



**International
Science Council**

The global voice for science

THE CASE FOR

Reform of

Scientific

Publishing

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About the International Science Council

The International Science Council (ISC) works at the global level to catalyze and convene scientific expertise, advice and influence on issues of major concern to both science and society. The ISC has a growing global membership that brings together over 245 organizations, including international scientific unions and associations from natural and social sciences, and the humanities, and national and regional scientific organizations such as academies and research councils.

This discussion paper has been developed by International Science Council as part of the Council's *Future of Publishing* project and is a companion piece to the Key Principles for Scientific Publishing <https://council.science/publications/key-principles-for-scientific-publishing>.

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PREFACE

This is a companion piece to *Key Principles of Scientific Publishing*.

In 2019, shortly after the creation of the International Science Council (ISC), its members, primarily international scientific Unions and Associations, national and regional scientific organizations including Academies and Research Councils, and international Federations and Societies, were asked to identify what they considered to be the most important contemporary issues for science.

A set of publishing principles were endorsed by the ISC's Members in 2021 at their General Assembly.

Following the endorsement of the principles, an international Steering Committee was created (see below) to help identify the actions needed to realise the principles. A series of studies were undertaken to identify ways in which barriers to realization might be overcome and business models, technologies and procedures followed to facilitate this.

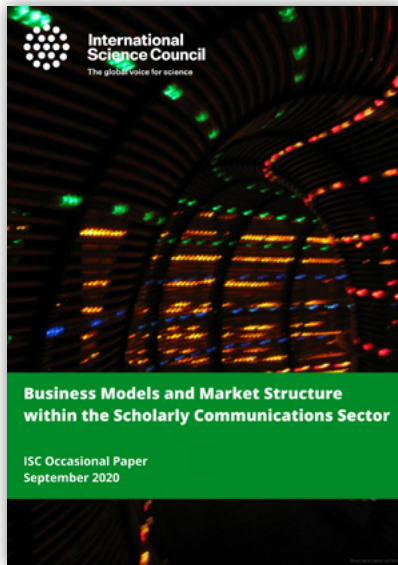
The process was aided by numerous formal and informal discussions and presentations, which resulted in the publication of three additional reports referenced below.

This document represents the culmination of this phase of work, setting out priorities for reform for the ISC. It is to be circulated to Members to seek their endorsement prior to action by the Council.

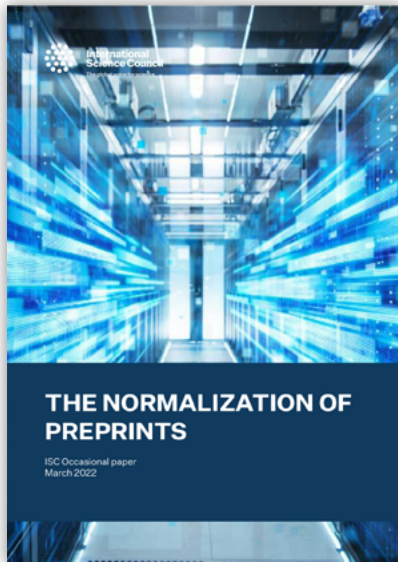
INTERNATIONAL STEERING COMMITTEE

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- Dominique Babini, CLACSO, Argentina
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- Ahmed Bawa, South Africa
- Geoffrey Boulton, UK (chair)
- Amy Brand, USA
- Luke Drury, Ireland
- Rupert Gatti, UK
- Heather Joseph, SPARC
- Joy Owango, Kenya
- Wang Qinglin

RELATED PUBLICATIONS



Gatti, R. 2020. *Business models and market structure within the scholarly communications sector*. International Science Council, Occasional paper.



Drury, L. 2022. *The normalization of preprints*. International Science Council, Paris, France. doi.org/10.24948/2022.02



Barbour, M. 2021. *Strengthening research integrity: The role and responsibilities of publishing*. International Science Council, Occasional Paper.

EXECUTIVE SUMMARY ·····

The publication and dissemination of the results of scientific inquiry are essential processes by which scientific knowledge and ideas are circulated and exchanged, scrutinized and tested. The efficient circulation of scientific output through a global network is vital to the production and use of knowledge. It has been, and will continue to be, the means by which distant minds interact to create new understanding and develop solutions to many of the problems confronting society. Humanity has benefitted greatly from the development of scientific publishing, which enabled the open science of recent centuries. A new era of open science, enabled by the digital revolution, now beckons. A globally effective publication system is indispensable to this new era. It is for these reasons that the International Science Council (ISC) has published its eight principles for scientific publishing shown in the companion piece to this paper, 'Key Principles of Scientific Publishing'.

The first and foremost principle stresses the central role of publishing as the enabler of the efficient and effective global network of ideas and information. The digital revolution of recent decades should have been a timely moment for step change in network functionality, providing the interactive communications system needed to satisfy the increasing demands placed on science. While some progress has been made (for example, the use of digital object identifiers for persistent reference linking across publishers), science publishing has so far failed to harness the full potential of digital functionality.

Fully adopting the tools of this revolution could have vastly improved the efficiency and effectiveness of knowledge dissemination; created discriminatory navigation tools that gathered all new knowledge relevant to any researcher's interests; ensured that data relevant to a published claims could be readily accessed and scrutinized; greatly improved the highly inefficient and ad hoc processes of peer review; more effectively opened the process of publication to innovation and greater bibliodiversity; maximized the extent to which the results of science are made available as a global public good; and made publication systems more accountable to the scientific community.

Instead, we have a system where the dominant commercial players allow the interests of investors to take precedence over the needs of science. Excessive prices and profits fracture the international science community based on the ability to pay. Moreover, too much scientific output is unreproducible or shown to be fraudulent, damaging trust in the scientific enterprise. A major cause of these and other problems has been the way that scientists and their institutions use bibliometric indices to evaluate scientific careers. This has incentivized a 'publish or perish' culture, enabled large profits to be made, spawned a vast predatory publishing industry which adds little of value to the record of science¹, and deflected scientists from other scientific roles that will be vital to a new era of open science.

1 The record of science is taken to be the record of published scientific discovery and speculation since the earliest times.

The urgent need for reform has been recognized by many stakeholders in the scientific process, including governments. Such reforms must include the abandonment of bibliometric indices as sole indicators of excellence and the creation of a comprehensive index of the record of science. We should work towards a new cultural norm in which publishing, as an integral part of the scientific process, is accountable to the scientific community and to those that fund its work. The ISC will work with other stakeholders to achieve this, ensuring that scientific output is treated as a global public good, that scientific papers are freely accessible to all through a variety of open-access models, that a full index of the scientific record is created, that the peer review process is reformed, and that all of the ISC's eight principles are observed.

Digital advances will continue to change the publication and dissemination of scientific knowledge. If the ISC does not take an active role in leading and structuring this transformation, we risk having a system imposed on us which does not prioritize the interests of science, the very issue that caused this crisis in the first place.

THE VALUE OF SCIENCE²

1. Recent decades have experienced an unprecedented growth in scientific activity, increasingly seen as indispensable to the advancement of societies both nationally and globally.
2. Science is concerned with the same phenomena that have taxed the human imagination from earliest times but pursues them in a way that makes it a special form of knowledge. This lies in the way that knowledge claims and the evidence on which they may be based are made widely available and formally tested against reality and logic through processes of sustained scrutiny by peers. It is a route by which error is identified and rejected, rather than truth established. Although this approach to knowledge arose in the specific social and cultural context of Europe in the 17th century, it has become part of a universal human heritage as people all over the world have come to accept this approach as the best way to accumulate reliable knowledge about nature and society.
3. The scientific community, which shares this particular approach to knowledge, has become the pre-eminent, non-religious, transnational community in the contemporary world. The effective operation of this community is essential for navigating the complex world we inhabit and confronting the global challenges facing humanity.

PUBLISHING AND THE GLOBAL COMMUNITY OF SCIENCE

4. Science has the greatest impact when its results are made openly available as a public good, free at the point of use, able to contribute to the work of other scientists and exploited in wider society for diverse and often unpredicted purposes. However, much resultant knowledge, rather than being freely available as the endpoint of the scientific workflow, is gifted by scientists to commercial publishers and only publicly available behind paywalls.
5. The network of communication by publication³ is essential to the effectiveness of science. It permits ideas and information to disseminate new ideas and new opportunities and the responses that these might inspire. There has been massive growth in scientific publication. However, much of this growth has been driven by the unfortunate culture of 'publishing at all cost', to the detriment of the scientific effort. It is an approach that limits information flow, particularly to and from low- and middle-income countries.

2 The word 'science' is used in a broad sense to refer to a formalized approach to knowledge that is rationally explicable and tested against reality, logic and the scrutiny of peers. It is inclusive of natural, social, medical, agricultural and engineering science and the humanities.

3 Although the publication of articles is the dominant mechanism of knowledge dissemination in many science disciplines, monographs and books are also important vehicles for this process, particularly in the humanities, while other, novel formats are increasingly common. The principles apply to all, however.

6. Much of the network is currently designed as a profit-focused commercial operation. This naturally preferences well-funded customers rather than performing the functions set out in the preceding paragraph. Many scientists, particularly in low- and middle-income countries, are unable to access articles published in expensive, highly cited journals and books, and as authors they are often unable to afford journals' and publishers' prices. A challenge for the community is to reform the current system so that its crippling network inefficiencies are removed. Without this, the vital interchanges between societies at different stages of economic development, essential if global sustainability goals are to be achieved, will remain beyond our grasp, with the attendant existential risks of a politically and socially fractured world.
7. From a commercial perspective, editors seek impact and novelty as means of embellishing the journal brand, while articles that demonstrate error – a success in scientific terms – are rarely admitted to a journal. The demonstration of error is a vital part of science's self-correcting process and not necessarily a black mark against a journal. In scientific terms, both approaches are deficient. They are commercial and not scientific responses. Modern sorting algorithms are highly efficient in identifying for readers that part of the global scientific production that is relevant to their interest, and should be used both make a journal editor's view of excellence irrelevant and to readily identify demonstrated error.
8. Extensive analyses by the ISC's Steering Group on scientific publishing reveal the scale of fracturing of the global science community. A 'North–South' chasm has opened up, preventing the Global North and Global South from accessing each other's scientific outputs. In the cases of Ebola and COVID-19, access to scientific output was inhibited in the Global South, with the consequence that global assessments tended to be biased in favour of Northern perspectives.
9. Evidence of widespread failures to reproduce scientific results and demonstrations of the extent of plagiarism, falsification of results and sloppy working practices, all driven by the incentives to publish or perish, have the potential to undermine the reality and public perception of the rigour, integrity and trustworthiness of science. The potential for dishonest practices through the use of large language models and generative AI increases this risk. Reforming the current publishing process and the evaluation procedures that support it, as well as opening the working practices of science to scrutiny and applying automated interrogation systems, are urgent priorities if scientific integrity is to be retained.

ESSENTIAL PRINCIPLES FOR SCIENTIFIC PUBLISHING ·····

10. The ISC has created eight principles for scientific publishing. These are set out in ‘Key Principles of Scientific Publishing’ together with comments on the extent to which scientific benefits are realized and consequently where reforms may be needed. This analysis has been accepted by the ISC Governing Board and by the 2021 ISC General Assembly as the position of the ISC.

11. The first principle for scientific publishing is designed to enable effective functioning of the global scientific community as an efficient network of ideas and information:

The rapid and global circulation of ideas is central to the scientific process. There should be universal, prompt open access to the record of science, both for authors and readers, with no barriers to participation, in particular those based on ability to pay, institutional privilege, language or geography.

This is of growing significance at a time when geopolitical tensions threaten to fragment the global scientific community.

THE DIGITAL REVOLUTION ·····

12. The digital revolution at the turn of the 21st century provided a novel and powerful means of almost instantaneously communicating ideas and information with near-ubiquitous social penetration. Its potential to serve science in new and creative ways was quickly recognized, for example in the first paragraph of the Budapest Declaration of 2002:

An old tradition and a new technology have converged to make possible an unprecedented public good. The old tradition is the willingness of scientists and scholars to publish the fruits of their research in scholarly journals without payment, for the sake of inquiry and knowledge. The new technology is the internet. The public good they make possible is the worldwide electronic distribution of the peer-reviewed journal literature and completely free and unrestricted access to it by all scientists, scholars, teachers, students and other curious minds.

13. This potential could have been realized, for example through free entry to internet-based scientific publications. Publication could have been seen as an intrinsic part of the process of doing science rather than as a separate transaction. It is a process that could have accommodated a variety of funding sources and routes to publication.

14. Rather than the digital revolution creating new ways of communicating science, with novel functionalities that exploited the full potential of the internet, little changed from the era of print publication. It simply led to replacement of the printed page with a PDF of that page and a failure to embed many of the functionalities facilitated by digital technologies. Rather than a free point of entry to universal access, the commercial

companies have negotiated repeated deals for the same output with different geographic entities. Rather than additional readers being satisfied at marginal cost, they incurred additional costs – in contrast to general the role of knowledge which, as a public good, knowledge spreads at zero marginal cost. The potential public good of science has thus been appropriated and privatized as a commodity.

THE ROLE OF BIBLIOMETRICS IN SCIENCE EVALUATION ·····

15. The processes that have undermined the opportunity to exploit new technologies for the benefit of science are in the hands of the scientific community and its institutions. Together they have created a market that has been exploited by publishers and had detrimental effects on research culture and practice. The community has used bibliometric indices and high impact factor journals as proxies⁴ for scientific excellence in evaluating the work of individuals and institutions. This has created a powerful incentive to maximize publication of scientific papers. It is a classic example of so-called Goodhart's Law, 'that when a measure becomes a target, it ceases to be a good measure'. Thus, rather than a market in science, which would have maintained the classic customer control on price, there is a market in reputation. A luxury market has developed, in which the 'brand' – the journal – determines price, not the excellence of the science it contains.
16. The science community has allowed publishing to play a role that was not part of its original job description. This has led to a situation where, for many authors and their employers, publishing a paper is more important than the science it contains. The use of publication metrics in academic job preferment and university reputation supports a publishing business model that is hostile to many of the ISC's eight principles for scientific publishing and to the essential role of science in advancing the public good. These same metrics have also encouraged the business model of predatory publishing and paper mills. The high level of sloppy or fraudulent behaviour encouraged by this approach has created a crisis of non-reproducible, -replicable and fake results that have brought the trustworthiness of the scientific process itself into question.
17. Bibliometrics have created powerful incentives that are not balanced by similarly powerful metrics for other activities. The consequences of this have been profound. They have:
 - driven up prices to the particular detriment of poorly funded science systems and institutions, thereby fracturing the global scientific community;
 - massively over-produced scientific publications, many of which are never cited;
 - created the phenomenon of predatory publishing, in which the purpose of authors is more to gain job preferment rather than serve scientific understanding, with the purpose of publishers being exclusively financial;

4 'It is much easier to make measurements than to know exactly what you are measuring'. J. W. N. Sullivan.

- generated such a strong incentive to publish that corners are cut, resulting in misconduct and fraud;
- incentivized the production of publications to the detriment of other priorities of science, such as work at the social and political interfaces of science and the education of younger generations;
- tempted researchers to break major research findings into multiple published articles rather than presenting their findings as a coherent whole;
- encouraged excessive claims;
- hidden scientific results behind copyright walls; and
- maintained the journal as a fundamental scientific vehicle, long after it had, in many cases, become an anachronism and an impediment to the rapid circulation of knowledge.

These issues, all based on archaic research metrics, stand in the way of the national and international system transformations that science needs if it is to address contemporary challenges.

A GENERATIVE AI REVOLUTION?

18. The potential impact of generative AI on the scientific enterprise was dramatically illustrated by the launch of ChatGPT in November 2022. When posed a question, the system formulates, within seconds, a coherent evaluative response in a comprehensible style that is at least as coherent as many scientific papers. Such large language models have the ability to analyse queries and produce fully fleshed-out answers and results based on most of the world's digitally accessible text-based information. Such systems do not 'understand' what they do. They do not distinguish between right and wrong, they do not reason in terms of cause and effect, and the question 'why' means nothing to them. But they are immensely powerful in recognizing patterns in pre-existing human discourse and archived information, whether correct or not.
19. Such systems have the potential to enormously expand scientific output, particularly in the predatory sector, but with little enhancement of scientific understanding. They also risk embedding disinformation or misinformation in ways that corrupt science. There are two great emerging challenges for science: to find ways of identifying such artefacts and excluding them from the record of science, and to use AI to contribute to the creation and dissemination of scientific findings.

20. The need for reform that will enable affordable access by both readers and authors is urgent, particularly if the hopes for a new era of open science are to be realized. A great deal of thought and creativity has been applied to improve other fundamental attributes of the publication process: more efficient and effective modes of peer review that are inspired by open norms; data release that is contemporaneous with the publication to which it relates; discovery algorithms for specific research-relevant content; rapid turnaround; processes that enhance integrity; and the development of preprints and diamond publishing, for example. Some innovations have been created by major commercial companies, some have been bought out by them, and some remain independent. However, because the five major commercial publishers are responsible for about 75 percent of published scientific articles, the further evolution of the publishing system could be hostage to their commercial interests.

21. The market created by bibliometric incentives has allowed companies to make commercial deals at institutional or national levels with price increases that have almost invariably exceeded the rate of inflation. These companies have persistently pressed for funding beyond budgetary limits, thereby leaving no slack to sustainably fund innovative developments by others.

22. The commercial publishing model arose because of the seamless inheritance by these companies of journal-based publications from the learned societies that had dominated scientific journal publishing in the first half of the 20th century. Many had operated at a loss, and many society journals that survived passed operational management to commercial publishers, with some profits returning to support the scientific activities of the society. Commercial publishers saw the market opportunity for a profitable business model, which Robert Maxwell, its originator, termed a ‘perpetual financing machine’, in which the crucial contribution of peer review was provided freely by scientists. (It is estimated that this free contribution to publishers’ profits is worth about \$3 billion per year). The sustainable growth that commercialization introduced supported the expansion of scientific activity in the second half of the 20th century, but the interests of science and investors have now diverged so strongly that major reform is needed.

23. Increasing dissatisfaction with the current state of scientific publishing is reflected in the activities of many scientific and library groups, mission-driven publishers, and governmental and inter-governmental groups working to change the current system in favour of open access and open science. The United States government has issued guidance that the rights for access to federally funded research results may not be surrendered to private interests. The European Union’s Council of Ministers strongly encourages multi-format scholarly publishing models with no costs for authors or readers. It also encourages dialogues in reforming research assessment and welcomes coordination within the European Union and with global partners to make immediate and unrestricted open access ‘the default

mode in publishing, with no fees for authors'. It has commented that current article processing charges rates can far exceed the actual cost of publication, deepening inequalities among researchers and institutions, and has sustained many of the problems referred to in paragraph 16. The Zuckerberg Foundation has begun to support non-profit development of an inclusive preprint-based ecosystem of review and curation. On the 24 May 2023, the G7 issued a communiqué stating that it 'supports immediate open and public access to government-funded scholarly publications and scientific data and supports the endeavours of the scientific community to address challenges in scholarly publishing for broader sharing of appropriate scientific outputs'. Apparent conflicts between scientific integrity and profit maximization are exemplified by recent resignations of entire editorial boards of commercial publishers in response to fee hikes or pressure to produce more fee-winning articles, which have led these boards to create new non-profit journals. The reluctance of publishers to expose their production costs to the European 'Plan S', which aims for full and immediate open access, may reflect an embarrassment to expose their high profit margins.

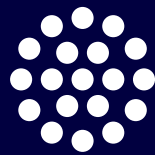
24. The ISC, as a representative body for the international scientific community, and as a global voice for science, must now speak and act for science. It has accepted the case for change, to correct the developing pathologies referred to above, to stimulate the creation of a digital commons, and in the interests of a new era of open science as frames for action.
25. The combination of persistent misuse of bibliometrics and increased commercialization of publishing is causing massive harm to the academic ecosystem (paragraphs 5, 6 and 8). Journal imprints that have become a proxy for excellence in research create other concerns (paragraphs 13 and 14). The combination of these two factors has the potential to create profound structural harm to the independent operations of higher education and research institutions. When a company controls both the means of distributing content and the metrics and systems used to assess its value, we are at risk of outsourcing the major roles our universities and research laboratories play in the research and education ecosystem. As publishers work to consolidate their ownership in both of these areas, and with the potential for further control through rapidly evolving AI systems, the need for structured regulation and accountability to the science community is essential.
26. It is important for the science community to recognize the fundamental role of science in contemporary national and international affairs. This is best achieved by framing scientific knowledge as a global public good in a global commons and in returning oversight of scientific publishing to the ownership and responsibility of the scientific community. These changes have been made possible by the digital revolution. Two essential steps are required for this to be achieved:
 - a) Bibliometric indicators, impact factors and publication in particular journals must not be used as primary proxies for scientific excellence or in the assessment of the performance of individual scientists. Without such

abstinence, the cycle of damage (paragraph 15) is perpetuated. A greater diversity of secondary proxies could be helpful, such as a richer set of bibliometrics indicators that consider contributions other than authorship, or more intelligent ways of tracking the downstream impact of a work, such as on the instructional uses or government policy. The danger here, however, is that indicators are used to increase profits in ways that obscure the science.

- b) A full international index of scientific publications should be created, with classificatory algorithms able to locate and download outputs of specified interest. It must be source-agnostic (i.e., capable of processing data in various formats or from multiple sources) and controlled by agents of the scientific community, who should also determine the criteria for inclusion.
27. Just as banks and other financial institutions are designated by governments as systemic or strategic, and regulated appropriately, should not scientific publication also be subject to an analogous form of oversight, although operated by the science community rather than government in such a way as not to stanch its creativity? Any market in which a very few companies are dominant should be the subject of review to determine how greater competition could be stimulated, potentially through the activities of a 'digital markets unit' that could also be charged to ensure data mobility, open standards and the entry of new, innovative providers.
28. The ISC believes that its eight principles for scientific publishing are essential to the future of science. It is important therefore to mobilize the global scientific community and its key stakeholders in pursuit of these objectives. The attributes of a publishing system that achieves these are:
- a) Scientific outputs should be freely available for anyone to access them online using non-proprietary protocols (i.e., outputs are not owned by any one company) and open platforms.
 - b) Access to the authoring process should also be free for potential authors.
 - c) Evaluation of all research outputs on open evaluation platforms should be enabled.
 - d) There should be full interoperability between publications, data, evaluation platforms and open discovery platforms (scientific search engines) to offer easy access to and filtering of research outputs through a single integrated web interface. This can be achieved by incorporating persistent identifiers that are able to create full interoperability, thereby solving the issues of persistence and accessibility.
 - e) A full index of the scientific record must be created, not one in the hands of a commercial operators. It should be source-agnostic, in contrast to current indices that give preference to the commercial journals from the Global North, thereby making much of the science contribution of the Global South invisible.

- f) There should be a fundamental re-imagining of the peer review process to identify its purposes, strengthen its scrutiny role, remove its inherent biases and increase its human-resource efficiency. The most fundamental elements of scientific scrutiny (paragraph 2) take place after publication, when truth claims are subject to deep experimental or observational testing. By contrast, pre-publication peer review is a ‘hit-and-miss’ affair. This should be strengthened by AI systems that have the capacity to identify invalid data series and plagiarism and will be needed to identify the roles of large language models.
 - g) It is vital to embed powerful new functionalities that enhance sorting, classification and multimedia interoperability. This would enable near-instant access to all the relevant previous work in any particular field.
 - h) There are combinations of functions that should not be permitted because of their capacity to corrupt scientific procedures for private benefit. An entity can be a research content provider, or a research assessment provider, but not both. Equally, data curation and data analytics functions must be separate from the publishing function.
29. These objectives have not been met by the current commercial system. If a high level of coordination could be achieved between those that ultimately fund the publication system, principally research funders and libraries, an ambitious, globally coherent system could adopt the attributes summarized above as follows:
- a) A reform is needed that recognizes that the ‘divide and rule’ process operated by publishers, in which regional entities are addressed one by one in closed negotiations, props up the current scientifically inefficient system and is hostile to the priorities of paragraph 23. National and international funding bodies, acting in concert, should seek a means of collective or federated funding for the processes in paragraph 25 through contracts with publishing providers that align their strategies and funding priorities towards multi-format models with no costs for authors or readers. This would re-assert the interest of customers as a key control on the system. This process could ensure that national contributions reflect ability to pay.
 - b) Such a reform should formalize, by contract, adherence to the ISC’s eight principles.
 - c) This reform would, at a stroke, exclude all so-called predatory publishers and paper mills provided that universities and national funded bodies agreed that only work passing through this system would be eligible for inclusion in any bibliometric component of assessments of science or scientists. If the problems posed by generative AI (paragraph 18) can be addressed, this approach would also negate their predatory aspects. Such assessments should use open research analytics that consider all aspects their work.

- d) The system should have double accountability to its funders and to a body representing the international scientific community (see principle 8). These two components should be crucial to any governance model. Funders, directly or indirectly linked to governments, would reflect the public interest, and an international body should represent the scientific community.
30. It is important that the principal stakeholders in the scientific enterprise develop systems capable of delivering the reforms set out in paragraph 23. These reforms will help create a new era of open science. Given the magnitude of the reforms, a clearly defined process of transition will be necessary. The most difficult part of the required change, however, is creating the will to act. But if science is to be a public good, as set out in the vision of the ISC, then scientific publishing, the principal output of the scientific enterprise, must also be a public good. The private appropriation of scientific publication fundamentally undermines this public vision.



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