

Open access: a journey from impossible to probable, but still uncertain

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Abstract

An overview of the evolution of open access (OA) to scientific publications over the last 20 years is presented. This retrospective look allows us to make two observations that seem to overlap: on the one hand, how close the initial objective seems to be to what initially seemed utopian and, on the other, the unanticipated and solid obstacles that open access has encountered along the way, as well as the unexpected and diverse solutions that are emerging to overcome them. The overall assessment of OA is positive, and it underscores that open access is (or is becoming) possible, that it is good, and that it is necessary. However, this overall positive evolution has come up against two major obstacles that are slowing its progress: the double payments generated by hybrid journals (subscription and article processing charges [APCs]) and the unchecked growth in APCs. In addition, this intensive use of APCs is creating a publishing gap between publishers that charge fees to authors and those that do not, and ultimately, it is causing dissension regarding the (previously shared) strategy toward open access. There are no immediate, one-off solutions to overcome the aforementioned dysfunctions, although three actions that, in the medium term, can remedy them can be mentioned: changing the approach to the evaluation of science, adopting measures to regulate APCs, and promoting alternative publication models. Finally, it should be noted that OA has acted as the vanguard and spearhead of a broader movement: that of open science.

Keywords

Open access; Evolution; Perspective; Future; Obstacles; Models; Economy; Pricing; APCs; Article processing charges; Scientific journals; Hybrid journals; Evaluation of Science; Science communication; Scholarly communication; Open science.

"We support the establishment of an online public library that would provide the full contents of the published record of research and scholarly discourse in medicine and the life sciences in a freely accessible, fully searchable, interlinked form. Establishment of this public library would vastly increase the accessibility and utility of the scientific literature, enhance scientific productivity, and catalyze integration of the disparate communities of knowledge and ideas in biomedical sciences."

1. Open access on the 20th anniversary of its official creation

The text at the head of this article seems as though it were written today, but it was written in the year 2000.

<https://plos.org/open-letter>

<https://en.wikipedia.org/wiki/PLOS>

It is part of a mass-distributed email signed by three prestigious scientists –Harold Varmus, Patrick Brown, and Michael Eisen– who shortly thereafter founded the *Public Library of Science (PLOS)*. They declared their intention to contribute



articles or reviews only to scientific journals that allowed free access to their content to everyone within no more than six months. The message called for adherence to these principles, and it was endorsed by thousands of scientists from 180 countries.

The letter calling for a *Public Library of Science* can be seen as the genesis of the open access movement. Its triple birth (in Budapest, Bethesda, and Berlin) has been expanded upon on different occasions (**Suber**, 2012; **Abadal**, 2012; **Poynder**, 2019), and there is a broad consensus that this year is its 20th anniversary. See the timeline of the open access movement at:

<https://oad.simmons.edu/oadwiki/Timeline>

As with any time when reality is seen through the rear-view mirror, everything seems to have followed a predictable course; however, the authors of this article, recipients of the email at that time, certify that they signed it with conviction, but at the same time with incredulity.

The scientific journal landscape had just begun the rapid and painless transition from print to digital (**Anglada**, 2017; **Borrego**, 2017). This came with the introduction of consortial subscriptions or big deals, which significantly increased the accessibility of scientific literature but did not substantially alter two characteristics of scientific communication of the time: the continuous increase in journal fees, and the accessibility restrictions stemming from paid subscription capabilities.

Looking back allows us to make two observations that seem to overlap: the first is how close the initial objective seems, in our view, to what seemed impossibly utopian a little more than twenty years ago. The second is the unanticipated and solid obstacles that open access has encountered along the way, as well as the unexpected and diverse solutions that are emerging to overcome them.

“The big deals did not substantially alter two characteristics of scientific communication at the time: the continuous increase in journal fees and the restrictions on accessibility to the paper versions”

We analyze these issues in the sections below.

2. Where are we? A stop on the way to the promised land

Although we may feel ambivalent when it comes to the goals achieved, the positive elements stand out above the rest, and we would like to mention at least three: that open access is (or is becoming) possible, that it is good, and that it is necessary.

It is possible. We might have thought it was just a dream, but we have discovered not only that the number of open scientific articles is very large but also that achieving 100% OA is a global goal set by *Unesco* itself (*Unesco*, 2021). The literature measuring the degree of OA from different countries is rich and varied (**Piwowar**; **Priem**; **Richard**, 2019). While it was found that the final result is highly dependent on the methodology used (**Borrego**, 2021; 2022), despite 20 years of OA, all countries and institutions are still far from having open access to all of their scientific production (**Johnson**; **Watkinson**; **Mabe**, 2018, pp. 134-136). However, some of the results are quite remarkable and show that achieving complete open access is possible, even if it has not been easy. The voices calling for a more demanding and qualitative view of the final objective are proof of how close we are to complete OA (**Bosman**, 2021).

It is good. The misfortune of Covid-19 has proven conclusively what was once just conjecture: that open and immediate access to research results accelerates science –in this case, the obtaining of results that prevent death and disease. In turn, the OA movement has shown many more things, such as institutions’ vitality in creating repositories where they collect and provide open access to their academic production, the range of tools that efficiently communicate scientific results, the validity of non-commercial journals, and the great amount of science beyond that included in reference databases (**Martín-Martín et al.**, 2018).

It is necessary. Thomas Kuhn showed that science advances in a non-linear fashion, creating stable frameworks –paradigms– within which it evolves continuously but also where what he called anomalies accumulate. Anomalies of a paradigm are tolerated until a better (more effective or efficient) alternative is found. The approach that has worked for so long (created under the paradigm of print) has notable inefficiencies –such as constant fee increases, inequalities in access, concentration in the publishing sector, lack of transparency regarding costs, and double payments to hybrid journals (paying to read with a subscription and paying to publish)– that have been accepted as inevitable. However, in today’s technological environment, these anomalies are solvable, and solving these anomalies is necessary to improve scientific communication (**Lewis**, 2012).

In any case, we cannot fail to point out that resistance to change does not only stem from inertia; it is often deeply rooted. Constructing the new OA framework or paradigm is possible, but these years of “practice” have shown that achieving what we have so far was not so easy. Along the journey that has led us to where we are today, we have seen that, underlying the journals, there is a web of often interdependent functions (*European Commission*, 2019), and that making a change for the better can lead to disturbances where we least expected them.

Open access is proving to be a complex movement, as, in its midst, diverse and often conflicting strategies are developing. We refer here to the discussions surrounding journals versus repositories (Lynch, 2017) or diamond journals versus those for which authors pay a fee (Herman *et al.*, 2020), or to the many colors (diamond, bronze, platinum, etc.) that we must add to our palette alongside green and gold to distinguish between types of open access modalities.

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This complexity obscures the core reasons behind the main obstacles to the full development of open access. These predate open access itself as well as the digitization of journals. Science’s importance as an economic engine and source of welfare has been increasing since the Industrial Revolution, which has led to a gradual professionalization of science (Snyder, 2021). At the end of the last century, this increase in the value of research led to a vicious cycle in scientific communication: publishing is central to one’s career (Fyfe *et al.*, 2017), many scientific journals are edited by commercial companies (Johnson; Watkinson; Mabe, 2018, pp. 73-76), subscription prices increase beyond the cost of living, some journals are viewed as the best and publishing in them increases professional prestige, improved library cooperation in terms of joint purchasing and interlibrary loaning reduces revenue from journal subscriptions, etc. It was not by chance that detailed economic studies on scientific journals were published in the first decade of the new century (Legros *et al.*, 2006; King, 2007; Houghton *et al.*, 2009).

In essence, what OA is doing is deconstructing the scientific communication system that was established in print so as to create an alternative model. And in this quest, as in many cases, the economy plays a central role. Thus, financial support for scientific communication today seems to be shifting from pay-per-read to pay-per-publish. The *Finch report* recommended supporting:

“publication in open access or hybrid journals, funded by APCs,”

as the primary system for publishing research and concluded that, if researchers want their results to be openly available, they must bear the cost of publication –something that readers have traditionally done (Finch, 2012). In his blog, Shieber (2014) advocated shifting from payments for reading to payment for publishing since, that way, the system had the potential to be a:

“much more transparent, competitive, and efficient market, which may well lead to overall cost reductions.”

Shortly thereafter, the *Max Planck Digital Library* published an influential white paper that stated that:

“all the indications are that the money already invested in the research publishing system is sufficient to enable a transformation that will be sustainable for the future. There needs to be a shared understanding that the money currently locked in the journal subscription system must be withdrawn and repurposed for open access publishing services” (Schimmer *et al.*, 2015).

This idea reinforces that of pay-to-publish and creates the drive to transform subscription agreements into open (“transformative”) agreements (Borrego; Anglada; Abadal, 2020). The economic background behind science communication’s shift to OA is highlighted by Poynder (2019) as follows:

“...governments have chosen to support OA for financial and economic reasons. For them, OA is grist to the neoliberal mill. That is, they believe greater openness will boost the national and/or regional economy and save money. They assume, for instance, that OA to scholarly papers will make it easier for SMEs to monetise publicly funded research and turn it into profitable products and services to drive the economy.”

3. Obstacles to building a new reality

However, this overall positive evolution has come up against two major obstacles that are slowing its progress: the double payments generated by hybrid journals (subscription and APCs) and the unchecked growth in APCs (Blanchard; Thierry; Van-der-Graaf, 2022). Thus, this has led to an increase in the overall cost of scientific communication, as, in addition to the costs of subscribing to journal packages, there is the new expense of publishing in journals that are fully open access owing to APCs (Johnson; Watkinson; Mabe, 2018; Blanchard; Thierry; Van-der-Graaf, 2022). In addition, this intensive use of APCs is creating a publishing divide between publishers that charge fees to authors and those that do not, and ultimately, it is causing dissension regarding the (previously shared) strategy toward open access.

Double payment

“Hybrid” journals, subscription journals that allow articles to be released with the payment of APCs, have been an opportunistic product that commercial publishers have created and leveraged to meet the demands of authors who had to comply with their agencies’ open access mandates, and they have been a strategy for them to further increase corporate profit margins. Springer, with its “open choice” option, was the first major publisher

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to provide the option of making articles openly available through the payment of publication costs or APCs. Since then (2012), this publisher and the others that publish hybrid journals claim that APCs lower subscription prices, a point that has been called into question by a part of the academic community that demands more transparency and has launched initiatives such as *Efficiency and standards for article charges (ESAC)* or *OpenAPC*:

<https://esac-initiative.org>

<https://openapc.net>

Hybrid journals represent a form of double payment that academic libraries (especially university libraries) have denounced from the outset: It is unacceptable that, in addition to their annual journal subscriptions, universities have to cover the APCs that their authors pay to these same journals. These abuses were denounced by library services in several countries (Germany, Sweden, etc.) and led to conflicts and discussions with journal publishers. *Plan S* has also been very critical of these journals and, in fact, requires them to have an open access transition plan by 2024 if the journals want to be “Plan S compliant”:

<https://www.coalition-s.org>

The aforementioned transformative agreements make it possible to change the pay-per-read model to a pay-per-publication model.

Increase in APCs

The cost for an author to publish a journal article can range from €200 to €10,000. According to a study by **Morrison et al.** (2022), the average APC per article has increased from USD 904 to USD 1,626 over the last 10 years, an increase well above inflation (an 80% increase compared with an actual inflation of 15%). **Khoo** (2019) also conducted a study on the evolution of APCs in the period 2012-2018 that included 319 journals from four major open access publishers (*BMC*, *Frontiers*, *Hindawi*, and the *MDPI*), revealing increases ranging from 17% (*BMC*) to 220% (*MDPI*).

How can this increase be explained? **Björk** and **Solomon** (2015) already showed that the level of APCs was correlated with the journal's prestige and impact factor. There is high demand from researchers for publication in the group of journals with the highest impact factor since they provide the opportunities for academic advancement that they are seeking. In this sense, the authors (the demand side) are not sensitive to fee increases or the existing range of the journal offering.

Thus, scientific journals are an economic sector that is “inelastic” in terms of price; that is, there is no price correction or adjustment between supply and demand (**Guédon**, 2001; 2014). There are journals that are similar (in terms of thematic focus), but authors want to publish in certain journals (those with a high impact factor), so there are no market mechanisms to regulate fees.

Finally, it has also been confirmed (**Khoo**, 2019) that the number of articles published continues to grow despite the high APCs. There is no relationship between the two variables.

The divide between publishers

This fee increase is creating a notable divide in the publishing world between publishers with APCs and those who are supported by public funding. APC revenues are constant and always rising, whereas public contributions, at best, remain flat (**Butler et al.**, 2022).

This divide can be seen at the editorial management level since journals with APCs can hire more staff, and therefore, the editorial processes (management of editing, proofreading, layout, publication, etc.) become faster and more agile.

On the other hand, there are also notable differences in terms of the capabilities of the publishing platforms since journals with APCs have better features available for managing edits, more attractive layouts, and preprint repository capabilities and include complementary metrics for each article (citation count, downloads, and presence on social networks, etc.).

This open divide between publishers has led to various initiatives that seek to strengthen non-commercial publishing platforms. Examples include:

- The *Action Plan for Diamond Open Access* (**Ancion et al.**, 2022).
- Latin American publishing consortia such as the scientific journal networks *Redalyc* and *SciELO*:
<https://www.redalyc.org>
<https://scielo.org/es>

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“*Plan S* has been very critical of hybrid journals and requires them to have an OA transition plan by 2024 if the journals want to be “Plan S compliant”

- The more unpretentious, but not insignificant, *RACO*:
<https://raco.cat/raco/index.php/es/inicio>
- *Scoap*, which transforms leading particle physics journals into open journals:
<https://scoap3.org>

Clearly, the weak point of some non-commercial open access schemes is their economic sustainability, and to address this, the *Global Sustainability Coalition for Open Science Services (Scoss)* has emerged; this is a union of major international associations committed to open access, and it raises funds that it then allocates to non-commercial open science projects and, more specifically, to open access to scientific publications:

<https://scoss.org/what-is-scoss>

Conflict among open access models

The heavy use of APCs has generated a schism of remarkable dimensions within the open access movement. Despite sharing the overall objective –to make all scientific content freely available for free– there is no longer any consensus on how to achieve this objective, and some authors and publishers openly criticize the use of APCs.

Thus, at one extreme, we have the main commercial publishers, those that had come from the traditional journal market and have converted to the open access model (*Elsevier, Springer, Sage, etc.*) and also those that were established in the new model (*PLoS, MDPI, Frontiers, Hindawi, etc.*). They all advocate for a free market when it comes to collecting APCs.

At the other extreme, we have Latin American publishers, producers of diamond journals (**Fuchs; Sandoval, 2013**), organized around *AmeliCA, Clacso, Redalyc, and SciELO*:

<http://amelica.org>

<https://www.clacso.org>

<https://www.redalyc.org>

<https://www.scielo.org>

They are highly critical of the collection of APCs because they believe that the original open access model is being distorted, and because it creates inequality between those who can publish and those who cannot (**Becerril, 2019; Aguado, 2021; Banzato et al., 2022**). They use a model that relies on cooperation and collaboration without having to use APCs, which, from their point of view, do not serve the interests of science but rather only those of the market (**Babini, 2019**).

In the middle ground, we have the publishing model being shaped by *Plan S* (**Abadal et al., 2019**), which does not prevent scientific journals from collecting APCs but imposes various restrictions, such as:

- Requiring transparency in regard to income
- Requiring discounts and exemptions to be given to authors from certain countries or those who are in entry-level (or late) positions in their academic careers
- Establishing fair costs for charges

This is a model that could be described as fair APC.

4. Some certainties in the road ahead

It seems, therefore, that there are no immediate, one-off solutions to overcome the aforementioned obstacles. Perhaps the first step we should take is to think of OA as just one part of science communication and as just one link in the chain of science. Everything as a whole form a coevolving system, in which one part cannot change if the others do not change as well, and in which any change in one agent leads to changes in others. Change is systemic and impossible to simplify (**Bartling; Friesike, 2014**). In any case, three actions can be mentioned that, in the medium term, can remedy the dysfunctions in the workings of open access mentioned above: changing the approach to the evaluation of science, adopting measures to regulate the APCs, and promoting alternative publication models.

Research assessment

Currently, the prevailing system for evaluating publications and authors is based almost exclusively on the journal's impact factor. To be promoted scientifically, authors must publish in the first quartile of the *Journal Citation Reports (JCR)*. As mentioned previously, APCs have been increasing unchecked because the pressure for authors to publish in journals with impact is incessant and relentless. Therefore, as long as the impact factor remains the key element in this evaluation, fees will continue their upward spiral.

“ Authors (the demand side) are not sensitive to fee increases or the existing range of the journal offering. Scientific journals are an economic sector that is “inelastic” in terms of price; that is, there is no price correction or adjustment between supply and demand ”

“ Journals with APCs can hire more staff, and editorial processes (management of editing, proofreading, layout, publication, etc.) become faster ”

The public request for changes in the approach to evaluation is now 10 years old. It started with the *San Francisco Declaration (DORA, 2012)* and was followed by the Leiden manifesto (**Hicks et al., 2015**) and by other European reports (**Wilsdon, 2015; European Commission, 2017**) and state petitions (**Delgado-López-Cózar et al., 2021; Ràfols; Molas-Gallart, 2022**) that demonstrated the need to modify the criteria for the evaluation of research and publications. These documents are highly critical of the monopoly on evaluating publications that the impact factor has held thus far and suggest, among other measures, evaluating at the article level, broadening the spectrum of measures to be incorporated into each publication (for example, with downloads or presence on social networks, i.e., altmetrics) and also incorporating qualitative points of view.

“The main difficulties when it comes to expanding OA are, on the one hand, the establishment of a new economic model that, taking into account the costs of quality publishing, is globally sustainable, and, on the other hand, the reputational system’s lack of adaptation to a new environment that values quality –social impact– over quantity”

More recently, there has been a very pronounced push on this issue. More than 350 European university and research institutions concerned about reforming the approach to evaluation have approved the document *Agreement on reforming research assessment*, launched by the *Coalition for Advancing Research Assessment (CoARA, 2022)*: <https://coara.eu/agreement/the-agreement-full-text>

The third commitment in this agreement clearly states that it should:

“Abandon inappropriate uses in research assessment of journal- and publication-based metrics, in particular inappropriate uses of Journal Impact Factor (JIF) and h-index.”

Fee regulation

Introducing some limitation on publication fees is a measure that has not yet been implemented, but it should not be ruled out (**Abadal; Nonell, 2019**). In this sense, one could conceive of a system with market prices regulated by research funders or state funding bodies, along the lines of the regulations that exist in the energy or drug markets.

Fee intervention could be carried out by applying maximum charges for the publication of articles, which would be set by the research funding agencies. This is already done in the health sector, which establishes maximum prices for medicines to be funded by the public health system, and also in the regulated gas market, which has maximum fees for reference.

The main argument in support of this proposal is based on the fact that this sector is primarily financed through public funds, which would make it possible to avoid the appeals to the unregulated free market that scientific publishers would make.

In any case, these are changes that will not happen quickly –far from it– because they also involve a change in the evaluation culture of many countries and because they require state intervention to regulate fees. However, it is also clear that, without these reforms, it will be truly difficult to decrease the high demand and, thereby, modify APCs.

Promoting alternative publishing models

Finally, it is important to explore and consolidate other models as alternatives to journals with APCs; among these alternative models, we should highlight peer review repositories, such as *Open Research Europe*: <https://open-research-europe.ec.europa.eu>

This is an open access publication platform funded by the *European Commission* and managed by *F1000* that, for the time being, is restricted to authors with funding from the *Horizon 2020*, *Horizon Europe*, and *Euratom* programs.

Two differential characteristics with respect to the prevailing model should be highlighted:

- The authors do not have to bear the publication costs (€780 per article); rather, they are directly financed by the *European Commission* itself, which would resemble diamond journals.
- They do not have an impact factor, nor do they intend to try to obtain one, as they are committed to a responsible use of metrics in evaluations. This does not preclude, however, the inclusion of metrics related to the article, such as citations, downloads, presence on blogs and social networks, etc.

These two characteristics make this new publication platform more similar to the aforementioned diamond journals.

Although it may seem impractical, it is sounder to base the development of open access on principles than on specific models. These, however ingenious and reasoned they may be, end up being overcome by a reality that is more than unpredictable, as can be seen if we look at the scenarios described by **Smith (2015)** or projected by **Van-Barneveld-Biesma et al.**

“Scientific communication must be open, yes, but it must also guarantee efficiency (with respect to cost), effectiveness (with respect to the role it fulfills), and equity (with respect to the society that it serves and that funds it)”

(2020). Instead, there are three trends that appear to be strong: increased diversity, the promotion of values, and interoperability. The promotion of diversity makes it possible to accommodate and make room in scientific communication for other languages, geographies, and disciplines beyond the dominant ones. Scientific communication is based on systems that respect and promote the values postulated by open science (equity, transparency, cooperation, social impact, etc.). Ultimately, all of this together creates an ecosystem of more or less independent but interoperable entities (i.e., findable, accessible, interoperable, reusable [FAIR]).

“ Changing the approach to the evaluation of science, adopting measures to regulate the APCs, and promoting alternative publication models can correct the dysfunctions in the way open access works ”

5. Open access: a systemic (and optimistic) view

Over the past 20 years, the OA movement has created a favorable environment such that the articles that come out of research can be used in a much more equitable environment than subscription-based access. OA has limitations and imperfections, but it still removes the payment barrier and frees up scientific content for reuse. In turn, and perhaps without being fully aware of it, OA has acted as the vanguard and spearhead of a broader movement: that of open science (Miedema, 2022; Nielsen, 2012).

OA's consolidation has been in parallel to data's rise to prominence, in general, and specifically in scientific research, and this greater prominence can only be understood today in conjunction with its openness. Open science naturally furthers OA's objectives because it aims to make the results of scientific research the “freely accessible, fully searchable, inter-linked form”, as called for in the *Public Library of Science (PLOS)* charter. Today we would say FAIR.

Some of the challenges related to open science are new, as they apply to very diverse things (data, lab notebooks, software, etc.), but some reflect those found in the process of opening up the scientific literature. OA's main achievements –its acceptance by the scientific community and the recognition of its benefits– have undoubtedly served as leverage for politicians to dare to expand these objectives to the whole of science. Finally, the idea at the core of open science –that science in the service of society cannot be penned in– is the one that influenced OA from the outset:

“this public library would vastly increase the accessibility and utility of the scientific literature [and] enhance scientific productivity” (Varmus; Brown; Eise, 2000).

The main difficulties when it comes to expanding OA have not been technological; rather, they are, on the one hand, the establishment of a new economic model that, considering the costs of quality publishing, is globally sustainable, and, on the other hand, the reputational system's lack of adaptation to a new environment that values quality –social impact– over quantity (CoARA, 2022). This shows that the necessary reform of scientific practice cannot be partial, and it must be systemic. The various analyses of the current research environment point to the profound transformation of all the processes of scientific research, as well as their clear interdependence. In this view of science, scientific communication does not stand alone, and if science is open, scientific content must also be open. If open access has acted as a torch-bearer of open science, the development of the latter will facilitate a faster, more extensive, and better development of OA through the expansion of the FAIR concept to all scientific objects, the use of new metrics, and the elimination of barriers that hinder interoperability.

What do we want science to be like? If we want it to be social, collaborative, and reproducible –that is, open– scientific communication must also be so. The driving force making this possible is the idealism that inspired the OA movement at its start, but it must be developed with the pragmatism of the lessons learned during the long journey already undertaken. Some obstacles encountered by OA are not groundless pretenses of the status quo but rather correspond to legitimate elements of what is at stake (reputational capital, the costs of scientific communication, and the need for innovation).

Complete OA will be achieved if it is tied to the challenges and solutions related to open science and if the emphasis is on the ends rather than the means. Scientific communication must be open, yes, but it must also guarantee efficiency (with respect to cost), effectiveness (with respect to the role it fulfills), and equity (with respect to the society that it serves and that funds it).

“ OA has acted as the vanguard and spearhead of the broader open science movement ”

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