



Citation differences across research funding and access modalities

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ABSTRACT

This research provides insight into the complex relationship between open access, funding, and citation advantage. It presents an analysis of research articles and their citations in the Scopus database across 40 subject categories. The sample includes 12 categories from Health Sciences, 7 from Life Sciences, 10 from Physical Sciences & Engineering, and 11 from Social Sciences & Humanities. Specifically, the analysis focuses on articles published in 2016 and the citations they received from 2016 to 2020. Our findings show that open access articles published in hybrid journals receive considerably more citations than those published in gold open access journals. Articles under the hybrid gold modality are cited on average twice as much as those in the gold modality, regardless of funding. Furthermore, we found that funded articles generally obtain 50 % more citations than unfunded ones within the same publication modality. Open access repositories significantly increase citations, particularly for articles without funding. Thus, articles in open access repositories receive 50 % more citations than paywalled ones.

Introduction

Since the emergence of the world wide web, scientists and scholarly publishers have used different forms of Open Access (OA), a disruptive model for the dissemination of research publications (Björk, 2004). Open access is a movement in academic publishing that aims to make academic materials freely and openly accessible to all. Academic libraries are crucial in supporting OA initiatives by providing access to OA resources and hosting institutional repositories where researchers can deposit their publications. Open Access is important in the academic community and academic libraries are at the forefront of this movement, working to make scholarly research more widely accessible (McAllister et al., 2022).

Open Access is becoming increasingly popular as a means of making scientific research more accessible, transparent, and impactful. Academic libraries have an important role in promoting the OA. They can provide financial support for OA publishing fees, help researchers identify OA publishing opportunities, and provide training on best practices for OA publishing (Mercer, 2011).

The defining trait shared by all variations of Open Access is that the peer-reviewed article, which serves as the main medium of communication for research findings, is freely accessible to anyone with an internet connection and without any access restrictions (Prosser, 2003).

In the last years, more and more scientists are making their research results openly accessible to increase its visibility, usage, and citation impact (Dorta-González et al., 2017, 2020). The citation advantage is important because it provides evidence of the impact and relevance of the research to the scientific community and to society (Aksnes et al., 2019). However, it is necessary to understand the factors that contribute to the citation advantage, and one of these factors is funding. Research funded by government agencies or non-profit organizations may require or encourage researchers to publish their findings in OA journals, thus increasing the visibility and accessibility of their research.

The four main modes of Open Access are as follows: Gold OA, which pertains to scholarly articles published in fully accessible Open Access journals; Green OA, which involves publishing in a subscription or pay-per-view journal, alongside self-archiving the pre-print or post-print paper in a repository (Harnad et al., 2004); Hybrid Gold, an intermediate form of OA where authors pay scholarly publishers to make articles freely accessible within journals that would otherwise require a subscription or pay-per-view to read (Björk, 2017); and finally, Bronze OA (delayed OA), which refers to scholarly articles in subscription journals that are made openly available on the internet directly through the publisher after a specific embargo period has elapsed (Laakso & Björk, 2013).

According to Prosser (2003), Hybrid journals offer a safe pathway to

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transition towards full Open Access (Gold), unlike creating new Open Access journals or converting existing ones, as subscription revenue is retained. Nonetheless, the cost of publishing in Hybrid Gold journals is usually around 3000 USD, which numerous authors and their institutions consider exorbitant (Tenopir et al., 2017). According to Zhang et al. (2022), certain publishers do not specify the APC for individual journals but instead provide a standardized rate. For instance, the APC for American Chemical Society's hybrid journals is 5000 USD, while IEEE's hybrid journals charge 2045 USD. Taylor & Francis' hybrid journals require a fee of 3000 USD, as do Sage's hybrid journals.

Although Lawrence (2001) proposed the Open Access (OA) citation advantage more than twenty years ago, its validity has been the subject of extensive debate without a consensus being reached, as noted by Davis et al. (2008) and Langham-Putrow et al. (2021). Additionally, some authors are sceptical about the causal relationship between OA and increased citations, arguing that the advantages of OA are not definitive and may differ across various disciplines (Davis & Walters, 2011).

Greater accessibility to research articles via Open Access likely contributes to some of the citation advantage as it enables more individuals to read and potentially cite papers they may not have had access to otherwise. However, establishing correlation is challenging, and numerous biases may exist. Several variables can influence the observed differences in citation rates, such as funder mandates. Funder requirements for Open Access are frequent, and studies with more funding are likely to receive more citations than those with less funding (Aagaard et al., 2020).

Costas and van Leeuwen (2012) state that the acknowledgments section of a research publication is where the authors express gratitude towards entities that contributed, inspired, or financed the research. However, the present study focuses solely on funding acknowledgements, which are acknowledgements that specifically recognize the financial support provided to the research. Funding is a crucial component of the research process, and it has been a subject of research interest since the 1970s (Álvarez-Bornstein & Montesi, 2020; Desrochers et al., 2017; Liu, 2020; Liu et al., 2020). These studies have examined various aspects of funding, including the types of funders acknowledged, the language used in funding acknowledgements, and the impact of funding on research outcomes.

The objective of this paper is to determine if citation differences are related to funding. We seek to quantify the variation in citation rates based on financing and accessibility modes, encompassing Gold, Hybrid Gold, Bronze, Green, and Paywalled options.

Open access citation advantage

The OA citation advantage, first proposed by Lawrence in 2001, has been observed in various academic fields including computer science (Lawrence, 2001), philosophy, political science, electrical and electronic engineering, and mathematics (Antelman, 2004), physics (Harnad et al., 2004), biology, and chemistry (Eysenbach, 2006), as well as civil engineering (Koler-Povh et al., 2014). However, despite extensive discussion in the literature, there is no agreement on this postulate (Davis et al., 2008; Dorta-González & Santana-Jiménez, 2018; Gargouri et al., 2010; González-Betancor & Dorta-González, 2019; Joint, 2009; Norris et al., 2008; Wang et al., 2015). Moreover, some authors have criticized the causal link between OA and higher citations, arguing that the benefits of OA are uncertain and vary across different fields (Craig et al., 2007; Davis & Walters, 2011).

Kurtz et al. (2005) and subsequent authors (Craig et al., 2007; Davis et al., 2008; Moed, 2007) proposed three postulates to support the existence of a correlation between OA and increased citations. Firstly, the Open Access postulate suggests that OA articles are easier to obtain, read, and cite. Secondly, the Early View postulate suggests that OA articles are often available online before their publication, giving them a head start in accumulating citations compared to pay-for-access articles.

Lastly, the Selection Bias postulate suggests that more prominent authors are more likely to provide OA to their articles, and authors tend to provide OA to their best quality articles.

Studies by Gaule and Maystre (2011) and Niyazov et al. (2016) found evidence of selection bias in OA but found statistically significant citation advantages despite controlling for this bias. While the validity and generalizability of their findings may be debatable, their research highlights the need for any analysis of OA citation advantages to consider the influence of time and selection bias.

Gumpenberger et al. (2013) showed that the impact factor of gold OA journals was increasing, and that after three years, one-third of newly launched OA journals were indexed in the Journal Citation Reports (JCR). However, Björk and Solomon (2012) disputed that the economic model of a journal is unrelated to its impact factor. This finding was supported by Solomon et al. (2013), who concluded that articles are cited at a comparable rate irrespective of the distribution model.

Not all studies support the existence of the OA citation advantage, with some being criticized for their methodology (Davis & Walters, 2011) and randomized-control trials failing to find evidence for it (Davis, 2011). However, recent studies employing robust methods have found evidence of an OA citation advantage. McCabe and Snyder (2014), for example, used a sophisticated statistical model to control for author bias and observed a modest but significant 8 % OA citation advantage. Archambault et al. (2014) used a large sample of over one million articles and field-normalized citation rates to demonstrate a 40 % OA citation advantage. Similarly, Ottaviani (2016) found a 19 % OA citation advantage when excluding the author self-selection bias and looking beyond the first few years after publication.

Piwowar et al. (2018) conducted a study that analyzed three sets of 100,000 articles to investigate OA in three populations: all journal articles assigned a DOI, recent journal articles indexed in Web of Science, and articles viewed by users of the open-source browser extension Unpaywall. The researchers found that at least 28 % of scholarly literature is OA, with gold and hybrid journals being the main contributors to the growth. After controlling for age and discipline, they found that OA articles received 18 % more citations than the average article, with green and hybrid OA being the primary drivers of this effect.

Methodology

The Scopus database includes open access filters as of the end of 2020, allowing users to access information on the modality of open access. With this classification system, users can filter their results or use specific open access tags such as gold, hybrid gold, bronze, and green. The source of OA information in Scopus is Unpaywall, an open-source browser extension (managed by Impactstory, a non-profit organization) that helps users find OA articles from publishers and repositories.

The reliability of the data source used to determine the publication modality depends on various factors that need to be considered. In this case, the study indirectly employs Unpaywall through Scopus. However, it is crucial to bear in mind that Unpaywall depends on algorithms rather than indexing, which may affect its ability to locate open access versions of journal articles across different disciplines. Consequently, the number of OA articles identified by Unpaywall may be lower than that obtained through manual searches. This shortcoming has been noted in previous studies conducted by Piwowar et al. (2018) and Sergiadis (2019).

Some authors choose to deposit a version of their paper in a thematic or institutional open access repository (Green). In some cases, this paper ends up being open accessible through the publisher, as is the case with the other forms of open access: Gold, Hybrid, and Bronze. However, in other cases, the version deposited in the open access repository ends up being the only one available for free access because the publication is ultimately produced in a subscription-based journal (Paywalled). In our work, we use the term "Only Green" to disaggregate this last group, that is, to be able to analyze the group of articles published in subscription-

based journals but that have open access through the repository provided by the authors themselves.

To achieve a comprehensive representation of all thematic fields, we opted to sample 12 % of the subject categories available in the Scopus database, which corresponds to one out of every eight disciplines and 6.5 % of the research articles in the Scopus database. The selection of thematic categories was done randomly. To do this, the 334 subject categories in the Scopus database were alphabetically sorted and then 40 numbers between 1 and 334 were randomly generated. Thus, the sample included 12 subject categories from Health Sciences, 7 from Life Sciences, 10 from Physical Sciences & Engineering, and 11 from Social Sciences & Humanities.

For each subject category, we downloaded the “research articles” from the Scopus database in the year 2016 and their corresponding citations received from 2016 to 2020. To minimize the influence of non-research article types, such as reviews or letters, we restricted our study solely to research articles. This was achieved by utilizing the metadata available in the Scopus database, which allows for the categorization of each journal's content according to document type. This information is summarized in a dataset provided in [Appendix A](#).

In terms of sample representativeness, a total of 1,992,035 research articles were indexed in the Scopus database in 2016, of which 640,032 specified a funding source (32.1 %). In the same year, the selected 40 subject categories included 128,663 research articles, of which 39,675 were funded (30.8 %).

We have calculated the OA citation advantage as the percentage difference in citations between each OA modality and the paywalled modality. Specifically, if the number of citations per article in an OA modality exceeds the number of citations per paywalled article, then the citation advantage for that modality is calculated as (Citations per OA article - Citations per paywalled article) / Citations per paywalled article. On the other hand, if the number of citations per article in an OA modality is less than the number of citations per paywalled article, then the citation disadvantage (which is negative) for that OA modality is calculated as (Citations per OA article - Citations per paywalled article) / Citations per OA article.

Finally, non-parametric Kruskal-Wallis tests were performed to examine the significance of differences between the funded and unfunded groups within each subject category.

Results

[Table 1](#) presents the distribution of publication modalities according to funding. It shows that in the sample, most research articles were paywalled, with 65 % of unfunded articles and 44 % of funded articles falling into this category. The use of open access repositories (green) was more prevalent among funded articles (45 %) than unfunded ones (25 %). The prevalence of the gold modality was similar in both groups (12 %). However, the prevalence of the hybrid gold modality was more than double in the funded group compared to the unfunded one (note that authors are required to cover publication costs under this modality).

It is notable that most research articles in the sample were unfunded (69 %), with only one-third (31 %) receiving funding. Among the

paywalled articles, the prevalence of unfunded articles rose to 77 %. In contrast, the proportion of funded and unfunded articles is similar in other open access modalities, despite the larger absolute size of the unfunded group. Therefore, there is a greater emphasis on offering open access to publications in the funded group.

[Table 2](#) displays the prevalence of publication modality by subject category and funding. Notably, there are significant variations across subject categories regarding both funding prevalence and open access modalities. To illustrate, funding rates are notably lower in the humanities (including Classics, Visual & Performing Arts, General Arts & Humanities, and Music) at a mere 5 %, compared to certain life sciences such as Developmental Biology, Structural Biology, and Ecological Modelling, which can exceed 50 %. Additionally, open access rates fall below 20 % in certain humanities and social sciences, such as Classics, Visual & Performing Arts, and Tourism, Leisure & Hospitality Management, whereas they can exceed 70 % in certain scientific disciplines like Immunology & Microbiology, Discrete Mathematics & Combinatorics, and Geometry & Topology.

Cites per article by funding and publication modality

[Table 3](#) displays the citations per article from 2016 to 2020, categorized by funding, publication modality, and branch of knowledge. In most cases, the mean citations per article are higher than the median citations per article. However, in some publication modalities within life sciences, the opposite is observed. On average, the highest citation rates are found in life and health sciences, whereas the lowest citation rates are observed in social sciences and humanities.

The largest differences are observed between funding groups. In the same publication modality, funded articles tend to receive 50 % more citations than unfunded ones. Among the different modalities, the hybrid gold receives the highest average number of citations, while gold receives the least, even lower than paywalled articles. Hybrid gold articles are cited on average twice as much as gold articles, while green articles receive 50 % more citations than paywalled ones. Furthermore, these relationships are not influenced by funding.

Citations per article are significantly higher for articles in the funded group across all publication modalities. To analyze the effect of funding on citations and publication modality, a non-parametric Kruskal-Wallis test was conducted, and the results indicate significant differences between the funded and unfunded groups for all subject categories at a 0.01 level of significance.

Open articles published in hybrid journals received considerably more citations than those published in open access journals, regardless of funding. Specifically, 75 % of articles published in open access journals (gold) received fewer citations on average than the 25 % least cited articles published in hybrid journals (hybrid gold). This evidence is strong and not dependent on funding. Apart from open access journals (gold), all other open access modalities received more citations than paywalled articles. Moreover, the hybrid open access modality received the most citations, regardless of funding.

The average citation count for unfunded articles deposited in open access repositories but published in the paywalled modality (only green)

Table 1
Prevalence of publication modality by funding.

		Gold	Hybrid Gold	Bronze	Green	Only Green	Paywalled	All ^a
Funded	Articles	4713	2734	7134	17,729	7796	17,298	39,675
	% of All	11.9 %	6.9 %	18.0 %	44.7 %	19.6 %	43.6 %	100 %
	% of Total	29.8 %	52.3 %	47.9 %	43.9 %	43.5 %	23.1 %	30.8 %
Unfunded	Articles	11,128	2492	7746	22,616	10,127	57,495	88,988
	% of All	12.5 %	2.8 %	8.7 %	25.4 %	11.4 %	64.6 %	100 %
	% of Total	70.2 %	47.7 %	52.1 %	56.1 %	56.5 %	76.9 %	69.2 %
Total	Articles	15,841	5226	14,880	40,345	17,923	74,793	128,663
	% of All	12.3 %	4.1 %	11.6 %	31.4 %	13.9 %	58.1 %	100 %

^a All = Gold + Hybrid Gold + Bronze + Only Green + Paywalled.

Table 2
Prevalence of publication modality by subject category and funding.

Subject Category	Funded					Unfunded				
	Gold	Hybrid Gold	Bronze	Only Green	Paywalled	Gold	Hybrid Gold	Bronze	Only Green	Paywalled
Accounting	1.1 %	0.7 %	0.3 %	2.1 %	5.0 %	8.8 %	0.8 %	2.0 %	18.4 %	60.8 %
Acoustics & Ultrasonics	0.4 %	4.0 %	2.3 %	6.6 %	20.4 %	0.7 %	2.2 %	4.3 %	6.0 %	53.1 %
Advanced & Specialized Nursing	1.1 %	0.8 %	5.5 %	7.5 %	4.7 %	5.3 %	0.7 %	7.6 %	7.8 %	59.0 %
Aging	12.0 %	3.0 %	6.7 %	14.6 %	11.2 %	19.3 %	1.6 %	4.1 %	6.1 %	21.4 %
Agricultural & Biological Sciences	2.1 %	4.3 %	3.7 %	2.9 %	13.6 %	10.6 %	7.4 %	5.2 %	8.3 %	42.0 %
Anatomy	2.4 %	2.2 %	4.0 %	8.2 %	9.6 %	8.6 %	2.9 %	7.9 %	7.3 %	46.9 %
Business, Management & Accounting	1.3 %	0.1 %	0.3 %	0.9 %	3.7 %	11.3 %	0.5 %	2.7 %	18.4 %	60.9 %
Chemical Engineering	2.6 %	10.0 %	4.0 %	3.0 %	23.1 %	9.5 %	4.8 %	4.9 %	1.8 %	36.3 %
Classics	0.0 %	0.2 %	0.7 %	0.2 %	2.0 %	2.0 %	5.0 %	3.0 %	5.7 %	81.2 %
Computer Science	5.5 %	0.6 %	1.8 %	3.5 %	25.5 %	10.6 %	0.2 %	3.7 %	5.4 %	43.2 %
Developmental Biology	13.7 %	4.6 %	14.7 %	7.3 %	18.0 %	7.3 %	2.0 %	7.2 %	4.0 %	21.1 %
Developmental Neuroscience	8.5 %	2.5 %	4.6 %	15.0 %	17.7 %	9.7 %	1.0 %	4.3 %	4.9 %	31.7 %
Discrete Mathematics & Combinatorics	9.5 %	1.2 %	17.0 %	4.7 %	5.9 %	16.1 %	2.6 %	11.9 %	8.0 %	23.0 %
Ecological Modelling	2.2 %	3.6 %	5.1 %	6.7 %	34.5 %	4.1 %	2.6 %	3.8 %	3.7 %	33.8 %
Economics, Econometrics & Finance	2.6 %	0.5 %	0.8 %	2.9 %	6.4 %	10.9 %	2.1 %	4.2 %	17.4 %	52.2 %
Emergency Nursing	0.3 %	0.5 %	0.5 %	3.3 %	7.4 %	1.8 %	1.0 %	1.7 %	1.9 %	81.8 %
Filtration & Separation	1.1 %	0.3 %	3.3 %	5.0 %	48.4 %	2.2 %	0.2 %	1.7 %	1.5 %	36.2 %
Food Animals	0.8 %	8.9 %	2.8 %	3.5 %	23.9 %	4.0 %	4.9 %	8.2 %	3.2 %	39.9 %
Gender Studies	0.6 %	0.2 %	0.3 %	2.3 %	3.9 %	9.7 %	1.0 %	2.4 %	11.9 %	67.8 %
General Arts & Humanities	2.4 %	0.2 %	0.2 %	0.5 %	1.8 %	28.7 %	1.7 %	3.0 %	3.2 %	58.3 %
Geometry & Topology	4.1 %	0.6 %	15.3 %	8.5 %	5.3 %	9.1 %	0.9 %	16.7 %	15.6 %	23.8 %
Gerontology	1.1 %	0.8 %	2.0 %	7.2 %	10.8 %	4.7 %	1.5 %	4.2 %	6.8 %	60.8 %
Health Information Management	1.8 %	1.3 %	2.3 %	6.3 %	8.1 %	5.6 %	1.9 %	17.2 %	8.4 %	47.1 %
Hepatology	1.7 %	2.4 %	8.8 %	8.0 %	11.5 %	10.9 %	2.9 %	11.2 %	6.7 %	35.9 %
History & Philosophy of Science	0.4 %	2.7 %	1.1 %	8.3 %	9.0 %	5.4 %	1.9 %	2.3 %	10.9 %	57.9 %
Immunology & Microbiology	17.0 %	0.1 %	7.9 %	0.1 %	0.3 %	37.6 %	0.2 %	35.6 %	0.0 %	1.4 %
Information Systems & Management	1.0 %	1.1 %	1.3 %	5.3 %	27.9 %	5.9 %	0.7 %	1.0 %	10.4 %	45.3 %
Mathematical Physics	1.3 %	2.3 %	4.1 %	19.7 %	9.7 %	2.6 %	1.3 %	2.9 %	29.0 %	27.1 %
Medical Laboratory Technology	2.8 %	1.1 %	1.7 %	2.8 %	3.9 %	7.4 %	2.3 %	11.6 %	5.8 %	60.7 %
Music	0.2 %	0.4 %	0.2 %	2.1 %	4.0 %	7.5 %	0.6 %	3.6 %	10.4 %	70.9 %
Nephrology	3.5 %	1.4 %	12.4 %	3.2 %	4.4 %	19.8 %	3.2 %	10.0 %	4.1 %	37.9 %
Numerical Analysis	1.2 %	1.5 %	14.5 %	9.9 %	18.3 %	1.9 %	1.8 %	8.4 %	9.7 %	32.7 %
Orthodontics	0.7 %	0.1 %	1.4 %	2.3 %	4.5 %	22.7 %	0.7 %	17.5 %	5.9 %	44.3 %
Palaeontology	3.5 %	3.4 %	13.7 %	5.0 %	23.1 %	7.5 %	1.6 %	3.9 %	3.4 %	35.0 %
Paediatrics	1.6 %	0.2 %	1.2 %	5.1 %	6.6 %	9.7 %	0.4 %	8.2 %	6.0 %	61.0 %
Sensory Systems	15.4 %	2.1 %	5.2 %	7.4 %	11.1 %	13.8 %	1.9 %	7.4 %	3.8 %	31.9 %
Structural Biology	7.3 %	3.6 %	8.5 %	10.3 %	27.4 %	8.3 %	1.0 %	2.8 %	2.6 %	28.2 %
Tourism, Leisure & Hospitality Management	0.3 %	0.6 %	0.5 %	2.4 %	11.1 %	3.3 %	0.9 %	0.3 %	11.3 %	69.1 %
Transplantation	0.6 %	5.3 %	11.7 %	4.5 %	10.1 %	5.0 %	3.5 %	14.8 %	2.3 %	42.2 %
Visual & Performing Arts	0.3 %	0.3 %	0.2 %	1.0 %	2.4 %	4.9 %	1.4 %	4.2 %	7.5 %	77.9 %

Table 3
Cites per article in 2016–2020 by funding, publication modality, and branch of knowledge.

Branch of Knowledge		Funded					Unfunded						
		Gold	Hybrid Gold	Bronze	Green	Only Green	Paywalled	Gold	Hybrid Gold	Bronze	Green	Only Green	Paywalled
Health Sciences	Mean	8.3	22.7	20.5	17.5	15.5	11.4	5.3	16.1	17.3	11.3	11.4	6.4
	Median	7.7	21.3	18.8	16.3	13.3	10.9	4.7	15.2	11.8	10.5	9.6	6.1
Life Sciences	Mean	15.2	19.8	15.5	16.9	15.0	12.0	11.4	15.1	11.9	11.6	11.1	7.2
	Median	13.7	21.0	17.4	18.0	14.4	12.9	11.7	13.8	11.0	11.3	10.6	8.3
Physical Sciences & Engineering	Mean	8.3	18.6	13.2	14.2	15.1	12.4	6.8	13.3	7.3	9.7	11.3	7.1
	Median	6.7	18.9	11.3	14.2	13.6	11.5	6.1	8.7	5.0	9.7	11.2	6.0
Social Sciences & Humanities	Mean	6.7	14.9	11.5	11.1	12.0	9.5	3.7	9.3	5.4	7.3	8.5	5.9
	Median	5.3	17.7	10.4	8.1	10.8	8.4	3.5	8.1	4.7	6.7	7.8	5.5
Total	Mean	9.1	19.0	15.3	14.8	14.4	11.2	6.3	13.4	10.6	9.9	10.5	6.6
	Median	7.5	20.0	14.1	14.5	13.7	10.7	5.7	12.2	7.9	9.8	9.5	6.1

is higher than the average citation count for all articles with versions in repositories (green). However, this trend is not observed within the group of funded articles. These findings suggest that using open access repositories significantly boosts citation counts, particularly for publications without funding.

Open Access citation advantage

The citation advantage (or disadvantage, if negative) for an open access (OA) modality is defined as the difference in citations compared

to the paywalled modality. Specifically, if the number of citations per OA article in a particular modality is greater than the number of citations per paywalled article, then the citation advantage of that modality is calculated as (Citations per OA - Citations per paywalled) / Citations per paywalled.

In contrast, if the cites per OA article in a particular modality is less than the cites per paywalled article, then the OA citation disadvantage (which is negative) of that modality is (Cites per OA - Cites per paywalled) / Cites per OA.

Table 4 displays the average OA citation advantage by funding,

Table 4

OA citation advantage (in relation to Paywalled) in 2016–2020 by funding, publication modality, and branch of knowledge.

Branch of Knowledge		Funded					Unfunded				
		Gold	Hybrid Gold	Bronze	Green	Only Green	Gold	Hybrid Gold	Bronze	Green	Only Green
Health Sciences	Mean	-51 %	93 %	80 %	55 %	38 %	-22 %	190 %	164 %	81 %	88 %
	Median	-42 %	83 %	57 %	41 %	29 %	-10 %	151 %	91 %	63 %	71 %
Life Sciences	Mean	49 %	76 %	40 %	58 %	24 %	172 %	152 %	188 %	181 %	39 %
	Median	21 %	67 %	34 %	38 %	23 %	39 %	115 %	67 %	78 %	37 %
Physical Sciences & Engineering	Mean	-66 %	59 %	14 %	27 %	37 %	0 %	84 %	-19 %	42 %	62 %
	Median	-22 %	60 %	3 %	9 %	15 %	-4 %	56 %	-13 %	44 %	64 %
Social Sciences & Humanities	Mean	-88 %	86 %	24 %	42 %	82 %	-63 %	72 %	13 %	54 %	82 %
	Median	-66 %	83 %	29 %	49 %	37 %	-27 %	69 %	31 %	27 %	55 %
Total	Mean	-46 %	79 %	41 %	45 %	47 %	6 %	124 %	81 %	81 %	72 %
	Median	-36 %	69 %	37 %	35 %	22 %	-6 %	80 %	42 %	50 %	61 %

publication modality, and branch of knowledge. However, it should be noted that outliers in the data distribution can potentially affect the mean and skew the results. Therefore, the median can be a more reliable measure of central tendency. Articles with an OA citation advantage above the median are exactly half of the distribution, and the other half have an OA citation advantage below the median.

There are notable variations among branches of knowledge. Excluding the gold modality, the average OA citation advantage in the funded group ranges from 41 % to 79 %, with a median of 22 % to 69 % for all subject categories. In the unfunded group, and excluding gold modality, the OA citation advantage ranges from 72 % to 124 %, with a median of 42 % to 80 %.

The highest OA citation advantage is observed in the hybrid gold modality, with 79 % and 124 % for funded and unfunded research, respectively. For half of the categories analyzed, the citation advantage in hybrid gold is greater than 69 % for funded articles and 80 % for unfunded ones. In the green modality, the average OA citation advantage is 45 % and 81 % for funded and unfunded research, respectively. Additionally, for half of the categories analyzed, the green citation advantage is greater than 35 % for funded articles and 50 % for unfunded ones. In the only green modality, the average OA citation advantage is 47 % for funded and 72 % for unfunded articles, but for half of the categories, the citation advantage is greater than 22 % and 61 % for funded and unfunded articles, respectively.

Discussion

We observed that funded articles generally receive 50 % more citations than unfunded ones, regardless of the publication modality. This result is interesting and indicates the importance of financial support in academic research. The higher citation rate of funded articles may be attributed to several factors, such as the availability of resources for conducting high-quality research, the ability to access and analyze larger datasets, and the potential for wider dissemination through marketing and publicity efforts (Álvarez-Bornstein & Montesi, 2020). Additionally, funding agencies may prioritize research topics that are more likely to have broader societal impacts, which could result in increased interest and attention from the scientific community (Aagaard et al., 2020).

It is important to note, however, that the correlation between funding and citation rates does not necessarily imply causation (Bornmann & Daniel, 2008). It is possible that articles receiving higher citations are more likely to attract funding, rather than the other way around. Further research is needed to investigate this relationship and determine the mechanisms through which funding may impact citation rates. Nonetheless, the present observation highlights the need for continued financial support for academic research to enhance its visibility and impact.

Among the various publication modalities, the hybrid gold modality was found to be the most cited, while the gold modality was found to be the least cited as also noted by Langham-Putrow et al. (2021), even

falling below the paywalled modality. This is an important finding in academic publishing. This finding suggests that the choice of publication modality can have a significant impact on the visibility and impact of research. The higher citation rate of hybrid gold open access articles may be attributed to their ability to reach a wider audience compared to traditional paywalled articles. Hybrid gold open access articles are freely accessible to readers online, while still being published in well-established and prestigious journals (Dorta-González & Dorta-González, 2023). This combination of wider accessibility and high visibility may lead to increased readership and citation rates.

Several factors may contribute to the lower citation rate of gold open access articles as also noted by Dorta-González et al. (2017), such as the perceived lower quality of open access journals or the lack of robust peer-review processes. Additionally, the lack of financial support for gold open access publishing may limit the marketing and publicity efforts that are crucial for increasing the visibility of research.

Based on these findings, it is important to recognize the significance of carefully choosing the appropriate publication modality for academic research, as it can have a significant impact on the visibility and impact of the research. Researchers should consider the advantages and disadvantages of different publication modalities and weigh them against their research goals and priorities.

Interestingly, using open access repositories had a significant positive impact on the number of citations received as also observed by Wheeler et al. (2022), particularly for articles without funding. In fact, articles in open access repositories (green) received 50 % more citations than paywalled articles, which is a remarkable finding independent of funding status.

Researchers who receive funding tend to display a greater inclination towards publishing their work on Open Access platforms (Piwowar et al., 2018). This is largely because the funding agencies and organizations they are affiliated with often require them to publish their research in such venues to maximize the dissemination and impact of their findings. As a result, the adoption of open access repositories (green) is more widespread within the funded group, accounting for 41 % of their publications, in contrast to the unfunded group, where it is 24 %.

Moreover, publishing on OA platforms enables researchers to reach a wider audience, including those who may not have access to traditional subscription-based academic journals. Additionally, publishing on OA platforms can improve a researcher's visibility and impact, which can be important for their career advancement and future funding opportunities (Niyazov et al., 2016). As a result, the trend towards OA publishing is likely to continue to gain momentum as funding agencies increasingly prioritize open access to research outputs.

Conclusions

This study analyzed Scopus data -publications from one year, and their citations over five years, in a random selection of subject categories- to determine whether open-access articles are cited more than

paywalled articles and whether any differences in citation are related to funding.

Our analysis revealed that while funded research articles tend to receive more citations than unfunded ones, there is a greater open access citation advantage for unfunded articles. This advantage is consistent across various fields and is largely due to the hybrid gold modality and author self-archiving in green open access repositories.

When considering the phenomenon of the OA citation advantage, it is important to notice that there are several complex factors at play that can influence the observed differences in citation rates. While increased accessibility due to open access publication can certainly contribute to the higher citation rates of OA articles, it is also possible that other biases are involved. One such bias is the selection postulate, which suggests that authors may be more likely to make only their most impactful studies open access, leading to a skewed representation of the overall impact of open access articles. Additionally, there may be social or cultural biases that influence who cite OA articles and how frequently they are cited (Hanel et al., 2018). For instance, certain disciplines or geographical regions may be more likely to value or prioritize open access publishing.

There are several factors to consider regarding the reliability of the data source used to determine the publication modality. In this case, Unpaywall is indirectly utilized via Scopus. However, it is important to note that Unpaywall relies on algorithms rather than indexing. As a result, it may not locate as many OA versions of journal articles as manual searches, regardless of the discipline. This limitation has been also observed in studies conducted by Piwowar et al. (2018) and Serigiadis (2019).

In recent years, the issue of access to academic literature has become a highly debated topic in the research community (Maddi & Sapinho,

2022). Research funders are placing greater emphasis on open access dissemination to promote wider readership and accessibility to their findings. At the same time, the rising cost of academic journals and other publications has forced many university libraries to cancel some of their subscriptions. This dilemma has put pressure on both researchers and publishers to find new ways to make academic literature more accessible while ensuring the sustainability of the publishing industry (Guédon et al., 2019). It remains to be seen how this issue will evolve in the future, but the debate over access to scholarly literature will continue to be an important issue for the research community.

CRedit authorship contribution statement

Pablo Dorta-González: Conceptualization, Methodology, Data curation, Validation, Writing- Original draft preparation, Writing- Reviewing and Editing, Supervision.

María Isabel Dorta-González: Conceptualization, Methodology, Data curation, Software, Validation, Writing- Original draft preparation, Writing- Reviewing and Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A

Table A1

Dataset for the sample. Cites per article and OA citation advantage (in relation to Paywalled) by subject category, funding, and publication modality. Research articles in 2016 and citations in 2016–2020 (Source: Scopus).

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Accounting	3758	Funded	Gold	43	1.1 %	6	30	61	78	81	256	6.0	-70 %
			Hybrid Gold	25	0.7 %	57	62	79	135	137	470	18.8	86 %
			Bronze	10	0.3 %	1	16	30	37	57	141	14.1	39 %
			Green	142	3.8 %	155	283	452	630	725	2245	15.8	56 %
			Only Green	78	2.1 %	95	195	298	408	489	1485	19.0	88 %
			Paywalled	188	5.0 %	73	249	396	486	700	1904	10.1	
		Unfunded	Gold	331	8.8 %	35	155	278	357	437	1262	3.8	-146 %
			Hybrid Gold	30	0.8 %	13	60	136	131	170	510	17.0	81 %
			Bronze	76	2.0 %	42	105	182	234	370	933	12.3	31 %
			Green	1006	26.8 %	515	1430	2460	3259	4353	12,017	11.9	27 %
			Only Green	691	18.4 %	459	1243	2107	2823	3796	10,428	15.1	61 %
			Paywalled	2286	60.8 %	878	2531	4473	5955	7647	21,484	9.4	
Acoustics & Ultrasonics	6350	Funded	Gold	26	0.4 %	20	45	62	96	97	320	12.3	1 %
			Hybrid Gold	255	4.0 %	463	1401	1636	1649	1617	6766	26.5	117 %
			Bronze	147	2.3 %	60	281	352	408	386	1487	10.1	-21 %

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Advanced & Specialized Nursing	3076	Unfunded	Green	575	9.1 %	415	1486	1889	2110	1950	7850	13.7	12 %
			Only Green	421	6.6 %	319	1122	1385	1535	1401	5762	13.7	12 %
			Paywalled	1298	20.4 %	729	2775	3977	4350	4006	15,837	12.2	
			Gold	45	0.7 %	9	57	56	82	59	263	5.8	7 %
			Hybrid Gold	137	2.2 %	253	696	865	849	863	3526	25.7	369 %
			Bronze	271	4.3 %	59	331	559	489	530	1968	7.3	32 %
			Green	558	8.8 %	340	1172	1616	1694	1522	6344	11.4	107 %
			Only Green	381	6.0 %	247	893	1221	1263	1122	4746	12.5	127 %
		Paywalled	3369	53.1 %	706	2961	4860	5303	4645	18,475	5.5		
		Funded	Gold	35	1.1 %	5	22	30	42	50	149	4.3	-163 %
		Hybrid Gold	26	0.8 %	29	106	150	158	156	599	23.0	106 %	
		Bronze	168	5.5 %	409	1375	1754	1720	1799	7057	42.0	275 %	
		Green	407	13.2 %	545	1927	2517	2627	2700	10,316	25.3	126 %	
		Only Green	230	7.5 %	189	818	1060	1189	1208	4464	19.4	73 %	
		Paywalled	146	4.7 %	81	278	409	460	407	1635	11.2		
		Unfunded	Gold	162	5.3 %	10	92	148	194	203	647	4.0	-3 %
Hybrid Gold	21		0.7 %	16	68	88	83	66	321	15.3	271 %		
Bronze	233		7.6 %	785	1801	1833	1659	1764	7842	33.7	717 %		
Green	447		14.5 %	322	1037	1375	1483	1604	5821	13.0	216 %		
Only Green	240		7.8 %	166	557	762	834	883	3202	13.3	224 %		
Paywalled	1815		59.0 %	383	1318	1776	1935	2064	7476	4.1			
Funded	Gold		344	12.0 %	304	1292	1722	1773	2021	7112	20.7	40 %	
Hybrid Gold	85		3.0 %	88	353	490	544	617	2092	24.6	67 %		
Aging	2863	Funded	Bronze	193	6.7 %	240	612	814	965	1015	3646	18.9	28 %
			Green	1010	35.3 %	949	3739	4911	5196	5765	20,560	20.4	38 %
			Only Green	418	14.6 %	355	1581	1985	2054	2273	8248	19.7	34 %
			Paywalled	320	11.2 %	238	948	1198	1125	1218	4727	14.8	
			Unfunded	Gold	552	19.3 %	370	1524	2056	2118	2442	8510	15.4
		Hybrid Gold	47	1.6 %	39	146	213	231	214	843	17.9	115 %	
		Bronze	116	4.1 %	117	375	459	466	549	1966	16.9	103 %	
		Green	806	28.2 %	583	2289	3096	3171	3620	12,759	15.8	90 %	
		Only Green	175	6.1 %	130	488	696	672	783	2769	15.8	90 %	
		Paywalled	613	21.4 %	292	956	1175	1275	1408	5106	8.3		
Agricultural & Biological Sciences	3417	Funded	Gold	71	2.1 %	31	163	236	237	307	974	13.7	6 %
			Hybrid Gold	146	4.3 %	191	473	842	947	945	3398	23.3	80 %
			Bronze	127	3.7 %	87	386	531	583	620	2207	17.4	34 %
			Green	407	11.9 %	362	1174	1773	1965	2068	7342	18.0	39 %

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage			
Anatomy	3431	Unfunded	Only Green	98	2.9 %	81	236	312	373	411	1413	14.4	11 %			
			Paywalled	464	13.6 %	316	976	1451	1594	1666	6003	12.9				
			Gold	362	10.6 %	52	339	469	650	697	2207	6.1	25 %			
			Hybrid Gold	252	7.4 %	80	445	762	804	1008	3099	12.3	152 %			
			Bronze	179	5.2 %	81	290	440	512	638	1961	11.0	124 %			
			Green	893	26.1 %	318	1263	1964	2289	2694	8528	9.5	96 %			
			Only Green	282	8.3 %	141	410	587	715	753	2606	9.2	89 %			
			Paywalled	1436	42.0 %	314	1183	1699	1850	1963	7009	4.9				
		Funded	Gold	84	2.4 %	23	115	197	222	225	782	9.3	-38 %			
			Hybrid Gold	76	2.2 %	134	333	419	398	411	1695	22.3	74 %			
			Bronze	137	4.0 %	89	326	363	380	419	1577	11.5	-11 %			
			Green	535	15.6 %	583	1834	2439	2429	2547	9832	18.4	43 %			
			Only Green	281	8.2 %	351	1105	1508	1480	1547	5991	21.3	66 %			
			Paywalled	330	9.6 %	411	820	939	988	1069	4227	12.8				
			Unfunded	Gold	294	8.6 %	44	207	280	334	296	1161	3.9	-84 %		
				Hybrid Gold	98	2.9 %	78	177	237	264	267	1023	10.4	44 %		
Bronze	272	7.9 %		142	439	545	572	623	2321	8.5	17 %					
Green	713	20.8 %		437	1454	1892	1957	2046	7786	10.9	50 %					
Business, Management & Accounting	2841	Funded	Only Green	250	7.3 %	213	816	1048	1037	1119	4233	16.9	133 %			
			Paywalled	1609	46.9 %	858	2265	2757	2747	3064	11,691	7.3				
			Gold	38	1.3 %	1	21	41	39	43	145	3.8	-117 %			
			Hybrid Gold	2	0.1 %	2	0	3	2	3	10	5.0	-65 %			
			Bronze	8	0.3 %	0	2	2	8	14	26	3.3	-154 %			
			Green	63	2.2 %	12	39	73	101	117	342	5.4	-52 %			
			Only Green	25	0.9 %	10	23	41	61	78	213	8.5	3 %			
			Paywalled	104	3.7 %	61	133	158	209	299	860	8.3				
		Unfunded	Gold	320	11.3 %	54	285	441	675	757	2212	6.9	-9 %			
			Hybrid Gold	15	0.5 %	7	21	34	42	55	159	10.6	40 %			
			Bronze	77	2.7 %	9	51	94	83	135	372	4.8	-57 %			
			Green	819	28.8 %	201	729	1177	1691	1945	5743	7.0	-8 %			
			Only Green	523	18.4 %	153	533	838	1199	1364	4087	7.8	3 %			
			Paywalled	1729	60.9 %	516	1666	2808	3730	4366	13,086	7.6				
			Chemical Engineering	2016	Funded	Gold	53	2.6 %	13	63	96	95	103	370	7.0	-152 %
						Hybrid Gold	201	10.0 %	410	1246	1401	1399	1389	5845	29.1	65 %
Bronze	81	4.0 %				57	190	235	256	280	1018	12.6	-40 %			
Green	141	7.0 %				92	396	494	534	550	2066	14.7	-20 %			
Only Green	61	3.0 %				45	211	236	263	273	1028	16.9	-5 %			

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage	
Classics	1050	Unfunded	Paywalled	466	23.1 %	391	1553	1959	2048	2260	8211	17.6		
			Gold	191	9.5 %	42	171	303	323	380	1219	6.4	-51 %	
			Hybrid Gold	96	4.8 %	199	602	740	709	776	3026	31.5	227 %	
			Bronze	99	4.9 %	8	83	90	73	60	314	3.2	-204 %	
			Green	228	11.3 %	98	348	514	544	612	2116	9.3	-4 %	
			Only Green	37	1.8 %	43	126	143	150	152	614	16.6	72 %	
		Funded	Paywalled	731	36.3 %	308	1199	1639	1850	2056	7052	9.6		
			Gold	0	0.0 %									
			Hybrid Gold	2	0.2 %	0	0	0	0	0	0	0.0		
			Bronze	7	0.7 %	0	2	2	3	2	9	1.3	29 %	
			Green	5	0.5 %	1	1	5	6	1	14	2.8	180 %	
			Only Green	2	0.2 %	1	1	4	6	0	12	6.0	500 %	
			Unfunded	Paywalled	21	2.0 %	1	4	6	4	6	21	1.0	
				Gold	21	2.0 %	0	2	4	4	3	13	0.6	-16 %
				Hybrid Gold	52	5.0 %	2	3	4	4	6	19	0.4	-97 %
Computer Science	2241	Funded	Bronze	32	3.0 %	1	11	10	8	16	46	1.4	100 %	
			Green	92	8.8 %	5	17	20	19	18	79	0.9	19 %	
			Only Green	60	5.7 %	4	12	16	15	12	59	1.0	37 %	
			Paywalled	853	81.2 %	44	97	159	173	140	613	0.7		
			Gold	123	5.5 %	58	303	388	395	394	1538	12.5	110 %	
			Hybrid Gold	13	0.6 %	18	30	64	45	54	211	16.2	173 %	
		Unfunded	Bronze	41	1.8 %	44	125	168	168	135	640	15.6	162 %	
			Green	208	9.3 %	166	648	805	908	899	3426	16.5	177 %	
			Only Green	79	3.5 %	81	306	340	449	445	1621	20.5	245 %	
			Paywalled	572	25.5 %	149	588	859	996	814	3406	6.0		
			Gold	237	10.6 %	84	360	447	407	453	1751	7.4	17 %	
			Hybrid Gold	5	0.2 %	0	7	8	4	7	26	5.2	-21 %	
			Bronze	82	3.7 %	18	74	94	118	106	410	5.0	-26 %	
			Green	289	12.9 %	148	539	754	754	710	2905	10.1	60 %	
			Only Green	120	5.4 %	94	322	484	505	419	1824	15.2	141 %	
Developmental Biology	6867	Funded	Paywalled	969	43.2 %	243	973	1553	1741	1594	6104	6.3		
			Gold	940	13.7 %	893	3674	4738	4763	5017	19,085	20.3	82 %	
			Hybrid Gold	319	4.6 %	405	1351	1592	1600	1743	6691	21.0	88 %	
			Bronze	1010	14.7 %	1005	3697	4475	4600	4788	18,565	18.4	65 %	
			Green	2328	33.9 %	2432	9403	11,450	11,863	12,383	47,531	20.4	83 %	
			Only Green	502	7.3 %	375	1371	1658	1782	1847	7033	14.0	26 %	
Paywalled	1238	18.0 %	753	2716	3500	3305	3534	13,808	11.2					

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Developmental Neuroscience	2301	Unfunded	Gold	498	7.3 %	347	1573	2244	2162	2309	8635	17.3	108 %
			Hybrid Gold	140	2.0 %	106	380	475	460	511	1932	13.8	66 %
			Bronze	492	7.2 %	337	1257	1519	1546	1631	6290	12.8	54 %
			Green	1178	17.2 %	817	3297	4377	4269	4677	17,437	14.8	78 %
			Only Green	277	4.0 %	180	626	806	801	918	3331	12.0	44 %
			Paywalled	1451	21.1 %	705	2275	2952	3031	3116	12,079	8.3	
	2301	Funded	Gold	196	8.5 %	72	442	671	673	657	2515	12.8	-15 %
			Hybrid Gold	58	2.5 %	77	242	288	282	291	1180	20.3	38 %
			Bronze	105	4.6 %	144	359	546	535	622	2206	21.0	42 %
			Green	647	28.1 %	634	2066	2619	2713	2888	10,920	16.9	14 %
			Only Green	345	15.0 %	414	1223	1415	1531	1639	6222	18.0	22 %
			Paywalled	408	17.7 %	323	1197	1489	1514	1511	6034	14.8	
Discrete Mathematics & Combinatorics	5098	Unfunded	Gold	224	9.7 %	85	427	482	514	543	2051	9.2	-1 %
			Hybrid Gold	22	1.0 %	69	141	159	148	150	667	30.3	228 %
			Bronze	100	4.3 %	120	249	325	426	426	1546	15.5	67 %
			Green	358	15.6 %	205	801	977	1061	1136	4180	11.7	26 %
			Only Green	113	4.9 %	72	250	336	327	374	1359	12.0	30 %
			Paywalled	730	31.7 %	466	1206	1553	1676	1841	6742	9.2	
	5098	Funded	Gold	486	9.5 %	127	418	630	591	663	2429	5.0	24 %
			Hybrid Gold	63	1.2 %	16	59	71	88	97	331	5.3	31 %
			Bronze	868	17.0 %	329	893	1109	1249	1260	4840	5.6	39 %
			Green	908	17.8 %	362	974	1209	1296	1385	5226	5.8	43 %
			Only Green	240	4.7 %	91	250	292	333	377	1343	5.6	39 %
			Paywalled	302	5.9 %	102	205	281	325	300	1213	4.0	
Ecological Modelling	3256	Unfunded	Gold	819	16.1 %	170	605	870	929	945	3519	4.3	75 %
			Hybrid Gold	135	2.6 %	20	62	74	79	63	298	2.2	-11 %
			Bronze	605	11.9 %	189	456	562	644	696	2547	4.2	71 %
			Green	1063	20.9 %	323	889	1149	1186	1254	4801	4.5	84 %
			Only Green	409	8.0 %	126	337	428	433	462	1786	4.4	78 %
			Paywalled	1171	23.0 %	170	523	651	712	821	2877	2.5	
	3256	Funded	Gold	73	2.2 %	35	169	213	258	213	888	12.2	-101 %
			Hybrid Gold	116	3.6 %	179	614	911	992	1143	3839	33.1	35 %
			Bronze	165	5.1 %	184	659	966	1081	1216	4106	24.9	2 %
			Green	402	12.3 %	458	1747	2464	2734	2880	10,283	25.6	5 %
			Only Green	218	6.7 %	266	986	1363	1510	1574	5699	26.1	7 %
			Paywalled	1122	34.5 %	1100	4553	6568	7403	7826	27,450	24.5	
3256	Unfunded	Gold	132	4.1 %	76	260	326	376	415	1453	11.0	-6 %	

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Economics, Econometrics & Finance	2643	Funded	Hybrid Gold	84	2.6 %	58	253	389	445	551	1696	20.2	73 %
			Bronze	123	3.8 %	138	460	669	865	1034	3166	25.7	120 %
			Green	297	9.1 %	255	976	1400	1626	1981	6238	21.0	79 %
			Only Green	122	3.7 %	99	373	517	572	654	2215	18.2	55 %
			Paywalled	1101	33.8 %	581	2238	2993	3366	3705	12,883	11.7	
			Gold	70	2.6 %	3	55	95	110	99	362	5.2	-62 %
			Hybrid Gold	14	0.5 %	10	45	68	92	85	300	21.4	156 %
		Bronze	21	0.8 %	10	24	37	28	45	144	6.9	-22 %	
		Green	161	6.1 %	55	199	314	345	388	1301	8.1	-3 %	
		Only Green	77	2.9 %	40	99	158	165	214	676	8.8	5 %	
		Paywalled	170	6.4 %	55	204	311	407	444	1421	8.4		
		Unfunded	Gold	288	10.9 %	46	162	316	387	408	1319	4.6	-21 %
		Hybrid Gold	55	2.1 %	31	98	118	147	166	560	10.2	84 %	
		Bronze	110	4.2 %	15	53	77	98	101	344	3.1	-77 %	
Emergency Nursing	1684	Funded	Green	758	28.7 %	232	651	1033	1307	1408	4631	6.1	10 %
			Only Green	459	17.4 %	160	423	638	833	899	2953	6.4	16 %
			Paywalled	1379	52.2 %	414	1092	1702	2087	2352	7647	5.5	
			Gold	5	0.3 %	0	2	6	10	7	25	5.0	-139 %
			Hybrid Gold	9	0.5 %	8	67	100	114	120	409	45.4	281 %
			Bronze	8	0.5 %	14	40	51	45	40	190	23.8	99 %
			Green	70	4.2 %	54	230	329	363	388	1364	19.5	63 %
		Only Green	55	3.3 %	34	133	187	211	236	801	14.6	22 %	
		Paywalled	124	7.4 %	69	291	375	378	366	1479	11.9		
		Unfunded	Gold	30	1.8 %	2	5	13	23	25	68	2.3	-40 %
		Hybrid Gold	16	1.0 %	13	38	29	45	70	195	12.2	283 %	
		Bronze	28	1.7 %	2	7	12	15	26	62	2.2	-44 %	
		Green	73	4.3 %	22	62	73	98	127	382	5.2	65 %	
		Only Green	32	1.9 %	15	48	51	61	82	257	8.0	153 %	
Filtration & Separation	2219	Funded	Paywalled	1377	81.8 %	234	747	1084	1107	1207	4379	3.2	
			Gold	25	1.1 %	2	20	37	24	40	123	4.9	-368 %
			Hybrid Gold	7	0.3 %	6	25	40	28	42	141	20.1	-14 %
			Bronze	74	3.3 %	64	366	499	440	408	1777	24.0	4 %
			Green	151	6.8 %	178	716	977	898	903	3672	24.3	6 %
		Only Green	112	5.0 %	156	609	797	753	743	3058	27.3	19 %	
		Paywalled	1074	48.4 %	1118	4901	6241	5972	6488	24,720	23.0		
		Unfunded	Gold	48	2.2 %	11	48	97	84	82	322	6.7	-84 %
		Hybrid Gold	4	0.2 %	4	6	8	1	6	25	6.3	-98 %	

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Food Animals	2736	Funded	Bronze	37	1.7 %	7	31	50	60	78	226	6.1	-102 %
			Green	86	3.9 %	50	165	244	195	215	869	10.1	-22 %
			Only Green	34	1.5 %	37	103	155	111	128	534	15.7	27 %
			Paywalled	804	36.2 %	563	2036	2437	2387	2517	9940	12.4	
			Gold	21	0.8 %	10	13	40	50	53	166	7.9	-7 %
			Hybrid Gold	243	8.9 %	63	252	399	547	608	1869	7.7	-10 %
			Bronze	77	2.8 %	27	121	160	134	170	612	7.9	-7 %
		Unfunded	Green	155	5.7 %	85	226	335	406	485	1537	9.9	17 %
			Only Green	95	3.5 %	52	148	206	246	302	954	10.0	18 %
			Paywalled	654	23.9 %	247	965	1394	1393	1550	5549	8.5	
			Gold	110	4.0 %	18	104	182	204	252	760	6.9	3 %
			Hybrid Gold	133	4.9 %	46	217	317	387	472	1439	10.8	61 %
			Bronze	224	8.2 %	56	193	274	275	362	1160	5.2	-30 %
			Green	210	7.7 %	79	331	482	561	672	2125	10.1	50 %
Gender Studies	3185	Funded	Only Green	87	3.2 %	31	137	193	226	251	838	9.6	43 %
			Paywalled	1092	39.9 %	345	1234	1751	1897	2121	7348	6.7	
			Gold	20	0.6 %	8	39	51	56	78	232	11.6	22 %
			Hybrid Gold	5	0.2 %	6	7	24	27	33	97	19.4	105 %
			Bronze	9	0.3 %	3	17	20	45	57	142	15.8	67 %
			Green	105	3.3 %	60	178	273	337	408	1256	12.0	26 %
			Only Green	74	2.3 %	45	116	182	214	256	813	11.0	16 %
		Unfunded	Paywalled	124	3.9 %	60	169	230	309	407	1175	9.5	
			Gold	309	9.7 %	40	158	235	296	338	1067	3.5	-71 %
			Hybrid Gold	32	1.0 %	6	20	38	47	59	170	5.3	-11 %
			Bronze	75	2.4 %	34	113	179	244	282	852	11.4	92 %
			Green	652	20.5 %	213	713	1077	1297	1707	5007	7.7	30 %
			Only Green	378	11.9 %	161	502	745	859	1189	3456	9.1	55 %
			Paywalled	2159	67.8 %	597	1685	2839	3357	4289	12,767	5.9	
General Arts & Humanities	3605	Funded	Gold	85	2.4 %	26	52	94	126	137	435	5.1	19 %
			Hybrid Gold	8	0.2 %	8	26	31	25	21	111	13.9	221 %
			Bronze	8	0.2 %	6	16	18	17	26	83	10.4	140 %
			Green	74	2.1 %	35	97	134	146	177	589	8.0	84 %
			Only Green	17	0.5 %	10	32	36	44	62	184	10.8	151 %
		Unfunded	Paywalled	66	1.8 %	18	49	74	70	74	285	4.3	
			Gold	1036	28.7 %	66	273	645	762	1070	2816	2.7	189 %
			Hybrid Gold	61	1.7 %	11	25	30	30	27	123	2.0	114 %
			Bronze	107	3.0 %	10	40	51	45	50	196	1.8	95 %
			Green										

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Geometry & Topology	4551	Funded	Green	599	16.6 %	56	175	290	307	443	1271	2.1	125 %
			Only Green	116	3.2 %	23	49	72	75	70	289	2.5	165 %
			Paywalled	2101	58.3 %	131	310	509	542	485	1977	0.9	
			Gold	185	4.1 %	32	166	240	216	219	873	4.7	-36 %
			Hybrid Gold	27	0.6 %	12	36	36	42	43	169	6.3	-3 %
			Bronze	697	15.3 %	162	569	735	778	828	3072	4.4	-46 %
			Green	964	21.2 %	304	929	1198	1293	1314	5038	5.2	-23 %
		Only Green	387	8.5 %	159	421	520	604	574	2278	5.9	-9 %	
		Paywalled	241	5.3 %	114	266	393	422	354	1549	6.4		
		Unfunded	Gold	416	9.1 %	110	294	433	438	456	1731	4.2	-37 %
		Hybrid Gold	43	0.9 %	14	54	61	81	90	300	7.0	22 %	
		Bronze	760	16.7 %	182	450	557	664	694	2547	3.4	-70 %	
		Green	1445	31.8 %	456	1136	1453	1513	1590	6148	4.3	-34 %	
		Only Green	712	15.6 %	271	593	745	776	809	3194	4.5	-27 %	
Gerontology	2060	Funded	Paywalled	1083	23.8 %	351	971	1510	1746	1591	6169	5.7	
			Gold	22	1.1 %	2	16	27	33	36	114	5.2	-103 %
			Hybrid Gold	17	0.8 %	16	56	80	84	109	345	20.3	93 %
			Bronze	41	2.0 %	63	97	167	160	176	663	16.2	54 %
			Green	227	11.0 %	200	423	648	720	880	2871	12.6	20 %
			Only Green	149	7.2 %	124	260	384	453	574	1795	12.0	14 %
			Paywalled	223	10.8 %	171	407	531	580	659	2348	10.5	
		Unfunded	Gold	97	4.7 %	17	69	130	176	198	590	6.1	4 %
		Hybrid Gold	30	1.5 %	32	64	104	118	134	452	15.1	157 %	
		Bronze	87	4.2 %	83	158	214	276	369	1100	12.6	115 %	
		Green	301	14.6 %	184	426	624	725	899	2858	9.5	62 %	
		Only Green	141	6.8 %	92	216	302	319	410	1339	9.5	62 %	
		Paywalled	1253	60.8 %	483	1169	1615	1840	2246	7353	5.9		
		Health Information Management	1594	Funded	Gold	29	1.8 %	18	47	65	102	106	338
Hybrid Gold	21				1.3 %	29	52	93	137	177	488	23.2	67 %
Bronze	36				2.3 %	28	140	198	223	185	774	21.5	54 %
Green	172				10.8 %	195	359	550	655	702	2461	14.3	3 %
Only Green	101				6.3 %	135	197	278	287	325	1222	12.1	-15 %
Paywalled	129			8.1 %	158	287	394	482	477	1798	13.9		
Unfunded	Gold			90	5.6 %	34	115	159	178	204	690	7.7	-33 %
Hybrid Gold	30			1.9 %	22	69	103	123	163	480	16.0	57 %	
Bronze	274			17.2 %	1850	3912	4491	3678	3125	17,056	62.2	509 %	
Green	365			22.9 %	771	1822	2202	1932	1723	8450	23.2	126 %	

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage		
Hepatology	5149	Funded	Only Green	134	8.4 %	231	524	761	692	630	2838	21.2	107 %		
			Paywalled	750	47.1 %	591	1254	1727	2022	2073	7667	10.2			
			Gold	87	1.7 %	97	296	366	345	347	1451	16.7	-47 %		
			Hybrid Gold	122	2.4 %	460	1218	1456	1429	1488	6051	49.6	103 %		
			Bronze	455	8.8 %	1350	3637	4190	3945	4223	17,345	38.1	56 %		
			Green	883	17.1 %	2138	5761	6839	6497	7001	28,236	32.0	31 %		
			Only Green	412	8.0 %	895	2558	2884	2759	3046	12,142	29.5	21 %		
		Unfunded	Paywalled	594	11.5 %	1058	3014	3613	3417	3420	14,522	24.4			
			Gold	559	10.9 %	263	965	1191	1173	1202	4794	8.6	-52 %		
			Hybrid Gold	150	2.9 %	339	870	883	701	548	3341	22.3	71 %		
			Bronze	578	11.2 %	990	2724	3460	3642	413	11,229	19.4	49 %		
			Green	1133	22.0 %	934	3293	3957	3834	4141	16,159	14.3	9 %		
			Only Green	345	6.7 %	254	1076	1314	1285	1437	5366	15.6	19 %		
			Paywalled	1847	35.9 %	1688	4999	5920	5618	5872	24,097	13.0			
History & Philosophy of Science	3653	Funded	Gold	14	0.4 %	4	3	7	14	8	36	2.6	-280 %		
			Hybrid Gold	100	2.7 %	71	268	397	473	559	1768	17.7	81 %		
			Bronze	42	1.1 %	26	91	139	139	200	595	14.2	45 %		
			Green	418	11.4 %	298	924	1440	1595	1933	6190	14.8	51 %		
			Only Green	302	8.3 %	234	642	1040	1098	1343	4357	14.4	47 %		
			Paywalled	328	9.0 %	151	469	718	892	979	3209	9.8			
			Unfunded	Gold	196	5.4 %	9	49	72	84	83	297	1.5	-217 %	
		Hybrid Gold		71	1.9 %	24	115	137	141	160	577	8.1	69 %		
		Bronze		85	2.3 %	23	79	83	102	113	400	4.7	-2 %		
		Green		572	15.7 %	191	623	874	993	1154	3835	6.7	40 %		
		Only Green		399	10.9 %	159	490	709	840	965	3163	7.9	65 %		
		Paywalled		2116	57.9 %	674	1749	2272	2618	2840	10,153	4.8			
		Immunology & Microbiology		1171	Funded	Gold	199	17.0 %	84	402	515	538	547	2086	10.5
			Hybrid Gold			1	0.1 %	0	5	1	2	1	9	9.0	170 %
Bronze	92		7.9 %			24	122	180	167	217	710	7.7	132 %		
Green	289		24.7 %			106	530	695	708	765	2804	9.7	191 %		
Only Green	1		0.1 %			0	1	1	1	1	4	4.0	20 %		
Unfunded	Paywalled		3		0.3 %	3	1	1	1	4	10	3.3			
	Gold		440		37.6 %	94	593	757	779	867	3090	7.0	921 %		
	Hybrid Gold		2		0.2 %	0	2	2	1	2	7	3.5	409 %		
	Bronze		417		35.6 %	100	620	764	789	769	3042	7.3	961 %		
	Green		854		72.9 %	193	1212	1521	1566	1630	6122	7.2	943 %		
Only Green	0	0.0 %													

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Information Systems & Management	4533	Funded	Paywalled	16	1.4 %	0	3	5	2	1	11	0.7	
			Gold	45	1.0 %	15	96	187	272	316	886	19.7	-36 %
			Hybrid Gold	49	1.1 %	57	175	275	379	390	1276	26.0	-2 %
			Bronze	61	1.3 %	79	234	459	452	473	1697	27.8	4 %
			Green	322	7.1 %	414	1243	1892	2088	2214	7851	24.4	-9 %
		Only Green	242	5.3 %	323	969	1383	1478	1531	5684	23.5	-14 %	
		Unfunded	Paywalled	1265	27.9 %	1625	5384	8126	9343	9281	33,759	26.7	
			Gold	269	5.9 %	77	334	558	805	991	2765	10.3	-27 %
			Hybrid Gold	33	0.7 %	25	80	119	182	170	576	17.5	34 %
			Bronze	46	1.0 %	8	43	85	97	101	334	7.3	-79 %
Green	658		14.5 %	606	1621	2523	2827	3158	10,735	16.3	25 %		
Mathematical Physics	5019	Funded	Only Green	471	10.4 %	544	1412	2214	2430	2742	9342	19.8	52 %
			Paywalled	2052	45.3 %	1260	3866	6149	7279	8174	26,728	13.0	
			Gold	64	1.3 %	14	83	119	92	104	412	6.4	-8 %
			Hybrid Gold	116	2.3 %	92	241	352	326	262	1273	11.0	59 %
			Bronze	204	4.1 %	169	312	376	417	442	1716	8.4	22 %
		Unfunded	Green	1313	26.2 %	922	2473	2926	2879	2751	11,951	9.1	31 %
			Only Green	988	19.7 %	669	1900	2174	2131	2046	8920	9.0	30 %
			Paywalled	487	9.7 %	242	718	815	806	790	3371	6.9	
			Gold	131	2.6 %	31	108	177	180	149	645	4.9	-2 %
			Hybrid Gold	67	1.3 %	30	90	118	115	118	471	7.0	39 %
Medical Laboratory Technology	2050	Funded	Bronze	147	2.9 %	84	136	167	184	166	737	5.0	-1 %
			Green	1725	34.4 %	895	2298	2753	2625	2538	11,109	6.4	28 %
			Only Green	1457	29.0 %	776	2020	2354	2238	2181	9569	6.6	30 %
			Paywalled	1358	27.1 %	398	1440	1723	1653	1630	6844	5.0	
			Gold	57	2.8 %	62	143	186	220	181	792	13.9	87 %
		Unfunded	Hybrid Gold	23	1.1 %	13	52	75	78	78	296	12.9	74 %
			Bronze	34	1.7 %	33	102	83	86	94	398	11.7	58 %
			Green	150	7.3 %	126	351	423	444	439	1783	11.9	60 %
			Only Green	57	2.8 %	29	100	125	103	138	495	8.7	17 %
			Paywalled	80	3.9 %	41	133	141	147	131	593	7.4	
Unfunded	Gold	152	7.4 %	33	119	182	198	184	716	4.7	19 %		
	Hybrid Gold	47	2.3 %	38	157	178	192	166	731	15.6	292 %		
	Bronze	237	11.6 %	198	536	664	598	599	2595	10.9	176 %		
	Green	380	18.5 %	201	605	793	817	808	3224	8.5	114 %		
	Only Green	119	5.8 %	85	165	230	254	267	1001	8.4	112 %		
Paywalled	1244	60.7 %	354	1010	1202	1173	1193	4932	4.0				

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Music	1853	Funded	Gold	3	0.2 %	0	0	0	1	3	4	1.3	-211 %
			Hybrid Gold	8	0.4 %	7	24	28	23	21	103	12.9	210 %
			Bronze	4	0.2 %	1	3	3	7	2	16	4.0	-4 %
			Green	52	2.8 %	32	79	85	100	90	386	7.4	79 %
			Only Green	39	2.1 %	25	58	58	74	68	283	7.3	75 %
			Paywalled	75	4.0 %	22	48	91	77	73	311	4.1	
		Unfunded	Gold	139	7.5 %	5	9	23	29	21	87	0.6	-251 %
			Hybrid Gold	12	0.6 %	6	7	8	5	3	29	2.4	10 %
			Bronze	66	3.6 %	15	45	49	41	47	197	3.0	36 %
			Green	289	15.6 %	71	200	236	231	270	1008	3.5	59 %
			Only Green	193	10.4 %	57	162	189	185	224	817	4.2	93 %
			Paywalled	1314	70.9 %	247	506	623	767	742	2885	2.2	
Nephrology	4527	Funded	Gold	160	3.5 %	43	281	385	427	451	1587	9.9	-14 %
			Hybrid Gold	65	1.4 %	87	319	431	405	383	1625	25.0	120 %
			Bronze	560	12.4 %	1288	3539	3958	4145	4204	17,134	30.6	170 %
			Green	796	17.6 %	1481	4225	4730	5003	5039	20,478	25.7	127 %
			Only Green	143	3.2 %	232	651	689	709	757	3038	21.2	87 %
			Paywalled	199	4.4 %	147	496	533	513	568	2257	11.3	
		Unfunded	Gold	897	19.8 %	179	1042	1388	1308	1471	5388	6.0	-4 %
			Hybrid Gold	146	3.2 %	93	343	404	400	446	1686	11.5	84 %
			Bronze	453	10.0 %	779	1869	2111	2148	2199	9106	20.1	221 %
			Green	967	21.4 %	786	2383	2745	2849	2958	11,721	12.1	93 %
			Only Green	187	4.1 %	101	346	318	420	390	1575	8.4	34 %
			Paywalled	1717	37.9 %	681	2192	2586	2618	2686	10,763	6.3	
Numerical Analysis	4356	Funded	Gold	52	1.2 %	5	39	59	74	84	261	5.0	-143 %
			Hybrid Gold	67	1.5 %	39	176	271	410	467	1363	20.3	67 %
			Bronze	631	14.5 %	364	1027	1347	1563	1628	5929	9.4	-30 %
			Green	832	19.1 %	512	1689	2343	2826	2824	10,194	12.3	0 %
			Only Green	433	9.9 %	254	918	1326	1547	1454	5499	12.7	4 %
			Paywalled	799	18.3 %	622	1855	2344	2493	2430	9744	12.2	
		Unfunded	Gold	83	1.9 %	18	68	96	144	133	459	5.5	-28 %
			Hybrid Gold	79	1.8 %	31	127	271	415	557	1401	17.7	151 %
			Bronze	366	8.4 %	134	276	338	407	427	1582	4.3	-64 %
			Green	723	16.6 %	355	1032	1448	1664	1886	6385	8.8	25 %
			Only Green	421	9.7 %	236	723	990	1023	1060	4032	9.6	35 %
			Paywalled	1425	32.7 %	547	1858	2406	2612	2658	10,081	7.1	
Orthodontics	1018	Funded	Gold	7	0.7 %	0	2	9	11	9	31	4.4	-47 %

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Palaeontology	4846	Unfunded	Hybrid Gold	1	0.1 %	0	1	2	3	5	11	11.0	69 %
			Bronze	14	1.4 %	1	23	37	33	52	146	10.4	60 %
			Green	35	3.4 %	10	54	71	87	95	317	9.1	39 %
			Only Green	23	2.3 %	10	44	50	59	61	224	9.7	50 %
			Paywalled	46	4.5 %	12	43	86	81	77	299	6.5	
			Gold	231	22.7 %	22	121	229	309	362	1043	4.5	-14 %
			Hybrid Gold	7	0.7 %	5	14	23	26	35	103	14.7	185 %
			Bronze	178	17.5 %	76	222	354	421	451	1524	8.6	66 %
			Green	326	32.0 %	67	251	430	518	648	1914	5.9	14 %
			Only Green	60	5.9 %	15	63	95	86	129	388	6.5	25 %
		Paywalled	451	44.3 %	80	334	546	672	698	2330	5.2		
		Funded	Gold	168	3.5 %	141	365	480	554	582	2122	12.6	16 %
		Hybrid Gold	163	3.4 %	141	456	753	796	727	2873	17.6	62 %	
		Bronze	666	13.7 %	687	1927	2635	2821	2950	11,020	16.5	52 %	
		Green	745	15.4 %	700	2022	2844	2949	2882	11,397	15.3	41 %	
		Only Green	243	5.0 %	176	593	816	843	838	3266	13.4	24 %	
		Paywalled	1119	23.1 %	818	2136	2794	3167	3252	12,167	10.9		
		Unfunded	Gold	362	7.5 %	230	753	956	1087	1066	4092	11.3	106 %
		Hybrid Gold	78	1.6 %	112	122	213	172	188	807	10.3	88 %	
		Bronze	189	3.9 %	102	268	378	415	442	1605	8.5	55 %	
Green	562	11.6 %	327	1122	1490	1621	1591	6151	10.9	99 %			
Only Green	163	3.4 %	97	290	391	441	418	1637	10.0	83 %			
Paywalled	1695	35.0 %	676	1712	2203	2352	2366	9309	5.5				
Paediatrics	1118	Funded	Gold	18	1.6 %	1	11	21	14	31	78	4.3	-87 %
			Hybrid Gold	2	0.2 %	0	1	8	7	7	23	11.5	42 %
			Bronze	13	1.2 %	3	23	34	35	46	141	10.8	34 %
			Green	82	7.3 %	38	133	204	202	223	800	9.8	20 %
			Only Green	57	5.1 %	34	110	156	161	169	630	11.1	36 %
		Paywalled	74	6.6 %	38	83	129	173	177	600	8.1		
		Unfunded	Gold	108	9.7 %	10	69	99	114	148	440	4.1	-5 %
		Hybrid Gold	5	0.4 %	5	15	32	54	52	158	31.6	636 %	
		Bronze	92	8.2 %	5	69	75	94	119	362	3.9	-9 %	
		Green	184	16.5 %	48	146	208	295	327	1024	5.6	30 %	
Only Green	67	6.0 %	33	60	87	141	149	470	7.0	63 %			
Paywalled	682	61.0 %	183	415	656	779	897	2930	4.3				
Sensory Systems	4708	Funded	Gold	724	15.4 %	329	1841	2428	2566	2604	9768	13.5	21 %
			Hybrid Gold	100	2.1 %	106	245	366	349	366	1432	14.3	28 %

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
Structural Biology	5557	Unfunded	Bronze	246	5.2 %	212	456	535	618	583	2404	9.8	-14 %
			Green	1190	25.3 %	842	3088	3899	4050	4233	16,112	13.5	21 %
			Only Green	350	7.4 %	340	959	1113	1131	1251	4794	13.7	23 %
			Paywalled	522	11.1 %	444	1162	1378	1400	1449	5833	11.2	
			Gold	648	13.8 %	255	1552	2144	2187	2418	8556	13.2	39 %
			Hybrid Gold	88	1.9 %	76	256	321	329	378	1360	15.5	62 %
			Bronze	348	7.4 %	183	556	761	812	938	3250	9.3	-2 %
			Green	861	18.3 %	381	1747	2348	2475	2813	9764	11.3	19 %
			Only Green	178	3.8 %	79	291	357	348	380	1455	8.2	-16 %
		Paywalled	1504	31.9 %	884	2753	3371	3621	3683	14,312	9.5		
		Funded	Gold	406	7.3 %	220	1140	1474	1646	1698	6178	15.2	-5 %
		Hybrid Gold	202	3.6 %	268	861	1160	1387	1627	5303	26.3	64 %	
		Bronze	473	8.5 %	447	1484	1785	1770	1867	7353	15.5	-3 %	
		Green	1377	24.8 %	1599	5097	6248	6452	7009	26,405	19.2	20 %	
		Only Green	571	10.3 %	885	2444	2878	2814	3026	12,047	21.1	32 %	
		Paywalled	1523	27.4 %	1298	4439	5996	6111	6491	24,335	16.0		
		Unfunded	Gold	464	8.3 %	257	949	1348	1460	1418	5432	11.7	23 %
		Hybrid Gold	53	1.0 %	34	142	163	157	149	645	12.2	28 %	
Bronze	154	2.8 %	105	326	371	387	410	1599	10.4	9 %			
Green	694	12.5 %	413	1414	1927	2016	1972	7742	11.2	17 %			
Only Green	144	2.6 %	93	271	341	321	309	1335	9.3	-3 %			
Paywalled	1567	28.2 %	857	2869	3562	3721	3905	14,914	9.5				
Tourism, Leisure & Hospitality Management	3491	Funded	Gold	12	0.3 %	0	8	17	20	30	75	6.3	-198 %
Hybrid Gold	22	0.6 %	17	74	129	137	173	530	24.1	29 %			
Bronze	19	0.5 %	15	63	98	120	128	424	22.3	20 %			
Green	114	3.3 %	72	266	443	613	719	2113	18.5	-1 %			
Only Green	85	2.4 %	52	192	298	461	549	1552	18.3	-2 %			
Paywalled	389	11.1 %	252	949	1523	2005	2525	7254	18.6				
Unfunded	Gold	116	3.3 %	11	93	147	166	231	648	5.6	-160 %		
Hybrid Gold	33	0.9 %	32	97	162	261	303	855	25.9	78 %			
Bronze	9	0.3 %	0	8	17	26	27	78	8.7	-67 %			
Green	476	13.6 %	245	894	1531	2231	2700	7601	16.0	10 %			
Only Green	393	11.3 %	227	778	1335	1954	2371	6665	17.0	17 %			
Paywalled	2413	69.1 %	1241	4113	7207	9729	12,738	35,028	14.5				
Transplantation	4076	Funded	Gold	26	0.6 %	7	26	53	60	50	196	7.5	-36 %
Hybrid Gold	217	5.3 %	285	893	989	1022	1128	4317	19.9	95 %			
Bronze	475	11.7 %	737	2202	2471	2561	2479	10,450	22.0	115 %			

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Table A1 (continued)

Subject Category	Total Articles	Funding	Publication Modality	Articles 2016	%	Cites 2016	Cites 2017	Cites 2018	Cites 2019	Cites 2020	Total Cites	Cites per Article	OA Citation Advantage
			Green	660	16.2 %	978	2853	3310	3456	3384	13,981	21.2	107 %
			Only Green	183	4.5 %	217	582	770	769	663	3001	16.4	60 %
			Paywalled	412	10.1 %	214	819	1079	1065	1037	4214	10.2	
		Unfunded	Gold	202	5.0 %	39	193	239	241	228	940	4.7	-54 %
			Hybrid Gold	143	3.5 %	184	521	550	613	633	2501	17.5	145 %
			Bronze	602	14.8 %	906	2533	3041	2772	2711	11,963	19.9	178 %
			Green	369	9.1 %	443	1314	1490	1535	1542	6324	17.1	140 %
			Only Green	94	2.3 %	82	254	301	281	285	1203	12.8	79 %
			Paywalled	1722	42.2 %	636	2455	3324	3005	2888	12,308	7.1	
Visual & Performing Arts	6729	Funded	Gold	18	0.3 %	1	20	23	24	28	96	5.3	51 %
			Hybrid Gold	17	0.3 %	4	15	18	26	21	84	4.9	40 %
			Bronze	11	0.2 %	5	9	16	24	24	78	7.1	101 %
			Green	101	1.5 %	40	79	111	144	159	533	5.3	49 %
			Only Green	68	1.0 %	33	51	63	86	97	330	4.9	37 %
			Paywalled	162	2.4 %	48	98	139	139	148	572	3.5	
		Unfunded	Gold	333	4.9 %	19	37	74	63	93	286	0.9	38 %
			Hybrid Gold	93	1.4 %	7	38	59	89	90	283	3.0	388 %
			Bronze	282	4.2 %	9	48	77	68	103	305	1.1	74 %
			Green	817	12.1 %	97	302	423	475	540	1837	2.2	261 %
			Only Green	502	7.5 %	79	242	315	358	391	1385	2.8	343 %
			Paywalled	5243	77.9 %	218	628	728	815	878	3267	0.6	

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