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**Open access for degrowth: a literature review on the economic, social, and environmental impact of journal models.**

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**Introduction:**

The traditional model of academic publishing largely relies on paid subscriptions, creating major barriers to information access for researchers and resource-limited institutions (Suber, 2012). The context of restricted access has gradually led to an increasing awareness of the limitations of the traditional publishing model and has fueled the rise of the open access movement, aiming to make academic research accessible to all without financial barriers (Suber, 2012). Open access literature (OA) is digital, online, free, and largely free of copyright and licensing restrictions (Suber, 2012). There has long been an idea that open access should bring benefits not only to readers but also to authors (Willinsky, 2005). Open access (OA) to research has become a major topic of interest in the global academic landscape, sparking lively debates on its economic and social implications. The European Plan-S initiative, aiming to make all publicly funded research immediately accessible to the public, embodies the increasing importance placed on research accessibility (Kwon, 2018; Rabesandratana, 2019). The open access movement is driven by a deep philanthropic mission, focusing on the dissemination of knowledge for the progress of society as a whole (Friesike et al., 2015). While the benefits of OA for scholars are often discussed, its broader social impact on research visibility and financial relief for academic institutions is becoming increasingly apparent (Tillinghast, 2009). Conversely, there is a gap in the scientific literature regarding the environmental impact of open access (OA).

Today, the Open Access (OA) system of scientific publications offers three main models: gold, where authors pay to make their article freely accessible; green, where articles are deposited in archives after a paid access period; and hybrid, combining restricted access and OA for a fee. A new approach, the diamond route, offers nonprofit free access, funded by grants and complementary paid services.

While open access can apply to all forms of published research outcomes (conference papers, images, etc.), the primary focus of open access is peer-reviewed research literature, in the form of scientific articles published in academic journals. Furthermore, the landscape of publishing these open-access journals is complex and diversified, with different models presenting unique benefits and challenges (Beall, 2013). Questions remain about the viability and effectiveness of open access publishing models, especially the Diamond OA model (Burgelman et al., 2019). Open access (OA) articles are accessible through green (deposits) and gold (journals) open access; OA journals come in three types: full, hybrid, and delayed.

In this debate on whether open access publishing should become the predominant model of scientific publishing, this literature review aims to explore the existing academic contributions regarding the measurement of the economic, social, and environmental impact of various open access journal models. This literature review sets the stage for an empirical study of systemic evaluation, examining, in a triangular manner (in terms of economic degrowth, social equity, and ecological sustainability), the different forms of access to scientific articles.

The objective of this systematic literature review is to examine the state of knowledge regarding the economic, social, and environmental impact of open access (OA) journals, with the aim of providing a comprehensive and informative overview of this rapidly evolving field. To achieve this objective, we will follow the methodological recommendations for synthesizing articles as defined by Guy Paré and colleagues (2023).

This literature review will examine OA according to Jamie Farquharson's model differentiation grid for OA models (2018) (see Figure 2), which provides a holistic perspective on the various approaches adopted by journals in opening access to scientific research. We will explore the distinctive characteristics of OA models, including costs for readers and authors, copyright retention, peer review practices, and implications for environmental sustainability. Additionally, we will analyze to what extent the scientific literature provides us with evaluation indicators for the economic, social, and environmental impact of OA journals. We will examine the methods and metrics used to assess these impacts, as well as the main findings and conclusions of previous studies. By combining these different perspectives, we aim to provide a comprehensive analysis of what the literature offers in terms of the impact of OA journals.

To do so, this article will first address I) in general, how is the evolution of Open Access perceived in the 20 articles, then II) the economic implications of open access journal models, focusing on cost structure, economic models, as well as collaboration and innovation aspects. Next, III) we will explore the social impact of open access, including its role in promoting equity of access to knowledge and global scientific collaboration. Finally, IV) we will address the issue of the environmental footprint of open access publishing, with our research perspectives on this matter.

### **Methodology:**

To select academic articles defining the impact of open access journals, a systematic research methodology is applied. This methodology provides a structured, systematic, and transparent approach to article selection.

Development of the search query: The research query "open access journals impact" was entered into the Web Of Science search engine: ALL= (open access journals impact). This query was entered into the "webofscience" search engine.

Initial results filtering: The research query generated an initial list of 2622 articles which we filtered. To refine this list, an initial filtering was done by selecting only "articles, in English, from journals published in academic journals," then a second selection was made by examining the titles and abstracts of the articles. Articles that, upon reading the title and abstract, did not seem relevant to the study's objective were excluded at this stage. The list of articles was thus reduced to 23.

Broadening the search: To ensure the inclusion of all relevant articles, additional similar queries were made on Google and Google Scholar, which allowed us to add 5 articles to the 23 selected via Web Of Science: "Environmental impact of open access journals," "Economic impact of open access journals," "Social impact of open access journals."

Final review and article selection: The remaining articles are examined in their entirety to assess their relevance and quality based on the inclusion and exclusion criteria defined previously. The selected articles forming the final sample for analysis are 20 in number.

**Table 1: The Economic, Social and Ecological aspects covered in the Selected Articles, with their methodologies**

Article	Methodology	Economic	Social	Ecological
Becerril et al 2021.	Survey and statistical analysis on 1619 journals	-Dynamics and life cycle of diamond open access academic journals. - Number of diamond open access academic journals and associated articles	-Scope of diamond open access academic journals -Dynamics and life cycle of diamond open access academic journals	----- -
Björk, Bo-Christer 2017.	a qualitative analysis based on a literature review	-Open access promotes innovation	-Level of accessibility and visibility of articles	----- -
Lewis, D. W. 2012	documentary study	-Benefits research authors and readers	-Level of accessibility and visibility of articles	----- -
Korean Council of Science Editors 2022	Survey and statistical analysis of diamond journals	- The dynamics and life cycle of journals	----- -	----- -
Farquharson et al. 2018	Literature review	-Cost of publishing articles	-Financial barriers to academic publishing	----- -
Fuchs and al. 2013	Analytical and argumentative approaches to the diamond open access publishing model	----- -	-Monopoly pricing and access inequalities -Equalizing the playing field between developed and	----- -

			developing countries	
Harnad et al. 2008	Benchmarking and trend assessment	-Publication fees and associated costs to cover.	- Level of maximizing access to research outcomes	----- -
Maddi et al. 2022	Quantitative analysis on OpenAPC database	-Cost structure, economic models -Paying high APCs does not necessarily increase publication impact.	-Level of accessibility and visibility of articles.	----- -
Martín-Martín, Alberto et al 2018	Documentary study	-A conceptual OA model with six different dimensions (authority, user rights, stability, immediacy, peer review and cost)	----- -	----- -
Morrison, Heather 2013	Macro-level economic data analysis	- Average cost per article. -Level of economic efficiency of journals	----- -	----- -
Mounier, Pierre 2012	Documentary study	-Free access to information with the option to subscribe to premium services -GDP per capita and the number of students or staff as a basis for pricing	----- -	----- -
Nosratabadi et al.2019	Documentary study	----- -	----- -	-The competitive advantage and performance of sustainable business models.
Publications Office of the	Documentary	-Indications of	- Privacy	-----

European Union 2023	study	benefits such as: innovation and improvement of public services.	protection -Data quality and equitable access.	-
Rodrigues et al.2020	Quantitative analysis on the DOAJ database	-The level of concentration of intellectual property ownership among different OA journals.	----- -	----- -
Schroter et al.2006	Quantitative data analysis on authorship and article's metadata on 3 journals	- Journal reputation and perceived quality.	----- -	----- -
Solomon et al.2012	Quantitative analysis on the OpenAPC database	-Article processing charges (APC).	----- -	----- -
Suber, Peter 2012	Documentary study	-Benefits research authors and readers	----- -	----- -
Suber, Peter 2016.	Documentary study	-Benefits research authors and readers -The flexibility of funding models	----- -	----- -
Tennant et al.2016	Documentary study	-The effect on publishers and non-publishers. -The price of Open Access	-Degree of access to knowledge -Open access in developing countries -Deceptive practices	----- -
Bouffard et al.2022	Comparative analysis and documentary study	----- -	----- -	-The carbon footprint of a scientific publication

*1) In general, how is the evolution of Open Access perceived in the 20 articles?*

Subscription fees for scientific publications experienced exponential growth towards the late 1990s, leading universities, libraries, and research institutions to face funding shortages to access all necessary publications (Suber, P., 2012). This access limitation gradually raised awareness of the shortcomings of the traditional publication model (Willinsky, J., 2006; Suber, P., 2012). The beginnings of the Open Access (OA) movement are generally dated to the year 2002, marked by the Budapest Open Access Initiative (BOAI) declaration (Chan et al., 2002). The advent of early pioneers such as arXiv.org in 1991 heralded a new era in the dissemination of scientific knowledge, offering an alternative that would later revolutionize the norms of scientific communication and pave the way for greater transparency within the scientific community.

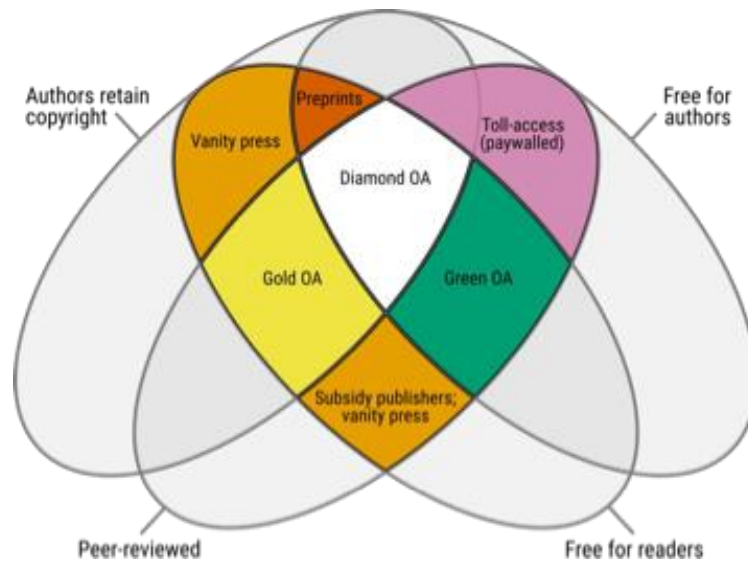
In 2000, the creation and launch of PubMed represented a major advancement in the field of open access, serving as an open-access repository containing a vast collection of scientific articles (Suber, 2009). This rapid growth of online publishing profoundly reshaped the future of scientific dissemination, challenging the conventional model. The concept of open-access publishing, offering free access to users, is now widely perceived as a viable new paradigm for the dissemination of scientific knowledge (Lewis, D. W., 2012).

Today, various OA models exhibit a diversity of characteristics regarding costs for readers and authors, copyright retention, and peer review practices. Additionally, several criteria for identifying and classifying OA models are available, such as the grid developed by Alberto Martín-Martín (2018), which proposes six distinct dimensions: prestige, user rights, stability, immediacy, peer review, and cost.

Open access to scientific publications generally consists of three main models, although there are several variants and combinations: the gold model, the green model, and the hybrid model. The gold model, according to Suber, P. (2012), allows readers to access articles for free, with publication fees often covered by authors in the form of article processing charges (APCs). In contrast, the green model allows authors to deposit a version of their article in an open-access repository, such as an institutional archive or disciplinary archive, after an embargo period, during which the article is typically accessible via a paid subscription to the journal (Harnad, S., 2001). Finally, the hybrid model offers a combination of traditional subscription-based access and OA, allowing authors to pay publication fees (APCs) to make their article freely available in a traditional subscription-based journal (Pinfield, S., 2014).

A third path is emerging, often considered a variant of the gold route, the diamond route, also known as the platinum or diamond route. In this view, non-profit organizations, associations, or networks publish digitally accessible content online, free of charge for readers and authors, and do not allow commercial or for-profit reuse (Fuchs et al., 2013). Journals or platforms adopting this model may be supported by grants as well as revenues related to a freemium model including paid complementary services or features. The OADJS study (John Willinsky, 2023) emphasizes the diversity of resources in the diamond model, a significant portion of which comes from researchers themselves, who, in addition to their research and teaching activities, engage in significant editorial work, as well as public funds playing a critical role.

Figure 1 : Diamond open access venn diagram



Source : [https://figshare.com/articles/figure/Diamond\\_open\\_access\\_venn\\_diagram\\_fr\\_SVG\\_/21602334](https://figshare.com/articles/figure/Diamond_open_access_venn_diagram_fr_SVG_/21602334)

These models offer different approaches to making research accessible to the public, each with its advantages and challenges. However, evaluating the impact of scientific articles is of paramount importance and attracts significant attention, thus becoming a concern for researchers, journals, institutions, and countries (Cronin and Sugimoto, 2014). These models also raise many questions, including who pays for and who benefits from the various implementations of open access (Tenopir et al., 2017). It is crucial to understand how open access publishing models may alter the revenue structures of publishers and stakeholders in the research industry. On a social level, it is important to assess to what extent open access promotes inclusivity and diversity in the dissemination of scientific knowledge, as well as to examine the environmental implications of different publishing models, considering the digital footprint of OA models and the carbon emissions associated with editorial processes.

*II) The importance of understanding cost structure, economic models, as well as collaboration and innovation for a comprehensive economic evaluation."*

In the literature on the economic impact of open-access (OA) scientific journals, a wide range of topics are addressed, ranging from the financial viability of OA models to their implications on publication costs, publisher revenues, and research institution budgets.

Understanding the cost structure of open-access (OA) journals is a fundamental pillar for assessing their economic impact (Chen et al., 2021). The study conducted by Chen and colleagues highlights the diversity of costs associated with OA publishing, encompassing both production expenses and management costs. This analysis underscores the crucial importance of this perspective in evaluating the financial sustainability of OA journals.



A detailed assessment of publication costs conducted by Richard Van Noorden (2013) reveals that the average cost for an editor to produce an article would likely range from \$3,500 to \$4,000, and the scientific publishing sector generated approximately 1.8 million English-language articles in 2011, with an average revenue per article of around \$5,000. Estimating industry profit margins between 20 and 30%. Furthermore, the study by Bo-Christer Björk and colleagues (2013), covering 100,697 articles published in 1,370 active open-access journals in 2010, reveals a wide range of publication fees, ranging from \$8 to \$3,900.

By examining publication practices, disparities between OA and traditional journals, as well as concerns regarding quality and editorial integrity, Richard Van Noorden (2013) provides a critical analysis of the scientific publishing landscape, focusing on the economic model of open-access (OA) journals and questioning perceived value versus incurred costs. While raising fundamental questions about the utility and impact of low-cost OA journals.

Economic models and sources of funding for OA journals play a determining role in their economic impact (Morrison, 2017). Examining various funding sources, including author publication fees, institutional grants, and partnerships, provides valuable insights into the financial dynamics underlying OA journals. There is a growing interest in the impact of OA journal economic models on collaboration and innovation (Park et al., 2023), highlighting the importance of collaborations among researchers, publishers, and institutions to enrich the OA publishing landscape, while exploring innovations in editorial and economic models as drivers of change.

Furthermore, another dimension of academic impact is frequently measured by the number of citations, which remain fundamental as "currency" for researchers, research groups, institutes, and universities (Lawrence, 2001). Open access (OA) of scientific articles also generates considerable interest regarding its influence on the number of citations received by articles. A frequently advanced hypothesis is that open access articles may benefit from an advantage in terms of citations compared to those subject to paid access barriers (Antelman, 2004; Eysenbach, 2006; Lewis, 2018). This hypothesis is supported by the theory that broader access to research increases citation opportunities, with each additional reader potentially citing the article.

Indeed, the debate on the existence of a systematic difference in the number of citations between open access (OA), self-archived open access (green), and non-open access (non-OA) articles is complex and ongoing (Antelman, 2004; Eysenbach, 2006; Craig et al., 2007). Some authors have questioned this observation, suggesting that the difference could be influenced by other factors such as the early availability of OA articles (Craig et al., 2007). Regarding citation diversity, few studies have addressed this issue, although some researchers suggest that open access could promote greater disciplinary diversity of citations (Chen, Arsenault, & Larivière, 2015). However, further research is needed to confirm these observations and explore in more detail the relationship between OA status and citation diversity.

*III) The literature on the social impact of open access to scientific research explores various areas such as equitable access to science, the high cost of journal subscriptions, the impact on the quality of education, and international scientific collaboration.*

The exponential growth of online publications has reshaped the methods of knowledge dissemination and access to scientific research, thus challenging the conventional publishing model. The most significant

advantages considered include "more equitable access to science for developing countries" (Sara Schroter and Leanne, 2006) and limited financial resources for research institutions. It goes without saying that OA provides a mechanism to level the playing field between developed and developing countries.

The issue of high subscription costs for journals has a major impact on access to scientific information, especially in developing countries. This situation has been documented by Tenopir et al. (2019), who found that academic institutions, particularly in low-income countries, struggle to finance access to scientific journals due to their high costs. One documented example in the OA literature is the 2014 Ebola epidemic in Liberia, which could have been better managed if doctors and officials had access to relevant research papers (Nyenswah et al., 2016), an example that clearly highlights the negative repercussions of financial barriers to accessing scientific information. In the field of public health, OA can have a significant impact by providing rapid and free access to the latest research on diseases and health interventions, as emphasized by Shaffer and Roberts (2008), Suber (2012).

The opening of access to scientific publications plays a crucial role in promoting equity in knowledge access. Studies such as those by Houghton and Swan (2011) and Chan and Costa (2005) have emphasized the importance of this aspect by enabling free and open access to research outcomes, thereby reducing disparities between developed and developing countries.

In a world offering free and unrestricted access to educational resources, open access and its derivative models present a unique opportunity to enhance educational relevance and effectiveness. Hilton III (2016) and Petrides et al. (2011) highlight the positive impact of using these open educational resources on students' learning experiences. By allowing learners to access a diverse range of educational materials, including textbooks, research articles, and online courses, OA expands educational horizons and encourages exploration and intellectual curiosity. Moreover, these resources can be adapted and customized to meet the specific needs of learners, thereby supporting innovative and differentiated teaching practices that promote active and engaged learning.

At the level of collaboration among researchers globally, Swan and Brown (2008) and Friesike and Söllner (2017) shed light on the crucial importance of transparent and instantaneous sharing of research findings in advancing scientific knowledge. This collaboration, intensified by OA, fosters the exchange of ideas, replication of studies, validation of results, and resolution of complex problems that transcend national boundaries. As a result, OA strengthens the global nature of scientific research, enabling significant advances in areas such as health, environment, technology, and many others.

*IV) The carbon footprint of a publication is estimated to be approximately 5 kg of carbon dioxide equivalent (CO<sub>2</sub>e).*

The scientific literature broadly explores the environmental impact of the digital transition, highlighting the challenges and opportunities associated with this technological evolution. However, despite the growing importance of open science in this context, there is a notable gap in research on the specific impact of open access (OA) journals on the environment.

The exponential growth of digital data, driven by technological advancements, raises concerns about the responsibility of their production and storage. In a research paper commissioned by the European Commission (as part of Data.Europa.eu), Charlotte van Ooijen et al. (2023) emphasize the urgency of rethinking current practices of data collection, processing, and storage to mitigate their environmental impact. By opting for approaches aimed at reducing data duplication and favoring less energy-intensive file formats, we can move towards more environmentally friendly open science.

The implementation of FAIR principles (Findable, Accessible, Interoperable, and Reusable) is crucial for effective research data management, ensuring their preservation under optimal conditions of interoperability and reusability. However, the application of these principles can also lead to increased consumption of computing resources, exacerbating the carbon footprint of open science. "Rigorous and consistent research data management is now a major challenge for the production of new scientific knowledge" (Hadrossek et al., 2023). Recommendations for more ecological data management are provided by the good practice guide on research data management (Hadrossek et al., 2023).

### **Research perspective:**

Building on the debate about whether open access publishing should become the predominant model in scholarly publishing, and following this literature review, our next step is to quantitatively evaluate each OA model across three levels of analysis (economic, social, and ecological).

We advance that the different models have different economic, social and ecological impacts. These differences depend on the phenomena described in Table 2.

**Table 2: Economic, social and ecological impacts of open access models**

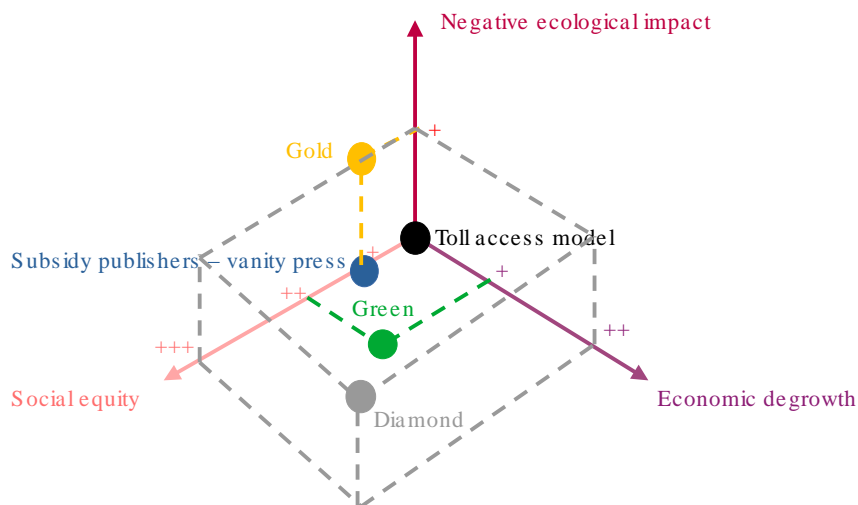
<i>Model</i>	<i>Economic degrowth</i>	<i>Social equity</i>	<i>Ecological sustainability</i>
<i>Toll-access (paywalled)</i>	<i>The readers pay for accessing the articles, while the authors publish for free. Articles are considered sources of financial profits for the publishers. This logic favors economic growth.</i>	<i>If we assume that, on average, authors (ex. researchers) are professional that can be financially backed by their employers to pay for publication and that readers (ex students) are less likely to be able to support the financial burden of a paywall to access the paper, the toll-access does not favor social equity.</i>	<i>The usual licenses for toll-access limit the distribution and sharing of the copies of the articles, hence the article is available only at a limited set of online databases. These databases have a negative ecological impact, by limiting the number of databases where the articles are available, toll-access limits the negative ecological impact.</i>
<i>Gold Open Access</i>	<i>Authors pay for publication via the Article Processing Charges, while readers will have free access to the article. Hence there is a</i>	<i>If we assume that, on average, authors are professional that can be financially backed by their employers to pay for publication and that readers are less likely to</i>	<i>The usual licenses for Gold open access allows free distribution and sharing of the copies of the articles, facilitating duplication in</i>

	<p><i>change in terms of payers, from readership to authorship, but the total amount of revenues and profits expected by publishers could be exactly the same of toll-access model. This logic still favors economic growth.</i></p>	<p><i>be able to support the financial burden of a paywall to access the paper, the gold open access favors social equity.</i></p>	<p><i>multiple online databases. These databases have a negative ecological impact, by freeing the number of databases where the articles are available, Gold open access increase the negative ecological impact.</i></p>
<p><i>Green Open Access</i></p>	<p><i>Authors do not pay to publish and readers do not pay to access the articles. The expenses of publication are usually double. By one side, the authors' employers or not-for-profit organizations, support the costs for the publication of the author's accepted manuscript. These employers and not-for-profit organizations are not allowed to paywalled the author's accepted manuscript. The pursuit of financial profits and economic growth is stopped. On the other side, the publishers, which support the costs for the publication of the version of record manuscripts, can pursue revenues and profits as in the toll-access model. This logic still favors economic growth. Nonetheless, the profit opportunities could be reduced by the availability of the authors' accepted version of the manuscripts. Finally, economic degrowth depends on degree of easy and widespread access to the authors' accepted version in comparison to the ones of publisher's versions of record.</i></p>	<p><i>The enhancement of social equity depends on two factors. By one side, the social equity depends on the degree of easy and widespread access to the authors' accepted version in comparison to the ones of publisher's versions of record. On the other side, social equity depends on the extent to which the financial resources to cover the publication costs of the author's accepted manuscript are not taken away from more important social equity initiatives (ex. refugee relief programs).</i></p>	<p><i>Same as Toll-access</i></p>
<p><i>Diamond Open Access</i></p>	<p><i>Authors do not pay to publish and readers do not pay to access the articles. The</i></p>	<p><i>The enhancement of social equity depends only on the extent to which the financial resources to</i></p>	<p><i>Same as Gold open access</i></p>

	<p>expenses of publication are usually supported by employers or not-for-profit organizations. The publication is hence a financial cost for the publisher, rather than a source of financial profits and economic growth. The publication being a financial cost, publishers would put in place cost reduction actions, inducing some economic degrowth. Only the establishment by publishers of advertising business models (generating revenue by selling advertising space on their publishing platform) could reverse the economic impact and generate economic growth.</p>	<p>cover the publication costs of the author's accepted manuscript are not taken away from more important social equity initiatives (ex. refugee relief programs).</p>	
Subsidy publishers vanity press	Same as Gold open access	Same as Gold open access	Same as Toll-access

The projection of these differences on a three dimensional space with at the axes the degree of economic, social and ecological impact of the different models produces Figure 2.

Figure 2: 3D comparison to the toll access model at the origin of the axes



We advance the following three propositions to be further explored:

-*Proposition 1: The model that contributes most to economic downturn is the Diamond access model, followed by Green, while the Gold and Vanity Press models are not significantly different from the paid model in terms of their contribution to economic growth.*

-*Proposition 2: The Diamond Green and Diamond models have a better contribution to social equity, followed by the -Green model, and then the Vanity Press and Gold models compared to the paid model.*

-*Proposition 3: Regarding ecological impact, the Green and Vanity Press models have the same impact as the paid access model, while Gold and Diamond have a more negative ecological impact.*

## **Conclusion:**

The potential benefits of open access, such as equity of access to knowledge, improvement of education, and promotion of global scientific collaboration, are clear. However, it is also essential to recognize the persistent challenges related to financial viability, the perception of the value of open access, and the carbon footprint of each model. As the transition to open science continues, it is imperative to conduct further research to quantify the economic, social, and environmental implications of this evolution. In-depth studies are needed to systematically evaluate the effectiveness of different open-access journal models and to identify strategies to maximize benefits while mitigating potential drawbacks.

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