FEATURE

Open Access and Citation Impact

Modality, Funding, Publisher, and Disciplinary Trends at the University of Kentucky

Ben Rawlins and Mitchell Scott

As publishers and libraries attempt to align business models and collection strategies to an ever-increasing open access (OA) publishing landscape, both have found that the message of open access citation advantage (OACA) resonates with current and prospective authors. Despite its widespread promotion and acceptance, however, OACA is not universal and is subject to ongoing debate. This quantitative study contributes to the OACA debate and research with a longitudinal focus on citation data from journal articles published 2018–2021 by University of Kentucky-affiliated authors. The article and citation data for University of Kentucky-affiliated authors are supplemented with University of Kentucky College and departmental data, providing valuable local context. In addition to author-level departmental data, this study also considers traditional confounding variables often investigated in OACA studies, such as OA modality, funding, and funding source, and introduces journal publisher as a variable for OACA analysis. This study not only provides local context for University of Kentucky Libraries, but also serves as a template that other librarians can leverage to gain insight into local OA publishing and influence how they collaborate with faculty, researchers, and publishers on how the OA landscape impacts authors, research outputs, and library collections budgets.

The open access (OA) movement emerged as a response to the increasing cost of scholarly journals and the restrictive nature of traditional publishing models that stripped authors of their rights as creators and limited access to their research. The OA movement aimed to transform how scholarly information is shared; to enhance its accessibility, transparency, overall impact of research; and give authors control over their work and its reproduction.[1] This was to be accomplished by removing barriers to access and making research freely available, thereby increasing equitable access to research and its reach.[2] Both publishers and libraries have embraced OA to advance and grow the movement in line with their respective interests.

Currently many publishers and libraries have shifted publishing and subscription models to both accommodate OA and further grow it. Due to funder mandates, the article processing charge (APC) marketplace for OA and the resulting OA models it has spawned, authors' changing perceptions of OA, and the willingness of libraries to support new OA models, there is a new alignment in the scholarly communication landscape toward OA. Publishers have seized on this opportunity and have begun shifting their publishing and business models to focus on OA, in some cases exclusively. Although

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publishers' reasons for supporting OA may vary—from aligning with the values of the academic and research community to increasing revenue opportunities—the outcome has been considerable growth in the number of OA articles published. For example, nearly 25 percent of all articles (roughly 150,000) published by Elsevier in 2022 were OA articles. The compound annual growth rate (CAGR) for OA articles for Elsevier is 45 percent, compared to the 7 percent CAGR for subscription articles.[3] Additionally, Delta Think's *Market Sizing Update 2023* highlighted that nearly half (49 percent) of all scholarly articles published in 2022 were OA, albeit fee-based OA, with an anticipated CAGR of 13 percent moving forward.[4] There was a slight decrease to 10 percent for Delta Think's 2024 projections.[5]

Libraries also increasingly align OA collection strategies with faculty and researcher expectations and engagement, often highlighting the advantages of OA in discussions and marketing. To further promote OA and the associated advantages, more and more libraries, particularly in the United States, are entering into OA agreements with publishers.[6] One of the advantages of OA that has been widely promoted by the scholarly communications community, and has resonated with authors, is the open access citation advantage (OACA). The concept of OACA suggests that articles made freely available online are cited more frequently than those behind paywalls. Advocates argue that increased accessibility leads to greater readership and, consequently, higher citation counts. This is of particular importance for faculty who may be evaluated on the citation counts of their research outputs in tenure and promotion processes. Despite its widespread promotion and acceptance, however, OACA is not, in fact, universal and is subject to ongoing debate. Some critics argue that the citation advantage may be overstated or vary across disciplines, while others question the influence of factors such as self-selection bias, publication quality, and the visibility of OA journals. Additionally, there is ongoing discussion about whether the citation advantage is primarily due to OA or other contributing factors, such as the increased availability of research through social and professional networks or whether the research and resulting publications are grant funded.

This quantitative study examines citation data from journal articles published by University of Kentucky authors 2018 through 2021, adding local context with University of Kentucky College and departmental data. It considers common OACA variables like OA modality and funding and introduces journal publisher as a new variable. The findings not only offer insights for University of Kentucky Libraries but can also guide other librarians in understanding how OA impacts authors, research outputs, and library budgets.

Literature Review

Open Access Citation Advantage

The assertion that OA articles are cited more frequently than non-OA articles first emerged in the research in 2001.[7] Since then, scholars have been divided on its existence, the confounding variables that may create it and influence it, and the environmental biases that contribute to its measurement. Numerous positions have been taken since 2001, both verifying and nullifying the existence of OACA, and this ongoing debate is best characterized and explored in Langham-Putrow, Bakker, and

Riegelman's 2021 systematic review of OACA research.[8] Their analysis of 134 OACA studies published since 2001 found that 64 (47.8 percent) confirmed the existence of OACA, 37 (27.6 percent) denied it, and 32 (23.9 percent) found that OACA exists but within subsets of populations.

The variability observed in OACA research largely stems from which confounding variables are considered and addressed in the research design. Researchers argue that a form of selection bias exists in OA, where authors select high-quality articles to be made available as OA, suggesting that this selection bias—not accessibility or readership—is the primary driver of OACA.[9] Much like OACA itself, however, the debate between author self-selection bias and user self-selection bias—the tendency of users to prefer OA articles for reading and citing due to their accessibility—has resulted in mixed findings, depending on the variables analyzed.[10] Other confounding variables often examined and proven to influence OACA variability include, but are not limited to, early view access (e.g., preprint platforms used to disseminate articles ahead of publication) and various bibliometrics associated with OA. These metrics include OA modality, the discipline of authors or journals in the dataset, and the journal's impact factor.

Why has OACA become such a focus for scholarship? Open access has often been touted as a research equalizer, ensuring equitable access to scholarship. By increasing exposure, OA scholarship is expected to garner more citations, which hold significant academic value. Davis aptly states that "citations are the indicator of scholarly impact. They measure the diffusion of new knowledge, acknowledge the contribution of peers, and, in many fields, form the basis of professional reward."[11] Therefore, gathering and reporting citation metrics to demonstrate scholarly impact has become a focus of researchers and research.

Most OACA studies to date rely on one or a combination of three sources for citation data: Scopus, Web of Science, or Journal Citation Reports. Although not included in this literature review, emerging tools like Dimensions and OpenAlex are gaining traction and are expected to become valuable resources for bibliometric research.[12] These sources provide rich metrics foundational to many OACA studies. Depending on the data source selected and the study design, these sources allow researchers to distinguish OA articles from paywalled articles, subdivide OA into its unique modalities (e.g., hybrid, gold, green), and identify articles that received research funding. They can also include impact factor and other journal metrics, in addition to bibliometrics data such as citation counts.

In developing OACA research studies, researchers employ different methods and define different samples. Some researchers focus on the corpus of scholarship within specific disciplines.[13] Others examine the work of institutional faculty within particular disciplines.[14] Some studies compare journals' OA publishing output with their paywalled content to evaluate differences in citation advantage.[15] Surveys have also been distributed to samples of institutional faculty to assess how APCs were being paid by authors to make articles OA and their underlying motivations to make an article OA.[16] Additionally, some researchers have analyzed the entire article output from specific institutions.[17]

One challenge for any OACA study, or any study evaluating faculty motivations to publish OA, lies in defining the OA modalities to be studied and whether OA categories will be grouped together and in identifying confounding variables with which to evaluate OACA. Many studies treat OA as binary, grouping gold OA and hybrid OA under one monolithic OA and paywalled content under non-OA.[18] These studies have often struggled with data sources that fail to distinguish between gold, hybrid, bronze, and platinum OA and can combine these groups into a generalized OA or exclude them in their identification. Some studies make this distinction and consider the complexities of APC publishing and its costs.[19] They also account for different paths to OA and their effects on OACA. Because many authors include APC costs in research proposals, funding can also be considered a confounding variable.[20] The traditional path of green OA and institutional repositories has also been evaluated and considered.[21]

Although the research of Langham-Putrow, Bakker, and Riegelman highlighted the inconclusive nature of OACA studies, analysis of article output and citations by various confounding variables has shown the presence of OACA. In terms of OA modality, Dorta-Gonzalez found that hybrid OA articles had twice as many citations as articles in gold OA journals, articles in gold OA journals had a lower OACA than paywalled articles, and green OA articles received 50 percent more citations than paywalled articles. Additionally, Dorta-Gonzalez found that for the forty discipline categories they investigated, 32.1 percent of the articles analyzed within these disciplines had a funding source, and funded articles saw 50 percent more citations than unfunded ones within the same OA publication modality. Within the disciplines they studied, Dorta-Gonzalez attributed the citation superiority of funded articles to a greater availability of resources for carrying out high-quality research, a greater ability to access and analyze larger datasets, and possibly, a greater ability for greater dissemination through networks and marketing efforts.[22] Boczar discovered that OACA was significantly larger for chemistry and geosciences articles, whereas other disciplines showed a small citation advantage, and one discipline, world languages, had paywalled content with a higher OACA than OA. In clinical medicine, Saravudecha found that gold OA journals, on average, received 30 percent more citations than paywalled articles.[23] Regarding the confounding variables influencing faculty to publish OA, Kirschner found that for education faculty, promotion and tenure were significant influences, and Heaton found that altruism and a sense of social responsibility were the highest motivators, followed by a perceived greater likelihood of being cited.[24]

OACA studies and their findings increasingly inform practices among academic librarians. Boczar intended their work to create a more "holistic understanding" of OACA and to inform faculty how their choice of an OA modality could affect the impact of their research.[25] Dorta-Gonzalez recommended similar advice, stating that faculty should be aware of the importance of choosing the right OA modality for their discipline and research to maximize visibility and impact.[26] Some are using OACA research and insights into faculty motivations for publishing OA to rethink strategies around transformative agreements (TA) and library subscriptions funding OA APCs. Saravudecha noted that as TAs become more widely adopted and more research shifts from paywalled to OA, it remains to be seen whether the documented OACA of OA will hold.[27] Halevi also expressed concerns with the APC model, pointing out that OA currently directs significant grant funding toward APCs, which increases publishing companies'

revenues and reduces funds dedicated to research and scientific advancement. They argued that asking libraries to cover APCs is also unrealistic.[28]

What has been missing from these studies—and could prove informative for libraries, the scholarly communications services and outreach they support, and OA deals they are evaluating—is research aligning institutional longitudinal publishing data with authors' college and departmental affiliations. By connecting University of Kentucky authors with their departments, this study contributes to the OACA discussion by examining granular institutional-based variables, such as the author's college and/or department, alongside more traditional OACA confounding variables, such as OA modality, funding, and article publisher. This approach offers a more comprehensive understanding of the institutional *why* (local context, OACA), *where* (local context and publisher), and *how* (funding, OA modality) of OA publishing. The addition of publisher as a variable to be considered is also novel and significant given publishers' varied gold and hybrid OA portfolios, as well as APC costs for OA, and libraries' greater involvement in TAs. Therefore, we believe that this study and its replicability could equip local library practitioners with nuanced insights for discussions on OA publishing and OACA and enable more informed and targeted scholarly communication strategies.

Methodology

The parameters established for this study were journal articles published by authors affiliated with the University of Kentucky, regardless of author position, from 2018 through 2021. We gathered the publication and citation data from Scopus in April 2024. Using the "Organizations" search function in Scopus, we searched for the University of Kentucky to identify all institutional affiliated publications. Results were limited by year (2018–2021), document type (article), and source type (journal). With these filters in place, a dataset of 12,450 journal articles were returned. We exported the following publication data: author(s), document title, year, source title, citation count, DOI (digital object identifier), open access, affiliations, correspondence address, and funding details. The exported data was then run through a locally developed Python script to identify and add University of Kentucky–affiliated author data to the Scopus dataset. This created new columns that included the name of the University of Kentucky corresponding or primary author or University of Kentucky–affiliated author, the University of Kentucky author department affiliation if it was listed in the affiliations, and the position(s) of University of Kentucky–affiliated authors. Additionally, we used OpenRefine to further clean the data and merge some elements together, such as publisher information and grant funding agencies. For records that did not have a University of Kentucky department affiliation identified with the Python script, we manually added the department and University of Kentucky college information. Once the data was formatted and cleaned, we created a MySQL database, an open-source relational database management system, to store, retrieve, and analyze the data. We then built a website using PHP, Bootstrap, and Highcharts to display and visualize the data outputs from the SQL queries.

Librarians replicating these methods for their local context can also use Scopus or other bibliometric databases, such as Web of Science or Dimensions, as these databases allow for searching by institutional affiliation and exporting of metadata that includes citation data and OA modality.

Data Analysis

Beyond contributing to the scholarship on this topic, we were interested to see whether the OACA exists within our local context, particularly as we continue to engage with faculty on issues related to OA publishing and publishing in general. With the data from this project, we explored and answered the following questions:

- Is there an OA citation advantage for research outputs by affiliated authors at the University of Kentucky?
- Does the modality of OA matter (e.g., is there a difference in citations between gold and hybrid OA)?
- In which University of Kentucky colleges and departments does OACA exist?
- What impact, if any, does grant funding have on the number of citations? Does the modality (paywalled, gold OA, or hybrid OA) of the grant-funded research matter when it comes to citations?
- What distinct OACA advantages exist between publishers and OA modality within those publishers' OA offerings?

Although there are many different lenses through which to analyze and evaluate citation data, this study looks at citation data overall as well as OA modality, college and department, grant funding, and publisher. Analyzing and evaluating these relationships provides a more nuanced understanding of citations and the contexts in which OACA exists.

Although we recognize the value of green OA, it was excluded from this study. For this study, we were interested in examining the citation differences between paid OA (gold and hybrid) and paywalled content to determine if, and when, an OACA exists. Additionally, there is a methodological challenge of reliably determining whether the paywalled or green OA version was cited, making it difficult to isolate and analyze its specific impact on citations.

Overall Citations Data

From 2018 to 2021, authors affiliated with the University of Kentucky published 12,540 journal articles (table 1). Of those articles, 3,073 (24.5 percent) were OA. Looking at the overall citation data and citation data for OA articles, articles published in OA journals have a higher average citation, 29.34, compared to the average citation of 20.91 for all University of Kentucky articles. That equates to an OACA of 8.43, or a 40 percent increase in citation for OA articles compared to the overall average citation.

Total Articles	OA Articles	Avg. Citations	Avg. OA Citations	OA Citation Difference
12,540	3,073	20.91	29.34	8.43

Table 1: Overall citation data

When the data is broken down by OA modality, gold and hybrid, however, a different story emerges. Table 2 shows that of the 3,073 total OA articles, 2,454 (79.8 percent) were published in gold OA journals and only 619 were hybrid. Despite the higher number of OA articles published in gold OA journals, an OACA does not exist for articles published in these journals. The average citation for articles published in gold OA journals is 20.55 compared to the overall average citation of 20.91. On the other hand, there is a significant OACA for OA articles published in hybrid OA journals. The average citation for articles published in hybrid OA journals is 64.18 compared to 20.55 for gold OA journals and 20.91 for overall average citation. Compared to the overall average citation, gold OA articles get 1.75 percent fewer citations, whereas hybrid OA articles get 207 percent more citations. This data demonstrates the importance of incorporating OA modality in any analysis of citation data, particularly when looking at whether an OACA exists.

Total OA	Gold OA	Hybrid OA	Avg. OA Citations	Avg. Gold OA Citations	Avg. Hybrid OA Citations
3,073	2,454	619	29.34	20.55	64.18

Table 2: Citation data by OA modality

University of Kentucky Colleges

The University of Kentucky is comprised of eighteen academic colleges (Agriculture, Food, and Environment; Arts and Sciences; Business and Economics; Communication and Information; Dentistry; Design; Education; Engineering; Fine Arts; Health Sciences; Honors; Law; Libraries; Medicine; Nursing; Pharmacy; Public Health; and Social Work). Of these colleges, most journal article research outputs are from four colleges (figure 1). These four colleges account for 72.5 percent, or 8,683 articles, of the total journal article research outputs, with Medicine accounting for the largest portion at 28.2 percent (3,381 articles),

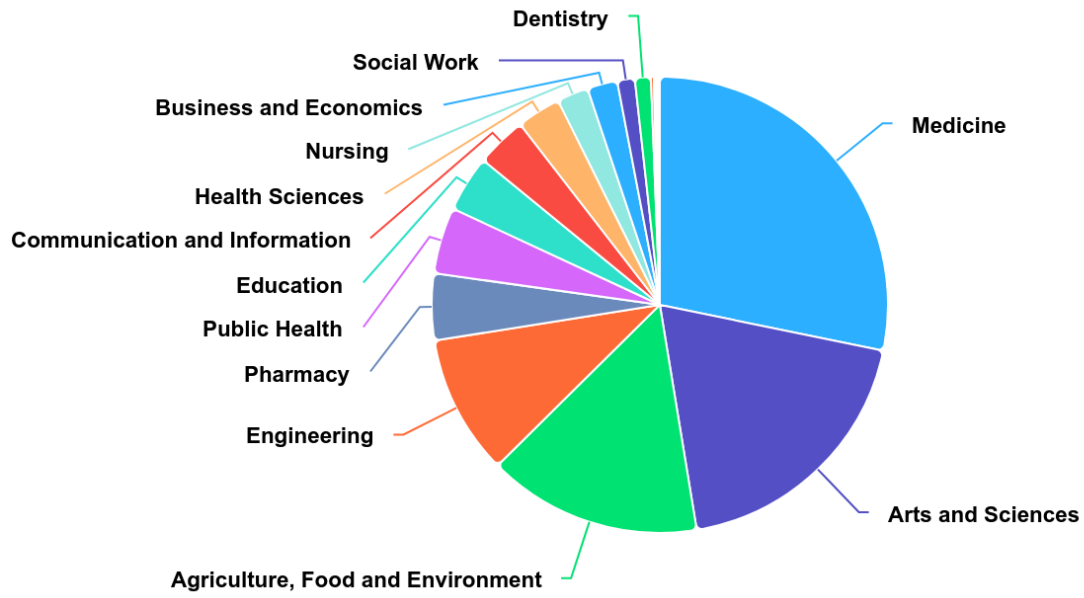

Figure 1: Articles by College

followed by Arts and Sciences at 19.2 percent (2,298 articles), Agriculture, Food and Environment at 15.2 percent (1,816 articles), and Engineering at 9.9 percent (1,188 articles).

Looking at the citation data by college shows that there is an OACA for twelve of the eighteen colleges (table 3). Although an OACA does exist for a majority of academic colleges, there is a variation in the extent to which it exists. For example, the OACA for Engineering (0.44) and Pharmacy (0.48) are negligible. On the other hand, there is a significant difference for Public Health, where the OACA is 80.35. The citation data for the four colleges (Medicine; Arts and Sciences; Agriculture, Food and Environment; and Engineering) that account for a majority of the journal article research outputs, and also account for 77.6 percent of OA articles, show that the OACA ranges from a 2.3 percent increase (Engineering) to a 44.4 percent increase (Arts and Sciences). For all colleges with an OACA, the range is 2.3 percent (Engineering) to 142.2 percent (Public Health).

College	Total Articles	OA Articles	Avg. Citations	Avg. OA Citations	OA Citation Difference
Medicine	3,381	1,032	24.28	27.99	3.71
Arts and Sciences	2,298	495	16.85	24.33	7.48
Agriculture, Food and Environment	1,816	641	18.23	20.35	2.12
Engineering	1,188	217	19.4	19.84	0.44
Pharmacy	565	147	15.13	15.61	0.48
Public Health	564	171	56.51	136.87	80.35
Communication and Information	431	38	27.52	31.37	3.85
Health Sciences	374	56	13.37	18.14	4.77
Business and Economics	255	16	23.17	33.19	10.02
Social Work	149	11	15.26	18.27	3.01
Law	12	1	4.5	10	5.5
Honors	9	3	7.11	9.67	2.56

Table 3: Colleges where an OACA exist

For the colleges where an OACA does not exist (table 4), there are some interesting variations. For example, although an OACA does not exist for Education, the citation difference between non-OA and OA articles is relatively the same, with the average citation barely higher, 0.04, than the average OA citation. There are two colleges, Fine Arts and Design, where there were no OA citations. No journal articles were published OA in Fine Arts during the period under review, and only two articles were published in Design. Research outputs in these colleges, particularly in fields like the Fine Arts, are often produced in nontraditional formats, such as performances, exhibitions, or creative works, rather

than journal articles. As a result, OA article publishing is less prevalent in these disciplines, contributing to the lower OACA observed in these colleges.

College	Total Articles	OA Articles	Avg. Citations	Avg. OA Citations	Avg. Citation Difference
Education	479	59	12.87	12.83	0.04
Nursing	266	40	11.01	8.98	2.03
Dentistry	136	24	7.37	5.29	2.08
Fine Arts	25	0	6.4	0	6.4
Libraries	17	7	1.82	1	0.82
Design	12	2	2.5	0	2.5

Table 4: Colleges where an OACA does not exist

Colleges where an OACA exists have a larger portion of the journal articles' research outputs published as OA (25.6 percent or 2,828 articles) compared to the colleges where an OACA does not exist (14.1 percent or 132 articles). This finding suggests that a higher rate of OA publishing could result in an increase in citations.

University of Kentucky Department

Although the citation data for a majority of the academic colleges, twelve of eighteen, demonstrate that an OACA exists, there is more variance when looking at the citation by departments. For example, citation data for two of the colleges with the highest research outputs and a clear overall OACA, Medicine and Agriculture, Food, and Environment, demonstrate that in roughly 50 percent of the departments, an OACA does not exist. To demonstrate this difference, tables 5 and 6 show a selection of ten departments from each college, where five departments have an OACA, and five departments do not have an OACA. For the College of Medicine, although the college overall has an OACA, the department with the highest research output, Internal Medicine, does not have an OACA. The citation data for Internal Medicine shows an average of 9.13 fewer (31.4 percent) OA citations than the overall average citation (table 5). For the selection of departments within the College of Medicine (table 5) where an OACA exists, the OA citation difference ranges from 1.02 (10 percent) for Orthopedic Surgery and Sports Medicine to 56.16 (90.7 percent) for Physiology. For the departments where an OACA does not exist, the average citation difference ranges from 1.42 (10.7 percent) for Behavioral Science to 26.18 (44.9 percent) for the Sanders-Brown Center on Aging.

Like the College of Medicine, the department in the College of Agriculture, Food, and Environment with the highest research output, Plant and Soil Sciences, does not have an OACA, although the difference here is negligible, with an average citation difference of just 0.3. For the selection of departments within the College of Agriculture, Food, and Environment (table 6) where an OACA does exist, the OA citation difference ranges from 1.53 (11.6 percent) for Veterinary Science to 13.81 (63.8 percent) for Plant

Department	Total Articles	OA Articles	Avg. Citations	Avg. OA Citations	OA Citation Difference
Internal Medicine	599	214	29.12	19.99	-9.13
Surgery	248	35	13.39	15.4	2.01
Behavioral Science	182	32	13.26	11.84	-1.42
Markey Cancer Center	179	70	31.22	26.8	-4.42
Pediatrics	163	40	14.74	19.1	4.36
Physiology	160	69	61.94	118.1	56.16
Neurology	146	58	30.45	43.17	12.73
Orthopedic Surgery and Sports Medicine	145	28	10.23	11.25	1.02
Radiology	123	32	12.53	9.09	-3.44
Sanders-Brown Center on Aging	109	55	58.33	32.15	-26.18

Table 5: Selection of Departments from the College of Medicine

Pathology. For the departments where an OACA does not exist, the average citation difference ranges from 0.04 (0.2 percent) for Biosystems and Agricultural Engineering to 13.63 (47.6 percent) for Retail Tourism and Management, although it should be noted that there is only one OA article published by this department.

Department	Total Articles	OA Articles	Avg. Citations	Avg. OA Citations	OA Citation Difference
Plant and Soil Sciences	350	127	21.55	21.25	-0.3
Entomology	307	131	21.3	26.97	5.67
Veterinary Science	267	98	13.29	14.83	1.53
Animal and Food Sciences	214	75	20.26	13.93	-6.33
Forestry and Natural Resources	122	44	19.58	22.73	3.15
Plant Pathology	120	38	21.64	35.45	13.81
Biosystems and Agricultural Engineering	110	25	17.32	17.28	-0.04
Agricultural Economics	76	20	10.87	16.9	6.03
Horticulture	69	40	17.88	14.3	-3.58
Retailing and Tourism Management	16	1	28.63	15	-13.63

Table 6: Selection of Departments from the College of Agriculture, Food and Environment

Grant Funding

In 2023, the University of Kentucky received $479.3 million in grant funding to support research and creative activity, with more than 52.7%, $252.6 million, coming from federal agencies.[29] The top ten funding agencies (figure 2) were the National Institutes of Health, National Science Foundation, US Department of Agriculture, National Cancer Institute, National Natural Science Foundation of China, National Center for Advancing Translational Sciences, US Department of Energy, National Institute of Drug Abuse, National Institute of Food and Agriculture, and National Heart, Lung, and Blood Institute. Of all the research outputs for the University of Kentucky from 2018 to 2021, grant-funded research outputs account for 66.3 percent, or 8,317 articles, of the total.

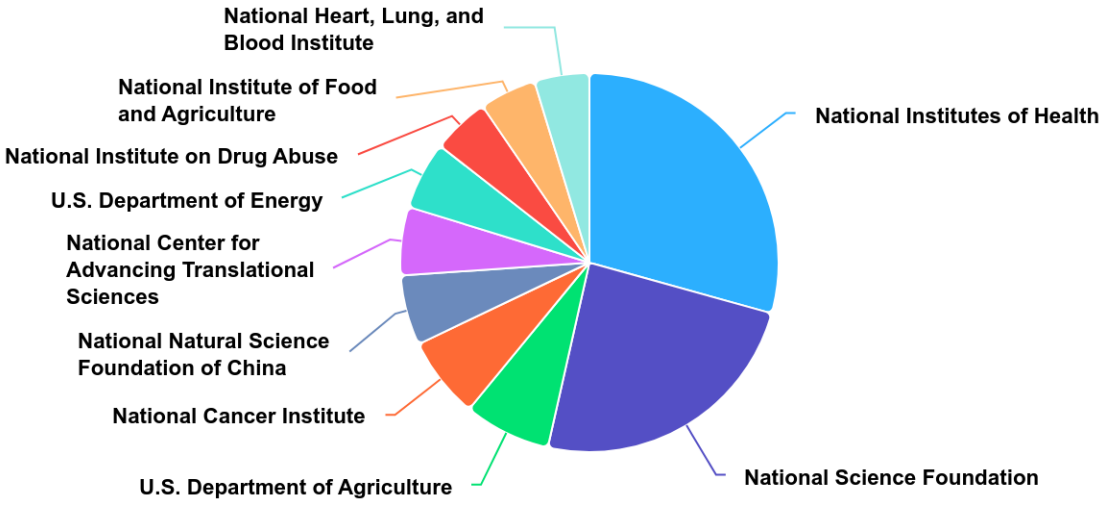

Figure 2: Top Funders

Of the 8,317 journal articles published as a result of grant funding, 2,337 articles, 28 percent, are OA (table 7). Although grant-funded OA articles only account for 28 percent of the total grant-funded journal article research outputs, they account for 76 percent of all OA articles (2,337 of 3,073) published by the University of Kentucky–affiliated authors. Grant-funded journal articles have a higher average citation rate, 24.75, compared to the overall average citation of 20.91 for all University of Kentucky journal articles, a difference of 3.84 (18.3 percent). OA citations follow the same trend, with grant-funded OA journal articles receiving an average citation of 34.32 compared to the overall OA average citation of 29.34, a difference of 4.98 (16.9 percent). Looking at the overall citation data for grant-funded journal articles, there is a distinct OACA, with OA articles receiving 9.57 (38.6 percent) more citations than the average overall citation (table 7).

Grant Funded Articles	Grant Funded OA Articles	Avg. Grant Funded Citations	Avg. Grant Funded OA Citations	OA Citation Difference
8,317	2,337	24.75	34.32	9.57

Table 7: Grant funded citation data

The data indicates a distinct OACA for grant-funded articles, with significant differences in average citations based on the OA modality—gold or hybrid. Of the 2,337 OA articles, 1,829 (78.2 percent) are gold OA and 508 (21.8 percent) are hybrid OA (table 8).

For gold OA articles, an OACA does not exist. On average, grant-funded gold OA articles receive 23.23 citations, which is 1.52 citations (6.5 percent) less than the overall average of 24.75 citations for grant-funded articles. In contrast, hybrid OA articles show a significant OACA. On average, grant-funded hybrid OA articles receive 74.26 citations, which is 51.03 citations (219.7 percent) more than gold OA articles and 49.51 citations (200 percent) more than the overall average for grant-funded articles.

Grant Funded OA	Grant Funded Gold OA	Grant Funded Hybrid OA	Avg. Grant Funded OA Citations	Avg. Grant Funded Gold OA Citations	Avg. Grant Funded Hybrid OA Citations
2,337	1,829	508	34.32	23.23	74.26

Table 8: Grant funded citation data by OA modality

Overall, a majority of the University of Kentucky OA articles are a direct result of grant funding. Grant-funded gold OA articles account for 74.5 percent of all OA articles, and grant-funded hybrid OA articles account for 82 percent of all OA articles. Therefore, the data from grant-funded journal article research outputs further illustrates the importance of OA modality in any analysis of citation data, particularly when looking at whether an OACA exists. This data has shown that gold OA articles have a lower citation rate compared to the overall average citation rate, and hybrid OA articles have a significantly higher citation rate than the overall average citation rate.

Publisher

Many publishers tout the citation advantage of OA publishing, particularly as OA is becoming central to publishers' strategy and more libraries and institutions are entering into OA agreements. Between 2018 and 2021, the University of Kentucky–affiliated authors published the most journal articles, excluding exclusively OA publishers, with Elsevier, Springer Nature, Wiley, Taylor & Francis (T&F), Sage, Lippincott Williams & Wilkins, Oxford University Press, American Chemical Society, IEEE, and the American Physical Society. These publishers account for 67 percent (8,395) of the published journal articles by the University of Kentucky–affiliated authors. Of these top ten publishers, eight have an OACA (table 9). The exceptions are Lippincott Williams & Wilkins and IEEE. For the publisher where an OACA exists the OA citation difference ranges from 2.71 (20 percent) for Sage to 30.95 (137 percent) for Wiley. For the publishers where an OACA does not exist, OA articles receive 2.77 (14.5 percent) fewer citations for Lippincott Williams & Wilkins and 7.88 (18.1 percent) fewer citations for IEEE.

Regarding OA, these publishers account for 48 percent (1,487) of OA articles published by University of Kentucky–affiliated authors. Although eight of ten publishers show an OACA, differences emerge when considering the OA modality. For instance, citation data from seven of the ten publishers (Elsevier, Sage, Lippincott Williams & Wilkins, Oxford University Press, American Chemical Society, IEEE,

Publisher	Total Articles	OA Articles	Avg. Citations	Avg. OA Citations
Elsevier	2,659	357	20.8	26.62
Springer Nature	1,489	580	26.54	30.46
Wiley	1,236	199	22.59	53.54
Taylor & Francis	756	32	9.51	15.78
Sage	700	78	13.58	16.29
Lippincott Williams & Wilkins	474	32	19.05	16.28
Oxford University Press	398	96	20.73	29.63
American Chemical Society	298	10	23.05	26.1
IEEE	209	34	43.59	35.71
American Physical Society	176	69	33.49	47.04

Table 9: Citation data by Publisher

and American Physical Society) indicate that the average citation for gold OA articles is lower than the overall average citation (table 10). Additionally, in seven of the ten publishers (excluding Wiley, Lippincott Williams & Wilkins, and IEEE), the average citation rate for gold OA articles is even lower than the overall average OA citation rate.

Conversely, hybrid OA articles from these publishers, except for Lippincott Williams & Wilkins and IEEE, have higher average citation rates than the overall average citation rate. Furthermore, the average

Publisher	OA Articles	Gold OA	Hybrid OA	Avg. OA Citations	Avg. Gold OA Citations	Avg. Hybrid OA Citations
Elsevier	357	220	137	26.62	14.7	45.75
Springer Nature	580	509	71	30.46	28.49	44.61
Wiley	199	143	56	53.54	62.36	31
Taylor and Francis	32	19	13	15.78	13.16	19.62
Sage	78	62	16	16.29	13.53	27
Lippincott Williams & Wilkins	32	17	15	16.28	18.88	13.33
Oxford University Press	96	58	38	29.63	18.74	46.24
American Chemical Society	10	3	7	26.1	10.67	32.71
IEEE	34	29	5	35.71	37.31	26.4
American Physical Society	69	9	60	47.04	19.78	51.13

Table 10: Publisher citation data by OA modality

citation rate for hybrid OA articles is higher than the overall average OA citation rate in seven of the ten publishers (excluding Wiley, Lippincott Williams & Wilkins, and IEEE).

Despite the clear citation advantage for hybrid OA, gold OA is the preferred OA publishing modality for University of Kentucky–affiliated authors, accounting for 1,069 OA articles (72 percent), whereas hybrid OA accounts for 418 OA articles (28 percent).

The citation data by publisher is consistent with the overall citation data and citation data for grant-funded journal articles in that the driver of whether an OACA exists appears to be the OA modality through which the article is published. The data has consistently shown that gold OA articles have lower citation rates than the overall average citation rates, whereas hybrid OA articles have significantly higher citation rates compared to both the overall average citation rates and gold OA citation rates. To the authors, this OACA advantage by modality for publishers suggests a reluctance on the part of some publishers to "flip" higher-impact journals to a gold OA model. Instead, they facilitate the OA participation of high-status journals through the hybrid model, which preserves the importance of subscription while also collecting on APCs to publish within these journals. Therefore, it is essential that any analysis of OACA include OA modality to accurately capture the extent to which an OACA exists or not.

Discussion

The data provided by the University of Kentucky aligns squarely with numerous studies showing that OACA is no monolith, but rather is highly dependent on the academic discipline of the authors, the OA modality of the published article, the journal in which the article is published, and whether the research was grant-funded. When considering the importance of OACA to faculty, it is crucial to understand the motivations for paying an APC to make an article OA. The University of Kentucky data shows that 24 percent of OA articles were not supported by funding, indicating that University of Kentucky authors chose to pay an APC for reasons other than a possible funder mandate or direct funding to support the APC. Although some authors may have received an APC waiver from the publisher, and with University of Kentucky Libraries having signed TAs with only the Association of Computing Machinery, Cambridge University Press, Company of Biologists, and Royal Society of Chemistry, the majority likely paid the APC from personal, institutional, or other funds.[30] In doing so, this set of authors was motivated by something outside of a funder's mandate to make an article OA. Possible motivations include a belief in the altruism of OA and the importance of equitable access to all scholarly output.[31] They may also believe in the benefits of OACA or that their discipline or department values OA publications in a way that is beneficial to their promotion and tenure cases.[32] It could also be a combination of all of these and other factors.

As seen in the University of Kentucky data, funded articles were 62 percent more likely to be OA than non-funded ones and 135 percent more likely to opt for hybrid OA than non-funded OA articles. These two confounding variables also created the greatest OACA when comparing funded hybrid OA to non-funded gold OA. Because hybrid OA supports author's choice of publication venue, and many authors prefer higher-profile, higher-impact journals that support hybrid OA publishing, it is not surprising that

funded research, with its potential to cover the burden of an APC, results in more hybrid OA articles. Pursuing a hybrid OA publication also aligns with three important priorities and motivations for authors:

1. Publish in the highest-profile journals to broadly disseminate research to area experts, leading to more impactful and cited work
2. Publish in the highest-profile journals to potentially meet the promotion and tenure demands of their department, discipline, and profession
3. Meet funders' OA mandates and magnify the reach of funded research

The role of funding and the potential use of that funding to cover the cost of an APC seems to play an important role in the current APC era of OA publishing. If more funders decide to adopt hardline stances against using funding dollars to pay APCs,[33] then some publishers stand to lose a significant portion of their APC revenue.

The University of Kentucky also sees this data as applicable to how it evaluates read and publish and transformative agreements that potentially provide an outlet for University of Kentucky corresponding authors to publish OA without an APC cost, or more accurately, with the APC covered by the library's agreement. These deals with the big five publishers (Elsevier, Springer Nature, Wiley, T&F, and Sage) vary widely and may include both gold OA and hybrid OA—though more commonly, only hybrid OA. For research-intensive universities such as the University of Kentucky, they typically come with publishing caps or a limited number of articles per year to be covered by the deal. As seen at the University of Kentucky, gold OA is the dominant OA modality (80 percent published as gold OA). Any TA with one of the big five publishers that excludes gold OA would exclude the vast majority of University of Kentucky OA articles with those publishers (Springer 87 percent gold, Sage 79 percent gold, Wiley 72 percent gold, Elsevier 62 percent gold, and T&F 59 percent gold) and effectively exclude articles that were less likely to have funding, not have the APC covered by funding, and require the author to use some other means to pay the APC to make the article OA, therefore providing considerably less benefit to University of Kentucky authors. The data on publisher OACA by journal modality also indicates that some publishers (Wiley and Springer) have shifted higher impact content to the gold model. Therefore, any read and publish deals that exclude gold OA could potentially be excluding major and pivotal publications within certain disciplines. More research on the impact factors of the gold and hybrid publisher portfolios, alongside OACA, is needed to draw more concrete conclusions.

Not to be lost in this conversation about TAs is the value of green OA and the role it can play in how libraries discuss OA publishing decisions with faculty. As can be seen with the University of Kentucky data and data from previous studies, green OA can also play a valuable role in meeting funder mandates, increasing OACA, and aligning with faculty priorities and motivations for OA, all without the cost or burden of an APC. Like most institutions, University of Kentucky has a low rate of self-archiving of published articles into UKnowledge, its institutional repository. Research has shown that institutional authors are reluctant to pursue green OA due to concerns about the archiving process and

the user experience of archiving in institutional repositories, unfamiliarity with author rights regarding archiving, doubts about copyright compliance, the potential role of green OA in the scholarly landscape, and their lack of time to investigate all of these aspects of self-archiving.[34] What is needed is a new model for green OA that meets the demands of both faculty and institutions. Green OA provides all of the same benefits as hybrid OA but without the APC. As we approach the potential implementation of the OSTP (Office of Science and Technology Planning) memo, its OA mandate, and the removal of embargoes, the role and impact of green OA will only be magnified. The University of Kentucky is exploring ways to rethink self-archiving. One possibility is to have the library take on this work; the University of Kentucky is also starting conversations with publishers about potential ways to create a more direct pathway for institutional-repository depositing that could better maximize green OA and make it a sustainable avenue for OA.

If the belief in OACA is at the heart of an author's decision to pay an APC and make an article OA, it is time for libraries to have honest discussions with their institutional authors about the reality of OACA and the true value and cost of OACA to authors. For those authors paying APCs with personal, institutional, or other funding, they should be aware of the return on investment of an APC in terms of OACA. As the University of Kentucky data shows, the ROI for these articles is relatively minimal overall, more advantageous for certain disciplines, and even more advantageous when publishing OA in a hybrid journal. As more and more libraries provide research services to faculty, authors could benefit from a decision tree or OACA workflow to help evaluate how the APC will be paid, whether a mandate needs to be met, and which OA modality (hybrid, gold, or green) could have the greatest OACA impact. This would enable authors to make more informed decisions about whether to pay an APC to make a work OA, consider green OA as a viable option, meet mandates, and choose the OA modality that best supports their priorities and motivations.

Conclusion

The goal of this study was to better understand OACA from a longitudinal set of articles at a major research institution; the confounding variables that correlate with increases, decreases, and null effects on OACA; and how these contribute to a more holistic understanding of OACA and its implications for libraries. Like many institutions and libraries, the University of Kentucky and the authors of this study have actively promoted the absoluteness of OACA to researchers and authors as a way to generate interest in and acceptance of OA. What this study adds to the literature, however, is the understanding that OACA is more nuanced and could be particularly influenced by factors that vary from institution to institution, such as the department of the primary or corresponding author, grant funding awarded to the institution and its researchers, and the publishers and OA modalities authors publish within.

This detailed and longitudinal examination of institutional publishing, OACA, and the confounding variables present in OACA has led the authors to pursue focus group discussions with institution-affiliated authors. These focus groups will explore many of the questions raised by the findings and discussion in this study, including institutional corresponding authors' OA publishing practices, how

APCs are paid, motivations for paying an APC, how often APCs are included in grant budgets, and how the University of Kentucky should locally evaluate and approach TAs. Using this data as a starting point for these conversations should enable the University of Kentucky to have nuanced conversations with its authors about the ROI of OA and discuss future interventions and strategies to help authors maximize the impact of their research, with or without an APC.

CRediT authorship contribution statement

Ben Rawlins: Writing – review & editing, Writing – original draft, Conceptualization, Data Curation, Formal Analysis.

Mitchell Scott: Writing – review & editing, Writing – original draft, Conceptualization, Data Curation, Formal Analysis.

References

1. BOAI, "Budapest Open Access Initiative Declaration," 2002, https://www.budapestopenaccessinitiative.org/read/.
2. Max Planck Society, "Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities," 2003, https://openaccess.mpg.de/Berlin-Declaration.
3. Elsevier, "Elsevier Journal and Article Ecosystem – 2022 Summary," 2023, https://assets.ctfassets.net/o78em1y1w4i4/3VYckZEl50MdEblMY7i9CF/29b6bbc2738c451b7ad7a191a2dc080a/Journal-and-article-ecosystem.pdf.
4. Delta Think, "News & Views: Open Access Market Sizing Update 2023," 2023, https://deltathink .com/news-views-open-access-market-sizing-update-2022/.
5. Delta Think, "News & Views: Open Access Loses Share – Market Sizing 2024 Sneak Peek," 2024, https://deltathink.com/news-views-open-access-loses-share-market-sizing-2024-sneak-peek.
6. EASC, "Transformative Agreement Registry," 2024, https://esac-initiative.org/about/transformative-agreements/agreement-registry.
7. Steve Lawrence, "Free Online Availability Substantially Increases a Paper's Impact," *Nature* 411, no. 6837 (2001): 521, https://doi.org/10.1038/35079151.
8. Allison Langham-Putrow, Caitlin Bakker, and Amy Riegelman, "Is the Open Access Citation Advantage Real? A Systematic Review of the Citation of Open Access and Subscription-Based Articles," *PLOS ONE* 16, no. 6 (2021): e0253129, https://doi.org/10.1371/journal.pone.0253129.
9. Philip M. Davis, Bruce V. Lewenstein, Daniel H. Simon, James G. Booth, and Mathew J. L. Connolly, "Open Access Publishing, Article Downloads, and Citations: Randomised Controlled Trial," *BMJ* 337 (2008): a568, https://doi.org/10.1136/bmj.a568; Michael J. Kurtz et al., "The Effect of Use and Access on Citations," *Information Processing & Management* 41, no. 6 (2005): 1395–1402, https://doi.org/10.1016/j.ipm.2005.03.010.
10. Yassine Gargouri et al., "Self-Selected or Mandated, Open Access Increases Citation Impact for Higher Quality Research," *PLOS ONE* 5, no. 10 (2010): e13636, https://doi.org/10.1371/journal.pone.0013636;

Jingfeng Xia and Katie Nakanishi, "Self-Selection and the Citation Advantage of Open Access Articles," *Online Information Review* 36, no. 1 (2012): 40–51.

11. Philip M. Davis, "Open Access, Readership, Citations: A Randomized Controlled Trial of Scientific Journal Publishing," *The FASEB Journal* 25, no. 7 (2011): 2129–34, https://doi.org/10.1096/fj.11-183988.
12. Juan Pablo Alperin et al., "An Analysis of the Suitability of OpenAlex for Bibliometric Analyses," *arXiv preprint arXiv:2404.17663* (2024).
13. Dorta-González, 2023.
14. Julie Arendt, Bettina Peacemaker, and Hillary Miller, "Same Question, Different World: Replicating an Open Access Research Impact Study," *College & Research Libraries* 80, no. 3 (2019): 303, https://doi.org/10.5860/crl.80.3.303; Boczar and Schmidt, 2022; Jessica Kirschner et al., "To Open or Not to Open: An Exploration of Faculty Decisions to Publish Open-Access Articles," *Journal of Librarianship and Scholarly Communication* 12, no. 1 (2024), https://doi.org/10.31274/jlsc.16894; Zhang and Watson, 2017.
15. Davis, "Open Access," 2011; Saravudecha et al., 2023.
16. Gali Halevi and Samantha Walsh, "Faculty Attitudes Towards Article Processing Charges for Open Access Articles," *Publishing Research Quarterly* 37 (2021): 384–98, https://doi.org/10.1007/s12109-021-09820-x; Heaton, Burns, and Thoms, 2019.
17. Hubbard, 2017.
18. Boczar and Schmidt, 2022; Davis, "Open Access," 2011; Halevi and Walsh, "Faculty Attitudes," 2021; Heaton, Burns, and Thoms, 2019; Hubbard, 2017; Langham-Putrow, Bakker, and Riegelman, "Is the Open Access Citation," 2021; Zhang and Watson, 2017.
19. Dorta-González, 2023; Saravudecha et al., 2023; Halevi and Walsh, "Faculty Attitudes," 2021; Heaton, Burns, and Thoms, 2019.
20. Zhang and Watson, 2017.
21. Dorta-Gonzalez, 2023; Jonathan S. Young and Patricia M. Brandes, "Green and Gold Open Access Citation and Interdisciplinary Advantage: A Bibliometric Study of Two Science Journals," *The Journal of Academic Librarianship* 46, no. 2 (2020): 102105, https://doi.org/10.1016/j.acalib.2019.102105; Zhang and Watson, 2017.
22. Dorta-Gonzalez, 2023.
23. Boczar and Schmidt, 2022; Saravudecha et al., 2023.
24. Heaton, Burns, and Thoms, 2019.
25. Boczar and Schmidt, 2022.
26. Dorta-Gonzalez, 2023.
27. Saravudecha et al., 2023.
28. Halevi and Walsh, 2021
29. University of Kentucky, August 2, 2023
30. Bo-Christer Björk and David Solomon, "How Research Funders Can Finance APCs in Full OA and Hybrid Journals," *Learned Publishing* 27, no. 2 (2014): 93–103, https://doi.org/10.1087/20140203.

31. Heaton, Burns, and Thoms, 2019; MacKenzie Smith et al., *Pay It Forward: Investigating a Sustainable Model of Open Access Article Processing Charges for Large North American Research Institutions,* 2016, https://escholarship.org/uc/item/8326n305.
32. Halevi and Walsh, 2021; Kirschner et al., "To Open or Not," 2024.
33. "Payment of Publishing Fees," Gates Open Access Policy, Bill & Melinda Gates Foundation, accessed July 10, 2024, https://openaccess.gatesfoundation.org/payment-of-publishing-fees/.
34. Jihyun Kim, "Faculty Self-Archiving: Motivations and Barriers," *Journal of the American Society for Information Science and Technology* 61, no. 9 (2010): 1909–22, https://doi.org/10.1002/asi.21336.