read Open Access. At present, data on transformative agreements is murky with of 836 on the ESAC registry (19) but up to 2,146 according to annual publisher reports. The details of these

agreements are tightly guarded, but the first between Dutch Institutions and Taylor and Francis reveals costs of more than US$9 million over three years for Open Access to all Taylor and Francis content and publication of up to 1,451 Open Access articles over this period (23). While transformative agreements may help to increase Open Access, they still maintain the costly status quo of research publishing.

- **No charge read or publish (the diamond route).** The diamond publishing model that emerged in the mid-2000s sought to avoid author fees or subscription payments, instead relying on an institution or other entity to fund the publication and maintenance of a journal or platform to ensure Open Access. There are an estimated 17,000–29,000 diamond Open Access journals worldwide and they are most prevalent in Europe (45 percent) and Latin America (25 percent) (24). While only 9 percent of articles published are in diamond journals, this represents 45 percent of all Open Access publications, illustrating their importance for open science (24). While diamond journals and platforms are favourable for both readers and authors, they require technical capacity and management (especially journals that are volunteer-run), visibility in a crowded and profit-driven journal market, and financial sustainability. The Diamond Open Access Action Plan (25), released by a consortium of European partners in 2022, aims to support and increase diamond Open Access by outlining priority actions to improve the efficiency, quality standards, technical capacity, and sustainability of diamond platforms and publications.

- **Publish and deposit (the green route).** Aside from paying to read or publish in journals, researchers can also follow the so-called 'green route' for Open Access by depositing their full text article in a subject or institutional repository, from which it is freely accessible by any user, though in some cases only following an embargo period imposed by the publisher of the final article. OpenDoar estimates there are close to 6,000 repositories around the world at national and institutional levels, although they often have limited interoperability (8).

The water we swim in, that shapes and often prevents the evolution of research publishing is the prestige economy of journal titles. A first author paper in *Nature* or *Science* can make a career, and the volume of publications in peer-reviewed journals is similarly impactful. This is an anachronism that stems from print publication, where constraints on how much could be published yielded a natural link between the curation and publication of research. In the 21st century, digital technology means that publication of research is possible at scale. This is a good thing. We need "unglamorous" research, often null or negative findings, to be just as available and accessible as the single, apparently paradigm-shifting study. However, the current system is straining under the tension between the increasing volume of published research (and financial incentives for publishers) and the prestige economy of peer-reviewed journal publication. The need to separate the assessment of research from publication of research is key to solving this issue—a point which has been most prominently recognised in the San Francisco Declaration on Open Research Assessment (DORA) (26).

Pre-print servers allow immediate publication of pre-peer review manuscripts at scale, but the final manuscript is then published elsewhere. This is unnecessarily confusing and technically inferior to platforms which support rapid publication and on-platform open peer-review. Alternatives are also emerging to curate the most interesting research in a given field including start-up efforts to evaluate research published elsewhere (27). Journals could consider evolving their business model to retain the value derived from assessment and curation but separate this from publication.

Leading initiatives towards research publishing reform in 2023

Frustration and exclusion have bred new solutions at national and regional levels and mobilised a broad movement for change, with many initiatives to promote Open Access and encourage policy change over the last two decades. The International Science Council's 2021 review of publishing (18) and UNESCO's 2021 Recommendation on Open Science (28) — with global standards endorsed by 193 countries — are notable. At a national level, the US Office for Science and Technology Policy has introduced a new public access mandate for federally-funded research (29) (but without requiring open licensing), while China has sought to strengthen standards in its own system (see appendix) (7). However there have been relatively few regional or global scale initiatives to engage directly with critical reforms needed in the publishing sector. Notable exceptions include OA2020 (30), which proposed re-allocating and thus leveraging subscription budgets to put pressure on publisher business models, and cOAlition S (see further below). Perhaps the most promising innovation for alternative publishing models have been those pioneered in various emerging economies, particularly Latin America.

Publishing innovation from emerging economies

Over the last two decades, Latin American researchers and their universities and science bodies have demonstrated the possibility of an alternative, non-profit and publicly- or community-owned infrastructure for research communication. The result is that 95 percent of Latin American journals are diamond Open Access (24). Notable initiatives include Brazil's platform Oasisbr (1,654 journals, 56,000 articles annually), the Redalyc platform (1,585 journals) hosted in Mexico, the LA Referencia network of 12 national repositories, and AmeliCA, a collaboration between several Latin America institutions and UNESCO to develop wider open science infrastructure and services. In Africa and Asia platforms have emerged to enable scientists from their regions to publish. African Journals Online enables 688 journals from across the continent to publish online (70 percent Open Access), Open Research Africa provides a pre-review platform for several funding schemes, and some countries, such as Uganda, have established national repositories (31). The Africa Open Science Platform seeks to build a wider open science infrastructure for the continent with funding from South Africa. Regional collaboration is less evident in Asia, but India's One Nation, One Subscription initiative (32) is notable for its vision of unified, national access to research for all Indians. Similarly,

China intends to establish a new national open research platform (7) to consolidate access across its existing series of journal platforms, pre-print servers, and repositories. Indonesia is notable as a major producer of Open Access articles with a large number of diamond journals and a national law requiring open licenses to enable public access (33). For more on initiatives in India, Brazil, South Africa, and China (see appendix).

cOAlition S

A high-profile attempt to disrupt the publishing system was Plan S (34), launched in 2018 by cOAlition S, which comprised a group of national research funding organisations, alongside the support of the European Commission and the European Research Council. Unprecedented in its success in achieving alignment among 29 major research funders (35), Plan S articulated a single goal—the full and immediate Open Access of all research funded by its member funders, without reader fees or embargoes, by January 2021 (with new funders given a year from joining to meet the target). The goal is underpinned by ten principles spanning copyright retention by authors and Creative Commons licensing, common service criteria for all journals, platforms and repositories, commensurate and transparent fees where charges are applied, and a rejection of publication venue as a measure of the value of research (36).

Plan S has been the most significant of recent efforts to reshape the research publishing market. Yet there have been challenges:

- **Neglecting models from emerging economies.** Unsurprisingly for an initiative set out to be a major disrupter, Plan S has met with strong criticism from some actors. The most significant—given its goal to improve global access to research—has been from some emerging economies who argue that its principles and provisions do little to accommodate their needs and the resources available to them. They argue that Plan S ignores a long history of alternative, non-profit, and publicly-owned and funded publishing models—particularly in Latin America—thereby entrenching existing inequities (37,38).

- **Eurocentric governance and participation.** Despite a wide-ranging advocacy campaign, Plan S has struggled to secure global support. Its only African funder partners are the South African Medical Research Council and the Zambian research commission; the African Academy of Sciences is the only African agency to provide a supporting statement. Asian and Latin American organisations are largely absent (though several leading Chinese institutions pledged support in a 2018 speech (39)). The former chair of the South African academy observed that while South Africa was aligned to the goal, it had its own locally designed solutions (40). The relative under-representation of members from Africa, Asia, and Latin America on its experts and ambassadors group—alongside a notable lack of endorsements—is perhaps an indication of Plan S' failure to gain the global traction it had hoped for.

- **Accelerating a transition to pay to publish.** The reluctance of publishers to accept models that do not include an embargo and provisions which allow subscription journals to transition towards Open Access and remain compliant for a set period, has accelerated moves towards the "gold" Open Access model. This, many argue, has consolidated the commercial publishing model at the expense of the non-profit repository or diamond publishing model, with little sign that publication fees are being reduced under pressure (*Nature's* publication fee is set, for example, at $11,690). This is particularly concerning to research leaders in many emerging and lower-income economies. Not only does it signal a move towards a costly model that many will struggle to afford, but it neglects established efforts to develop alternative infrastructures.

- **Failure of transformative arrangements.** The big five publishers have been transitioning over 1,900 journals towards Open Access, but progress has been slow with the proportion of Open Access research content in transitional journals growing from an average of 10 percent in 2020 to 16 percent by 2022 (41). In 2022, 68 percent of 2,326 "transformative" titles failed to meet their Open Access targets. While performance was good amongst smaller publishers (across a smaller portfolio), there was a 79 percent failure amongst Springer-Nature's 1,329 titles, and a 63 percent failure amongst Elsevier's 115 (41). The fact that progress has been slow and that some journals chose not to adopt Open Access, despite reaching the agreed 75 percent tipping point at which publishers had agreed to transition to Open Access, has led cOAlition S to conclude that some large publishers are not serious about doing so (41). Moreover, transformative agreements continue to uphold a costly status quo and further undermine competition in the publishing market.

Pushing all countries to follow models developed in wealthier economies, not only risks damaging emerging systems but could make the global research communication system poorer by killing off successful alternative models. cOAlition S has engaged publicly with these criticisms and has more recently investigated alternative models (39,42). In partnership with Jisc, the UK's agency for digital and IT services in higher education and the Public Library of Science (PLOS), it has launched a working group to explore a more equitable system that avoids author publishing fees, considers how existing funder Open Access budgets could be redirected, and explores alternative business models as part of a larger transition to open science (43). It is also consulting on a proposal to develop a new community-based infrastructure for Open Access and has begun to engage more systematically with the diamond Open Access movement (44), commissioning a recent report with a set of detailed recommendations covering collective funding and capacity strategies to advance diamond infrastructure (24,45), and supporting a summit in Mexico in October 2023 (46).

The role of the G20 in achieving research publishing reform

The G20 nations are responsible for approximately 90 percent of global research spending, researcher population, publication output, and patent registration (47). The current structure of the research system was largely established, and continues to be dominated, by the US and Europe. However, the status quo is shifting as emerging economies are reinvesting the fruits of economic development in research. China now has the largest volume of research publications and India publishes more than any other G20 country except for the US and China (figure 4).[2] Research outputs in Brazil and Indonesia are also growing at a faster rate than many European countries.

Will the new research producers continue to choose to publish with (relatively expensive) Europe- and US-based journals when many emerging economies are innovating and developing alternative publishing models? What will be the impact on global research? There are perhaps two broad options for how global systems for research publishing could develop in this context.

1. Further fragmentation and siloing. Countries or regions develop and prioritise their own systems but connections and interoperability between these networks are weak. International and trans-disciplinary collaboration is hindered. Public investment is wasted and inequities persist. Progress against global challenges, in particular, is impaired.

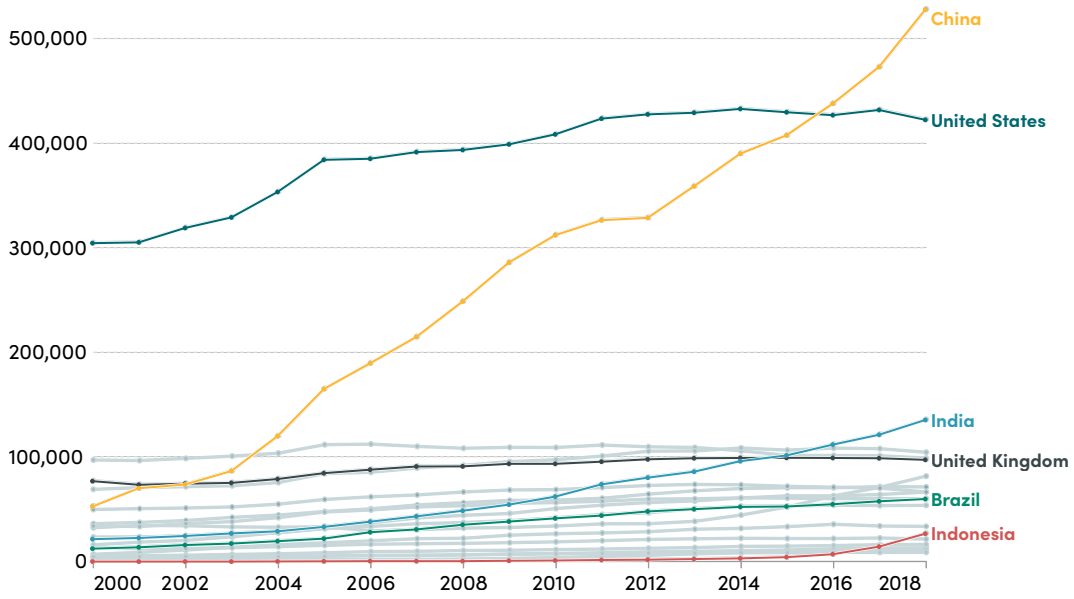
2. Comprehensive research publishing reforms yield a global research culture where the publication of research facilitates maximum value as a freely available global public good. International collaboration is facilitated by an openly available research record, fuelling progress.

Without concerted political leadership, the first scenario is far more likely. There is a window of opportunity now, but without action, the landscape of research publishing will develop through piecemeal initiatives that reflect narrow and short-term interests. There will be some successes, but overall, fragmentation will leave an ecosystem that is ineffective, inefficient, and inequitable.

However, with the combined might of the political leaders of the world and a collective research expenditure that runs to hundreds of billions, the G20 holds the dual leverage of political and economic strength, allowing it to spur change on a scale beyond what cOAlition S and its predecessors could achieve. Crucially, the G20 also has legitimacy to champion change. Unlike, say, the G7, the G20 is not only a gathering of rich countries and, with respect to research, it includes countries along the spectrum of investment, infrastructure, and outputs. Figure 5 not only illustrates

2 Public research systems are largely separable from geopolitical strategy as research that is sensitive for commercial or security reasons are not shared in this way. Published research is intended to be a public good and the systems should reflect that.

FIGURE 4: Annual articles published in scientific and technical journals for selected G20 countries



*Based on original graphic from Our World in Data. Greyed out lines are other G20 countries.

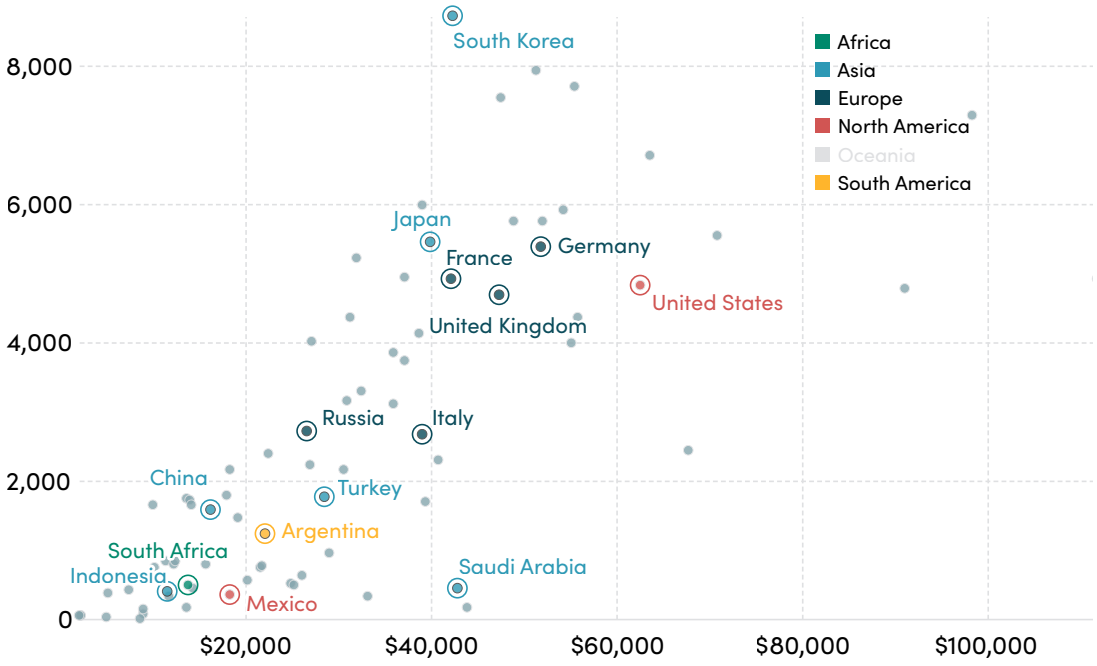
Source: National Science Foundation. Includes physics, biology, chemistry, mathematics, medicine, biomedical research, engineering and technology, and earth and space sciences. Articles counted by country of first author's institution.

the correlation between economic productivity and researchers per million people, but also highlights that G20 countries represent the broad spectrum of current research investment.

Taking the long view, it is unlikely that the current dominant system for disseminating research knowledge could persist in its current form. Its shortcomings are too great and the technical tools to drive rapid and rigorous dissemination are becoming ever better and ever more available. Still, strong leadership can make a huge difference in when and how this reform takes place. The sooner change occurs and the more effective this change is, the more likely we will be to meet the challenges of our time: climate change, AI, biosecurity, and extreme poverty.

Some G20 countries are home to one or more of the big five publishers and may highlight their economic contributions to the domestic economy or financial contributions through tax receipts. Such arguments must be balanced against the greater good of systemic reform, including benefits to national interest. These include greater productivity and trust in domestic research, greater access to worldwide research, and soft power though science and diplomacy. Research publishing reform does not need to be anti-commercial. It can create space for innovation that the private sector is well-placed to serve. To the extent that publishing revenues are moderated, policy makers should remember that much of this revenue is from public funding in the first place.

FIGURE 5: Research and development researchers per million people vs GDP per capita in 2021



* Adapted from Our World in Data. Data unavailable for Australia, Brazil, Canada, India, or the EU
Source: World Bank

Fortunately, the issue of reform to research publishing and the wider issues of open science in general, are already part of G20 discourse. A meeting of research ministers in July this year noted a unanimous *"commitment to open, equitable and secure scientific collaboration, and recognize[d] the important contribution that open science policies make in the development of solutions to address societal and global challenges"* (48). At the Chief Scientific Advisers Roundtable (CSAR) one of four agenda topics was "Synergizing Global Efforts to Expand the Access to Scholarly Scientific Knowledge" (49). Similarly, Open Access is also on the agenda at the ministerial meeting of the G20 Education Working Group and will be of concern to the Science20 (S20), a vertical engagement group on science in the G20 ecosystem (50). Looking beyond the G20, there is a further opportunity for G20 leaders to consolidate political momentum for Open Access at the Science Summit of the United Nations General Assembly (51).

So what can G20 actors do?

Elevate the discourse and articulate a vision for change

Research publishing reform is a multifaceted and complex issue, with many different policy positions, stakeholder opinions, and administrative hurdles. The task of aligning interests is a monumental one, as illustrated by initiatives like cOAlition S. Bringing together research funders is challenging on its own, and the difficulty grows exponentially when attempting to reach a consensus among the world's 20 biggest economies. As shown earlier in this paper, several decades of Open Access initiatives have sought to reform research publishing, yet progress remains sluggish.

It would not be possible, or appropriate, for G20 participants to centrally manage reform of the world's research publishing systems. The greatest opportunity for the G20 is to change the way the issue is *perceived*. Reforming research publishing is too often seen as a niche concern of scholars and academics; tedious, and irrelevant to those interested in action and real-world results. This misperception obscures the reality that research publishing is not a mere academic issue, it is a global, systemic concern that intersects with almost all social and economic progress. Through neglect we have allowed a global system to emerge that actively inhibits the dissemination of new knowledge rather than promoting it. The harms of this system are real and deep. By treating research publishing as a peripheral matter, we risk stifling innovation, collaboration, and the shared pursuit of knowledge that fuels societal advancement.

G20 officials could seek to elevate the discourse on research publishing reform and confer seriousness and credibility to the issue through the status of the high-level political gathering. By recognising and articulating the importance of reforms to research publishing, the G20 would send a strong signal that change matters and should be prioritised. Such signals cascade through economies and public institutions. They can fuel political will to prioritise public investment in necessary infrastructure, spur diplomatic efforts towards cross border initiatives, drive policy in the public interest, encourage innovators and private investors to (continue to) disrupt failing markets, and nudge the established publishers to follow through on promised reforms to their business practices.

While it may be wise to avoid getting drawn into discussion of the finer details, there are two clear principles the G20 could endorse.

1. **Flipping from pay-to-read to pay-to-publish is not a viable solution.** While appealing as a solution to restructuring research publishing that seems to be acceptable to many researchers, publishers, and research funders (in the Global North), as many G20 countries are likely to note, this solution effectively locks many countries out of full participation in the global research system.

2. **Research publication must be separated from assessment of importance and quality.** In the early days of research publishing, the curation of high-quality and interesting research was integral to the value of research pamphlets and later journals. In the 21st century, digital tools mean we no longer face the same constraints on the volume of research that can be published online. There may still be value in the curation of the best and most relevant research for interested audiences and this may remain a valuable commercial service, but it must be separated from publication.

Achieving a significant shift in perception will not be easy. It will take sustained political focus and commitment. If G20 participants are interested in changing perceptions of research publishing, the first thing they could do is develop a clear communications strategy. This strategy should start by articulating the goal, key messages, and key stakeholders. Messaging may well need to be tailored to different stakeholders considering what they stand to gain, or lose, from reforms. Getting buy-in will not always be easy. The strategy would need to lay out a programme of activities through which the goal can be achieved; public events, publications, private meetings, even one-to-one phone calls. It may also be useful to include guidance on communications tactics (in addition to strategy). For example, language that refers to things being "scholarly" or "academic" can put off some readers and it may be preferable to refer to variations on "research". Similarly focusing high-level communication on the nuts and bolts of the failures of research publishing may be counterproductive, depending on the audience. The second section of this paper seeks to frame the issue not in terms of the usual challenges of barriers to reading papers or having to pay high publication fees, but in the systemic effects these barriers produce. To ensure sustained momentum on the issue, countries could consider i) agreeing to nominate a dedicated Open Access government lead (if one does not already exist) and ii) forming a working group to steer the development of the communications strategy.

Priority issues for action

While high-level advocacy for research publishing reform is the comparative advantage of the G20, there are also specific issues that could be taken up.

Consider endorsing cOAlition S

While Plan S is not without its shortcomings, cOAlition S is evolving as an Open Access initiative and is doing a better job of embracing some of the innovation from Latin America and Africa. A vehicle for effective reform is essential and cOAlition S is by some way the most promising initiative there is. The CSAR could open a dialogue with cOAlition S leadership with a view to considering endorsement.

Champion equitable funding mechanisms

The transformation to Open Access is not without financial implications. Though research publishing cannot be fixed by continuing to spend on ever increasing article processing charges, there will be costs to new infrastructure that is likely to be needed to ensure effective reforms. This necessitates innovative and equitable funding mechanisms that ensure all researchers, irrespective of their geographical location or institutional affiliation, can publish their work Open Access. G20 nations, due to their significant research funding capabilities, can lead the way in establishing these mechanisms. The CSAR could consider commissioning analysis to explore the potential for a coordinated multilateral initiative to invest in non-profit digital publishing platforms, conditional on adherence to appropriate interoperability standards to avoid fragmentation and siloing.

Pursue policy harmonisation

Policy harmonisation in the context of Open Access refers to the process of aligning various rules, regulations, and standards that pertain to the dissemination of research. The current landscape of Open Access is marked by a patchwork of different national and institutional policies, leading to confusion and hindering the free flow of knowledge. G20 is a high-level political platform and may not be the right forum for negotiating comprehensive Open Access policies. But if the G20 nations, were to endorse specific Open Access policy positions, it would provide direction for national and multilateral initiatives. This will require a careful balance, recognizing the diverse economic, political, and cultural contexts of different countries. Harmonisation doesn't imply a one-size-fits-all solution, but creating a flexible framework that upholds the principles of Open Access while accommodating unique national circumstances.

From India to Brazil to South Africa: why the passing of the G20 presidency could mean a continued focus on Open Access

That Brazil is next in line for the G20 presidency could be fortunate for science diplomacy and research publishing reform. Brazil is already recognised for its a strong record pioneering alternative models of research publishing. SciELO, a bibliographic database, digital library, and cooperative electronic publishing model of Open Access journal was born in Brazil and Brazil has played a leading role in other pan-Latin American initiatives to disseminate scientific literature Open Access at low cost.

Brazil's G20 presidency will be followed by South Africa, giving South Africa the opportunity to build on its established leadership in the global Open Access movement and success in solidifying a unified, national position. South Africa's own Open Access research publishing service, SciELO SA, built on Brazil's platform and funded by South Africa's departments of Science and Technology and Higher Education and Training and South Africa's National Research Foundation. It leads the African Open Science Platform and is also building a continental infrastructure for open science. Moreover, it is home to the long-established African Journals Online platform.

The transfer of the G20 presidency is an important juncture where political momentum can wane or accelerate. India's G20 presidency has created multiple spaces for diplomatic discourse on the challenge of research publishing reform. At this year's G20 summit, Brazil will have half an eye on the 2024 summit next summer (12–14th July) in Rio de Janeiro. Given their established leadership and innovative solutions for Open Access, Brazil and South Africa would be well placed to lead this important discussion in the coming years as they take up their own presidencies.

Conclusion

The G20, with its international influence and commitment to cooperation, has a significant role to play in promoting access to research. By advocating for effective policy change vehicles, promoting equitable funding mechanisms, and driving policy harmonisation, it can help to dismantle the barriers to research access created by the current publishing system. Perhaps most importantly, the G20 has the ability to change the way that research publishing is perceived. To recognise, and help others to recognise, that the systems we have for sharing new knowledge are inadequate, despite technological developments that should make dissemination far easier. Ensuring low-cost universal access to research is a complex and multifaceted challenge, but one where the G20 is well-positioned to provide leadership. Such efforts are vital for advancing global knowledge, promoting innovation, and ultimately creating a more prosperous, resilient and equitable world.

Appendix

Selected G20 Country Briefings

India

India is the world's fourth largest producer of scientific knowledge (57), behind China, the US, and the UK, and ahead of Germany. It has ambitious plans to drive growth and development through investments in its scientific capacity and research system, aiming to double its research base every five years and become of the world's top three scientific superpowers in the next decade. India's draft Science, Technology, and Innovation Policy (32) sets out 19 policy priorities to strengthen the overall innovative ecosystem, ensure it is more inclusive, better connected to Indian society and the economy, and better able to serve specific sectors including health, agriculture, energy, and climate. The policy promises a "future-looking, all-encompassing Open Science Framework" to enable all Indians to access scientific data and knowledge, and to make the results of publicly-funded knowledge available to all citizens under FAIR principles (58). Full texts of all publicly-funded research are expected to be deposited in a new national repository. A Strategic Technology Board is planned to facilitate the process of connecting across government and a Strategic Technology Development Fund to stimulate private sector and university innovation. In 2022 the Ministry of Education announced the next steps in its One Nation, One Subscription initiative (59) to provide all Indians with access to research, which it now expects to be in place by 2024 (60).

Brazil

In recent years Brazil has articulated its ambitions to advance its research base and drive innovation, with its 2020 National Innovation Policy anticipating that new investments will contribute to increased productivity, competitiveness, prosperity, and wellbeing. A special Innovation Committee, chaired by the office of the president, is to coordinate across nine line-ministries and formulate a national innovation strategy. The costs of access to research led Brazil to invest early in Open Access alternatives and it has become a globally recognised leader in the Open Access movement. Although Brazil lacks a national Open Access mandate, a 2005 manifesto (61) published by its institute for science and technological information made Open Access a national goal , and its investment in infrastructure and services, has led to high levels of Open Access at low-cost to researchers. 1,648 Brazilian Open Access journals are listed by the Directory of Open Access Journals (62) with around 400 journals (and 493,000 articles) published by Brazil's leading Open Access platform, SciELO, established in 1998. A diamond platform, supported by public and institutional funding, SciELO is a leading example of a collective infrastructure developed and maintained for the public good. It has since grown to host collections for another 15 countries in Latin America (and extending to Spain, Portugal and South Africa) with each hosted collection funded by their own national science agencies and has expanded its services to include a book publishing platform, a pre-print server, and

a citation index (later integrated into Web of Science). Oasisbr, operates as a national portal for all Open Access scientific content, including journals, theses, books, and data, and providing access to the collections of Brazilian universities. In 2020, and galvanised by the COVID-19 pandemic, Brazil established a new pre-print server, EmerRI, to speed up access to research which would subsequently be published in Brazilian journals. Nevertheless, the author/funder pays model for has made it much harder for Brazilian researchers, unable to afford article processing charges and ineligible for waivers (63), to publish in Open Access journals outside of Brazil and subscriptions account for a growing proportion of the budget of the federal funding agency, CAPES, which hosts the Portal de Periódicos, providing access to almost 46,000 international and nationally produced journals to Brazilian research institutions.

South Africa

The importance of research to South Africa's economy and development has been recognised through national policy and several government-funded programmes have been established to strengthen its research system capacity and enhance international collaboration, with open science prominent, and with investments in large-scale facilities such as the MeerKAT telescope and the Square Kilometre Array (SKA). Research output and citations have increased steadily over the last two decades, performing well relative to low levels of investment (64). Affordable access to research has been a significant constraint on its research productivity. Unlike its neighbours, it has not qualified for philanthropic schemes offering free or reduced cost access, while subscription prices, and now publishing fees, have outstripped its domestic science budgets, particularly as the Rand has weakened against the Euro and US Dollar. As a result, it has been a long-term Open Access champion, framing it as both a scientific and social justice issue. National and institutional repository platforms have been a major focus, and Open Access publishing has been promoted through national initiatives, and it has been active in the global Open Access community. In collaboration with Brazil, it launched SciELO South Africa in 2009 which currently host 100 Open Access journals (65). South Africa's national Vice Chancellors' body has taken the issue up, endorsing the OA2020 initiative, committing to drive a shift towards Open Access, recognising the need to work closely with other countries to do so, and collaborating with government agencies and scientific bodies to drive change as part of a wider national open science project (66). It has notably ruled out the pursuit of a national license, but believes the transformative agreement model could work (66). South Africa is also active in initiatives to strengthen scientific capacities and open access across the wider continent. South Africa hosts African Journals Online (AJOL), the major continental journal platform, with Open Access titles accounting for around 60 percent of its 688 titles (67). Its National Research Foundation is a co-funder (with the UK, Canada, Germany, Norway, and Sweden) of the Science Granting Councils Initiative, which supports 17 national science agencies (68), and it is the host and primary funder of the African Open Science Platform, which seeks to build a continental infrastructure for open, data intensive research.

China

China has invested heavily in research in recent decades. It is now second only to the US in funding (69), and has become the world's leading publisher of academic articles with a 375 percent increase in Chinese-authored papers over ten years (70). Over a decade, open access papers increased at an annual rate of 25 percent and in 2021 accounted for 37.8 percent of outputs (7). Domestic publishing has also become increasing Open Access, with 36 percent of almost 5,000 officially listed journals publishing Open Access (though the majority are 'Bronze' journals: freely accessible but lacking clear re-use licenses) (7). This growth has been driven in part by a 2015 Open Access mandate for publicly funded research, and more recently a 2021 revision to the law on scientific and technical progress which made the development of open science an explicit requirement (7). This has been accompanied by the development of Open Access infrastructure. Repositories (including a national repository for full-text public access to publicly funded research), Open Access platforms (Sciencepaper: 850 journals and 1.3 million documents; the National Open Platform for STM Journals: 1325 journals with 8.92 million articles; the National Social Science Database: 2,000 journals with 11.4 million articles) and pre-print servers (ChinaXiv and biomedRxiv) provide access to both internationally and domestically published articles. China also has its own platforms for accessing global research outputs (Socolar and GoOA with 33,500 journals). Reflecting the complexity of access and publishing routes, a new "National Unified Sharing and Open Platform for Sci-tech Literature and Information" is being established. In 2019 a consortium of national agencies launched an "Excellence Action Plan" to strengthen the Open Access ecosystem and improve the quality of selected journals and platforms. Around a third are Bronze, mainly Chinese-language journals (7). 351 of the journals included are published by or with international publishers—with Springer (133), Elsevier (59), KeAi (a joint venture between China Science Publishing and Elsevier with 53 titles), and Wiley (16) the most significant (7). In addition to co-publishing with international firms CSP acquired the French publishing firm EDP Sciences and as a result, strengthening its ability to offer high quality services at lower cost to the domestic market.

UK

The United Kingdom occupies a unique position in research publishing. From the 17th century publication of "Philosophical Transactions" by the Royal Society, to today's advanced, digital-first models, the UK has contributed significantly to the growth and evolution of the global publishing sector. Several of the big five publishers have their origins in the UK. Substantial parts of what are now Elsevier, Springer-Nature, Taylor & Francis and Wiley-Blackwell were established in the UK in the late 19th and early 20th centuries, becoming leading international businesses, and the academic presses of Oxford and Cambridge are the oldest and largest university presses in the world. Since the early 2000s, UK public researcher funders have played a significant role in the evolution of Open Access, establishing mandates and policies for open access, and investing in national repository and related Open Access infrastructure. In 2022, UK Research and Innovation (UKRI) (52) and the National Institute for Health and Care Research (NIHR) (53) introduced new Open Access policies for

research articles, as part of the UK Government's commitment to open access for publicly funded research. The UK's national academic digital service, Jisc (54), has negotiated with many publishers to enable UK researchers to publish their work immediate Open Access, establishing a series of principles to govern transitional agreements which require cost reductions and transparency, and has supported the development of services like Sherpa (55) which assists researchers and librarians to navigate funders Open Access policies, and supporting UK universities to establish their own self-archiving policies and systems. Alongside public funders, the UK-based Wellcome Trust has been a significant actor in global Open Access, commissioning some of the early analysis on the market, establishing an early funder Open Access mandate and policy, and establishing or co-establishing new publishing services (such as like eLife and Wellcome Open Research), and playing a leading role in cOAlition S (56). External factors, such as the UK's decision to leave the European Union, have prompted reflection on collaborative research and knowledge sharing. While the long-term impacts of such geopolitical shifts remain to be fully understood, the UK invests heavily in research and continues to work closely with other countries on research publishing reform.

Europe

The EU has positioned research as central to regional prosperity, putting it at the heart of green and digital transitions. This includes plans to modernise the European Research Area and launch a new "Horizon" framework programme for research with a commitment to open science at its core (71). The European Commission and the European research funding agencies have been strong supporters of Open Access and of related movements to reform research evaluation. The EU's Horizon 2020 programme mandates Open Access publication for the outputs of all funded research. Through Horizon 2020 the EU has also invested in initiatives such as Open Aire, a European-wide non-profit partnership spanning 35 countries, which has developed an open, shared infrastructure for research communication. Services and platforms are hosted by partners, such as the Zenodo repository managed by CERN. The European Commission created its own Open Access publishing platform, Open Research Europe, also built on the F1000 system (as is Open Research Africa) for outputs from European Commission funded research. Member states have also been the sponsors of the FAIR initiative for research data. More recently the European community has been the major driver of Plan S (see above) through Science Europe, an association of European public research agencies. In May 2023, the Council of the EU noted the importance of a quality, open, and equitable approach to research publishing and aligned itself to a non-profit Open Access model without charges for readers or authors.

References

1. Burke A, Okrent A, Hale K. The State of U.S. Science and Engineering 2022 [Internet]. 2022 [cited 2023 Aug 30]. Available from: https://ncses.nsf.gov/pubs/nsb20221/u-s-and-global-research-and-development
2. Piwowar H, Priem J, Larivière V, Alperin JP, Matthias L, Norlander B, et al. The state of OA: a large-scale analysis of the prevalence and impact of Open Access articles. PeerJ. 2018 Feb 13;6:e4375.
3. STM Global Brief 2021—Economics & Market Size [Internet]. STM; [cited 2023 Aug 30]. Available from: https://www.stm-assoc.org/2022_08_24_STM_White_Report_a4_v15.pdf
4. Apple Operating Margin 2010-2023 [Internet]. [cited 2023 Aug 30]. Available from: https://www.macrotrends.net/stocks/charts/AAPL/apple/operating-margin
5. Eger T, Scheufen M. Economic perspectives on the future of academic publishing: Introduction to the special issue. Managerial and Decision Economics. 2021;42(8):1922–32.
6. Björk BC. Scholarly journal publishing in transition: from restricted to open access. Electron Markets. 2017 May;27(2):101–9.
7. Open Access Publishing in China 2022 [Internet]. CAST and STM; 2022 Dec [cited 2023 Aug 30]. Available from: https://figshare.com/articles/online_resource/CAST_STM_Open_Access_Publishing_in_China_2022-EnglishEdition-final/21708113/2
8. OpenDOAR Statistics - Sherpa Services [Internet]. [cited 2023 Aug 30]. Available from: https://v2.sherpa.ac.uk/view/repository_visualisations/1.html
9. Fazackerley A. 'Too greedy': mass walkout at global science journal over 'unethical' fees. The Observer [Internet]. 2023 May 7 [cited 2023 Aug 30]; Available from: https://www.theguardian.com/science/2023/may/07/too-greedy-mass-walkout-at-global-science-journal-over-unethical-fees
10. Bishop D. Times Higher Education (THE). 2020 [cited 2023 Aug 30]. Nature's OA fee seems outrageously high—but many will pay it. Available from: https://www.timeshighereducation.com/blog/natures-oa-fee-seems-outrageously-high-many-will-pay-it
11. Milliot J. Wiley Buys Open Access Publisher for $298 Million. Publishers Weekly [Internet]. [cited 2023 Aug 30]; Available from: https://www.publishersweekly.com/pw/by-topic/industry-news/industry-deals/article/85242-wiley-buys-open-access-publisher-for-298-million.html
12. The Bookseller [Internet]. [cited 2023 Aug 30]. Taylor & Francis buys F1000 Research. Available from: https://www.thebookseller.com/news/taylor-francis-buys-f1000-research-ltd-1150791
13. Milliot J. Control of SAGE Publishing Moves to Trust. Publishers Weekly [Internet]. [cited 2023 Aug 30]; Available from: https://www.publishersweekly.com/pw/by-topic/industry-news/industry-deals/article/88071-control-of-sage-publishing-moves-to-trust.html
14. Research4Life [Internet]. [cited 2023 Aug 30]. Home. Available from: https://www.research4life.org/

15. Dwivedi YK, Kshetri N, Hughes L, Slade EL, Jeyaraj A, Kar AK, et al. Opinion Paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. International Journal of Information Management. 2023 Aug 1;71:102642.
16. Pollock D, Michael A. Delta Think. 2020 [cited 2023 Aug 30]. News & Views: Open Access Market Sizing Update 2020. Available from: https://deltathink.com/news-views-open-access-market-sizing-update-2020/
17. Pollock D, Michael A. Delta Think. 2022 [cited 2023 Aug 30]. News & Views: Open Access Market Sizing Update 2022. Available from: https://deltathink.com/news-views-open-access-market-sizing-update-2022/
18. Opening the record of science: making scholarly publishing work for science in the digital era [Internet]. International Science Council; 2021 Mar [cited 2023 Aug 30]. Available from: https://council.science/?post_type=publications&p=28587
19. ESAC Transformative Agreement Registry—ESAC Initiative [Internet]. [cited 2023 Aug 30]. Available from: https://esac-initiative.org/about/transformative-agreements/agreement-registry/
20. Grossmann A, Brembs B. Current market rates for scholarly publishing services [Internet]. F1000Research; 2021 [cited 2023 Aug 30]. Available from: https://f1000research.com/articles/10-20
21. Harle J, Warne V. Open Access: challenges and opportunities for Low- and Middle- Income Countries and the potential impact of UK policy.
22. Kwon D. Open-access publishing fees deter researchers in the global south. Nature [Internet]. 2022 Feb 16 [cited 2023 Aug 30]; Available from: https://www.nature.com/articles/d41586-022-00342-w
23. Taylor & Francis 2021-2023 [Internet]. [cited 2023 Aug 30]. Available from: https://www.openaccess.nl/en/publisherdeal/taylor-francis-2021-2023
24. Bosman J, Frantsvåg JE, Kramer B, Langlais PC, Proudman V. OA Diamond Journals Study. Part 1: Findings [Internet]. Zenodo; 2021 Mar [cited 2023 Aug 30]. Available from: https://zenodo.org/record/4558704
25. Ancion Z, Borrell-Damián L, Mounier P, Rooryck J, Saenen B. Action Plan for Diamond Open Access. 2022 Mar 2 [cited 2023 Aug 30]; Available from: https://zenodo.org/record/6282402
26. DORA [Internet]. [cited 2023 Aug 30]. San Francisco Declaration on Research Assessment. Available from: https://sfdora.org/read/
27. The Unjournal [Internet]. [cited 2023 Aug 30]. Available from: https://unjournal.pubpub.org/
28. UNESCO Recommendation on Open Science | UNESCO [Internet]. [cited 2023 Aug 30]. Available from: https://www.unesco.org/en/open-science/about
29. White House Office of Science and Technology Policy (OSTP). Desirable Characteristics of Data Repositories for Federally Funded Research [Internet]. Executive Office of the President of the United States; 2022 May [cited 2023 Aug 30]. Available from: https://repository.si.edu/handle/10088/113528

30. OA2020 [Internet]. [cited 2023 Aug 30]. Available from: https://oa2020.org/
31. The National Research Repository of Uganda [Internet]. [cited 2023 Aug 30]. Available from: https://nru.uncst.go.ug/
32. Science, Technology, and Innovation Policy [Internet]. Government of India Ministry of Science & Technology Department of Science & Technology; 2020 Dec [cited 2023 Aug 30]. Available from: https://dst.gov.in/sites/default/files/STIP_Doc_1.4_Dec2020.pdf
33. Irawan DE, Zahroh H, Puebla I. Preprints as a driver of open science: Opportunities for Southeast Asia. Frontiers in Research Metrics and Analytics [Internet]. 2022 [cited 2023 Aug 30];7. Available from: https://www.frontiersin.org/articles/10.3389/frma.2022.992942
34. Why Plan S [Internet]. [cited 2023 Aug 30]. Available from: https://www.coalition-s.org/why-plan-s/
35. Organisations endorsing Plan S and working jointly on its implementation | Plan S [Internet]. [cited 2023 Aug 30]. Available from: https://www.coalition-s.org/organisations/
36. Plan S Principles [Internet]. [cited 2023 Aug 30]. Available from: https://www.coalition-s.org/plan_s_principles/
37. Aguado-López E, Becerril-Garcia A. AmeliCA before Plan S—The Latin American Initiative to develop a cooperative, non-commercial, academic led, system of scholarly communication [Internet]. Impact of Social Sciences. 2019 [cited 2023 Aug 30]. Available from: https://blogs.lse.ac.uk/impactofsocialsciences/2019/08/08/amelica-before-plan-s-the-latin-american-initiative-to-develop-a-cooperative-non-commercial-academic-led-system-of-scholarly-communication/
38. Aguado-López E, Becerril-Garcia A. The commercial model of academic publishing underscoring Plan S weakens the existing open access ecosystem in Latin America [Internet]. Impact of Social Sciences. 2020 [cited 2023 Aug 30]. Available from: https://blogs.lse.ac.uk/impactofsocialsciences/2020/05/20/the-commercial-model-of-academic-publishing-underscoring-plan-s-weakens-the-existing-open-access-ecosystem-in-latin-america/
39. Smits RJ, Pells R. Plan S for Shock [Internet]. Ubiquity Press. Ubiquity Press; 2022 [cited 2023 Aug 30]. Available from: https://www.ubiquitypress.com/site/books/m/10.5334/bcq/
40. Plan S is a grand plan, but the devil is in the detail: Robin Crewe on Open Access in South Africa [Internet]. International Science Council. 2019 [cited 2023 Aug 30]. Available from: https://council.science/current/blog/plan-s-is-a-grand-plan-but-the-devil-is-in-the-detail-robin-crewe-on-open-access-in-south-africa/
41. Transformative Journals: analysis from the 2022 reports [Internet]. [cited 2023 Aug 30]. Available from: https://www.coalition-s.org/blog/transformative-journals-analysis-from-the-2022-reports/
42. Rooryck J. The Plan S open access initiative creates more opportunities than threats for Latin America [Internet]. LSE Latin America and Caribbean blog. 2019 [cited 2023 Aug 30]. Available from: https://blogs.lse.ac.uk/latamcaribbean/2019/12/03/the-plan-s-open-access-initiative-creates-more-opportunities-than-threats-for-latin-america/

43. Plan S [Internet]. [cited 2023 Aug 30]. Moving away from APCs: a multi-stakeholder working group convened by cOAlition S, Jisc and PLOS. Available from: https://www.coalition-s.org/moving-away-from-apcs/
44. Consulting the research community on cOAlition S's "Towards Responsible Publishing" proposal: an Invitation to Tender (ITT) to support this initiative | Plan S [Internet]. [cited 2023 Aug 30]. Available from: https://www.coalition-s.org/consulting-the-research-community-on-coalitions-towards-responsible-publishing-proposal-invitation-to-tender/
45. Becerril A, Bosman J, Bjørnshauge L, Frantsvåg JE, Kramer B, Langlais PC, et al. OA Diamond Journals Study. Part 2: Recommendations [Internet]. Zenodo; 2021 Mar [cited 2023 Aug 30]. Available from: https://zenodo.org/record/4562790
46. Cumbre global sobre—Acceso Abierto Diamante [Internet]. [cited 2023 Aug 30]. Available from: https://globaldiamantoa.org/
47. 2021 Science Report [Internet]. [cited 2023 Aug 30]. Domestic spending on research and development as a share of GDP for the G20, 1996–2018 (%). Available from: https://www.unesco.org/reports/science/2021/en/dataviz/gov-expenditure-rd-race
48. G20 Research Ministerial Meeting Outcome Document and Chair's Summary [Internet]. 2023 Jul. Available from: https://www.g20.org/content/dam/gtwenty/gtwenty_new/document/G20_Research_Ministerial_ODCS.pdf
49. G20-Chief Science Advisers Roundtable [Internet]. [cited 2023 Aug 30]. Available from: https://www.g20csar.org/
50. Sherpa Track [Internet]. [cited 2023 Aug 30]. Available from: https://www.g20.org/en/workstreams/sherpa-track/
51. Science Summit at UN General Assembly—Science Summit at the 78 United Nation General Assembly [Internet]. [cited 2023 Aug 30]. Available from: https://sciencesummitunga.com/
52. UKRI Open Access Policy [Internet]. UK Research and Innovation; [cited 2023 Aug 30]. Available from: https://www.ukri.org/wp-content/uploads/2023/07/UKRI-220523-OpenAccessPolicy-v1.6.pdf
53. NIHR Open Access publication policy - for publications submitted on or after 1 June 2022 [Internet]. [cited 2023 Aug 30]. Available from: https://www.nihr.ac.uk/documents/nihr-open-access-publication-policy-for-publications-submitted-on-or-after-1-june-2022/28999
54. Jisc [Internet]. [cited 2023 Aug 30]. Our role in open access. Available from: https://beta.jisc.ac.uk/our-role-in-open-access
55. About Sherpa Juliet - Sherpa Services [Internet]. [cited 2023 Aug 30]. Available from: https://v2.sherpa.ac.uk/juliet/about.html
56. Wellcome [Internet]. [cited 2023 Aug 30]. Open Access Policy - Grant Funding. Available from: https://wellcome.org/grant-funding/guidance/open-access-guidance/open-access-policy
57. Bothwell E. Times Higher Education (THE). 2020 [cited 2023 Aug 30]. India overtakes Germany on research output. Available from: https://www.timeshighereducation.com/news/india-overtakes-germany-research-output

58. Go FAIR [Internet]. [cited 2023 Aug 30]. FAIR Principles. Available from: https://www.go-fair.org/fair-principles/
59. Mallapaty S. India pushes bold 'one nation, one subscription' journal-access plan. Nature. 2020 Sep 30;586(7828):181–2.
60. Mohanty BK. One Nation One Subscription rollout delayed. Telegraph India [Internet]. [cited 2023 Aug 30]; Available from: https://www.telegraphindia.com/india/one-nation-one-subscription-rollout-delayed/cid/1916348
61. Costa MP da, Leite FCL. Open access in the world and Latin America: A review since the Budapest Open Access Initiative. Transinformação. 2016 Apr;28:33–46.
62. Journals—DOAJ [Internet]. [cited 2023 Aug 30]. Available from: https://doaj.org/search/journals?source=%7B%22query%22%3A%7B%22query_string%22%3A%7B%22query%22%3A%22brazil%22%2C%22default_operator%22%3A%22AND%22%2C%22default_field%22%3A%22index.country%22%7D%7D%2C%22size%22%3A50%2C%22sort%22%3A%5B%7B%22created_date%22%3A%7B%22order%22%3A%22desc%22%7D%7D%5D%2C%22track_total_hits%22%3Atrue%7D
63. Kowaltowski A, Naslavsky M, Zatz M. Times Higher Education (THE). 2022 [cited 2023 Aug 30]. Open access is closed to middle-income countries. Available from: https://www.timeshighereducation.com/opinion/open-access-closed-middle-income-countries
64. Johann Mouton, Isabel Basson, Jaco Blanckenberg, Nelius Boshoff, Rein Treptow, Heidi Prozesky, et al. The State of the South African research enterprise [Internet]. [cited 2023 Aug 30]. Available from: http://www0.sun.ac.za/crest/wp-content/uploads/2019/08/state-of-the-South-African-research-enterprise.pdf
65. SciELO - Scientific Electronic Library Online [Internet]. [cited 2023 Aug 30]. Available from: http://www.scielo.org.za/
66. Bawa AC. South Africa's journey towards open access publishing. The Biochemist. 2020 Jun 3;42(3):30–3.
67. African Journals Online [Internet]. [cited 2023 Aug 30]. Available from: https://www.ajol.info/index.php/ajol
68. Science Granting Councils Initiative (SGCI) in Sub-Saharan Africa [Internet]. [cited 2023 Aug 30]. Available from: https://sgciafrica.org/
69. Normile D. China again boosts R&D spending by more than 10%. Science [Internet]. [cited 2023 Aug 30]; Available from: https://www.science.org/content/article/china-again-boosts-rd-spending-more-10
70. Tollefson J. China declared world's largest producer of scientific articles. Nature. 2018 Jan 18;553(7689):390–390.
71. Strategic Plan 2020-2024 DG Research and Innovation [Internet]. European Commission; [cited 2023 Aug 30]. Available from: https://commission.europa.eu/system/files/2020-11/rtd_sp_2020_2024_en.pdf