RESEARCH ARTICLE

The pricing of open access journals: Diverse niches and sources of value in academic publishing

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ABSTRACT

Open access (OA) publishing has created new academic and economic niches in contemporary science. OA journals offer numerous publication outlets with varying editorial philosophies and business models. This article analyzes the Directory of Open Access Journals (DOAJ) (n = 12,127) to identify characteristics of OA academic journals related to the adoption of article processing charge (APC)-based business models, as well as the price points of journals that charge APCs. Journal impact factor (JIF), language, publisher mission, DOAJ Seal, economic and geographic regions of publishers, peer review duration, and journal discipline are all significantly related to the adoption and pricing of journal APCs. Even after accounting for other journal characteristics (prestige, discipline, publisher country), journals published by for-profit publishers charge the highest APCs. Journals with status endowments (JIF, DOAJ Seal) and articles written in English, published in wealthier regions, and in medical or science-based disciplines are also relatively costlier. The OA publishing market reveals insights into forces that create economic and academic value in contemporary science. Political and institutional inequalities manifest in the varying niches occupied by different OA journals and publishers.

1. INTRODUCTION

Open access (OA) academic publishing has yielded numerous diverse economic and academic niches. The new incentives and institutions of OA publishing shape innovation and pricing strategies for publishers, while influencing publication preferences for scholars and academic stakeholders. Prices for OA journals funded via article processing charges (APCs) are set strategically by publishers. The APC-based business model departs from the traditional subscription-based publishing model. The subscription model often entails academic journals purchased via "big deal" bundles (Bergstrom, Courant, McAfee, & Williams, 2014; Shu et al., 2018). In contrast, APC-based OA journals no longer charge readers (represented by librarians who pay for journal subscriptions) but instead directly charge authors. Consequently, funding mechanisms in academic publishing shift from reading to writing.[1] Contemporary academic

[1] Notably, this shift entails increasing the relative cost burdens of academic publishing for prolific institutions, while reducing costs for institutions that publish relatively fewer articles (University of California Libraries, 2016). For example, a 2019 publishing agreement between Springer Nature and German negotiators was budget neutral for Germany as a whole. However, the agreement entailed increased costs for research universities and institutions that publish frequently, while reducing costs for teaching-oriented universities and other institutions that are less prolific (Matthews, 2019).

an open access journal

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OA publishing markets reveal the dynamics of knowledge pricing and valuation in contemporary science.

OA academic publishing has substantially expanded over the past two decades, occupying complementary and/or competitive niches vis-à-vis established subscription-based journals. Since the early 2000s, there has been a steady increase in OA journals and articles (Piwowar et al., 2018). These increases were driven via the founding of new journals and the conversion of subscription-based titles to OA. The prevalence of OA journals and business models will likely continue to increase in the future (Hook, Calvert, & Hahnel, 2019; Piwowar, Priem, & Orr, 2019). In July 2018, Science Europe announced Plan S, a contentious policy initiative mandating that all grant-funded research be published via an OA platform by 2020 (coalition-s.org, 2019; Debat & Babini, 2019; Quaderi, Hardcastle, Petrou, & Szomszor, 2019; Science Europe, 2018; Stoye, 2019), which was later delayed to 2021 (Else, 2019a). Since the introduction of Plan S, the initiative has diffused and been endorsed by numerous institutions and jurisdictions, including some outside Europe (Rabesandratana, 2019). Even industry-leading publisher RELX (formerly Reed Elsevier)—which owns extensive subscription journal assets—touted increases in OA publishing output in its 2018 annual report (RELX, 2019).

Although the convenience and accessibility of OA publishing is attractive to many scholars and academic stakeholders, there are concerns about cost control and fairness in APC-based publishing (Aguzzi, 2019; Matthews, 2017; Shulenburger, 2016). Given the newness of the OA publishing market, as well as the complexity of vetting and funding OA journals, understanding the valuation of OA journals is particularly important for contemporary science policy. A wide variety of scholars and institutions have founded thousands of OA journals with differing academic niches, editorial philosophies, and business models. Due to heterogeneity in scholarly and economic publishing philosophies, as well as the competitive, growing, and relatively nascent nature of OA publishing, there is substantial variation in journal prices. This wide variation in the OA journal market reveals a variety of factors that underpin scholarly and economic value in contemporary science.

Past research has linked OA journal pricing to citation activity (Björk & Solomon, 2015; Mueller-Langer & Watt, 2018). Journals that receive attention and status from other publications and scholars are valuable on both the supply and demand sides of the publishing market. At the high end of the market, publishing consultants have floated the notion of US$25,000 APCs for outlets such as *Nature* and *Science* (Pollock, 2018), based on the premise that the willingness of authors to submit articles to prestigious journals is highly price inelastic. A Springer Nature publishing executive once argued, "In the end, the price is set by what the market wants to pay for it" (Van Noorden, 2013, p. 429). Such a market-based philosophy may be at odds with the "public good" ethos of science, where there are professional norms discouraging avarice and self-interested behavior (Merton, 1942). However, academic publishing is also a context where science interfaces with the profit-oriented world of business, often creating conflicts between market and professional institutional logics (Thornton & Ocasio, 1999).

This article uses a large-scale database of OA journals to examine the diverse factors that imbue published academic knowledge with economic value in publishing markets. As OA publishing becomes increasingly prominent in academic communication, understanding sources of value is important for stakeholders who evaluate complementary and conflicting academic and economic markets in publishing. We analyze 12,127 journals, of which 3,309 apply an APC. We examine both factors conducive to the adoption of APCs by OA

journals and, for the subset of journals that apply an APC, the factors affecting the prices charged, using a hedonic price regression model.

2. FACTORS INFLUENCING JOURNAL VALUATION

Hedonic pricing posits that products possess certain attributes or characteristics that are valuable or desirable to consumers (Rosen, 1974). Pricing is influenced by actual production costs, as well as sociopolitical forces that influence the valuation of products on both supply and demand sides of the market (Beckert, 2011; Zelizer, 1995). Prices generate necessary revenue but also can function as status signals that influence perceptions of value by both producers and consumers (Ding, Ross, & Rao, 2010; Podolny, 2005). Both objective production costs and social sources of value can influence the pricing and valuation of goods, including academic journals.

2.1. Journal Impact Factor

Since its inception in 1975 by Eugene Garfield, the journal impact factor (JIF)—calculated annually by Clarivate Analytics—has emerged as the preeminent quantitative measure of journal quality (Archambault & Larivière, 2009; Larivière & Sugimoto, 2018; Wouters, 1999). Journals with higher JIFs receive relatively more citations (Larivière & Gingras, 2010) and downloads from university libraries (Wood-Doughty et al., 2018). In turn, publications in high-JIF journals offer scholars and their institutions greater opportunities for attention and prominence. However, concerns abound regarding the methodological rigor and empirical validity of JIF calculations (Baum, 2013; Larivière et al., 2016; Martin, 2016; Vanclay, 2012; Wilhite, Fong, & Wilhite, 2019), as well as the normative appropriateness and perverse incentives of measuring academic merit with simplified—and arguably flawed—quantitative metrics (Alberts, 2013; Callaway, 2016; DORA, 2013; Hicks, Wouters, Waltman, de Rijcke, & Ràfols, 2015; Molas-Gallart & Ràfols, 2018; Wang, Veugelers, & Stephan, 2017). Regardless, the JIF remains influential within research evaluation and professional reward structures in many academic contexts (Berenbaum, 2019; Casadevall & Fang, 2014; European University Association, 2019; Koya & Chowdhury, 2017; Müller & de Rijcke, 2017; Tijdink et al., 2016). Due to the close relationship between the JIF and many academic and institutional reward structures, the JIF is often of significant value to publishers, institutions, and scholars alike. In many universities, publishing in high-JIF journals is linked to professional rewards, including salary, hiring, tenure, and promotion (Else, 2019b; Fuyuno & Cyranoski, 2006; Hecht, Hecht, & Sandberg, 1998; Moher et al., 2018; Verma, 2015; Quan, Chen, & Shu, 2017), which influences career and publication incentives for scholars. Even if certain metrics or rankings are perceived as questionable or unfair, they remain important if others take them seriously (Sauder & Espeland, 2009).

OA journals with higher JIFs and higher average citation counts charge higher APCs (Andrew, 2012; Mueller-Langer & Watt, 2018; Pinfield, Salter, & Bath, 2016; Solomon & Björk, 2012). In turn, there is a dialectic in the OA journal market, where high-quality journals can charge higher APCs, but the revenue raised from higher prices also generates increased resources to support legitimate journal quality (Siler, Haustein, Smith, Larivière, & Alperin, 2018). Subjectively, exclusive journals are selling a prestigious imprimatur—albeit one that publishers may have curated carefully and invested in over time—as well as the social signal of affiliation with high-status scholars who publish in such journals (Hartley, Potts, Montgomery, Rennie, & Neylon, 2019). High APCs can also fund "objective" publishing qualities, such as copyediting, professional editors, and stylish typesetting. Further, revenues from high APCs

can cover the increased production costs associated with high rejection rates (Gans, 2017), which can underpin both actual and perceived quality of journals. This raises questions of how much of an APC—or any revenue-generating mechanism—for a given journal reflects legitimate value.

The ability and willingness of consumers to pay for products influences supply-side pricing decisions. Accordingly, APCs are often set according to journal or sectoral prestige, as opposed to actual production costs. For example, Elsevier differentially prices journals based on relative funding levels in various academic disciplines (Björk & Solomon, 2015). A 2018 Springer Nature Initial Public Offering on the Frankfurt Stock Exchange candidly promoted the following business strategy for academic journals: "[W]e intend to employ a price differentiation strategy by tailoring APCs to the discipline and impact factor of the relevant journal[.]… We also aim at increasing APCs by increasing the value we offer to authors through improving the impact factor and reputation of our existing journals" (Springer Nature, 2018, p. 99). In turn, academic publishers are often acutely aware of the importance and value of the JIF in the "prestige economy" (Fyfe et al., 2017) of academia and price journals accordingly.

As third-party rankings become increasingly influential in professional fields (Espeland & Stevens, 1998; Espeland & Sauder, 2007), merely being measured is an important sign of legitimacy. When a journal is first indexed in Web of Science (WoS) and receives a JIF, publishers often capitalize on the increased status of the journal and raise prices. However, there also can be legitimate costs created when a journal is first listed on WoS or experiences upward mobility. When a journal receives its first JIF, this often leads to increased legitimacy and an influx of new submissions (Davis, 2017). For example, after *PeerJ* received its first JIF, submissions doubled and the demographics of authors shifted to "late adopters" (Hoyt, 2018). Likewise, MDPI executives acknowledged a sharp increase in submissions to journals after being indexed in WoS (Vazquez, 2019). After achieving indexing, rejections in MDPI journals increased at a greater rate than the increase of submissions. This necessitated higher APCs to cover the increased costs of processing proportionally more manuscripts that do not generate revenue. Status endowments and institutional inclusion via WoS increases demand for publishing in such journals, which can increase costs at higher rates than revenues.

Receiving and maintaining status endowments such as the JIF requires continued legitimacy and conformity to institutionalized criteria. In turn, marshaling the resources—financial, reputational and/or academic—in order for a journal to attain status endowments, (e.g., JIF, Scopus coverage) is an important challenge for publishers and journal stakeholders.

2.2. Publisher Type

Historically, academic publishing has involved tensions between economic and academic priorities (Thornton & Ocasio, 1999). Publishing is both a means of disseminating academic research and an economic activity. Different journals and publishers have different underlying goals and philosophies, which span the continuum between purely academic and purely profit seeking. This heterogeneity in publishing institutions and philosophies contributes to wide variation in journal pricing. For example, journals published by commercial publishers tend to be more costly than those published by not-for-profit organizations (Bergstrom, 2001; Coomes, Moore, & Breau, 2016; Dewatripont et al., 2006). In theory, the oligopolistic power of large publishers coupled with the profit-oriented missions of such institutions should be conducive to relatively higher prices (Larivière, Haustein, & Mongeon, 2015). Further, large publishers tend to offer higher status, more costly publications than smaller publishers (Björk & Solomon, 2012). Publishers of varying size and status occupy different economic and academic niches in the scholarly communication market.

2.3. Peer Review/Editorial Delays

Peer review and business strategies are intertwined in scholarly publishing. Cotton (2013) posited that journals optimize quality with an appropriate combination of fees and editorial delays. Publishing speed is a quality on which some OA journals and publishers compete.[2] However, extremely fast turnaround of papers may raise suspicions that peer review was cursory or nonexistent. Conversely, extremely slow peer review is unattractive to most authors and also raises concerns about journal professionalism. Hence, a curvilinear relationship (inverted U-shape) between publishing speeds and APCs is expected, with the most costly journals exhibiting relatively moderate peer review speeds.

2.4. Language and Geography

The political stature and economic development of the home countries of academics and their institutions influences scholarly productivity (May, 1997; King, 2004). Inclusion in global academic networks is conducive to academic productivity for nations and individual scholars alike (Sugimoto et al., 2017). Such networks tend to be dominated by the English language, which usually functions as the *lingua franca* of modern science. Consequently, publishing in English generally increases the chances of attracting readers and citations to an article, which leads to the expectation that English-speaking journals will charge higher APCs. Further, geography influences scholarly collaboration and citation behavior (Frenken, Hardeman, & Hoekman, 2009). Academic journals are institutions via which academic communities can either promote or inhibit geographic diversity (Chavarro, Tang, & Ràfols, 2014). Topical priorities in the scholarly corpus are shaped by academic reward structures, which often devalue or balkanize local concerns in peripheral locations in the global political economy (Ciarli & Ràfols, 2019; Meneghini, Packer, & Nassi-Calò, 2008). The lowered barriers to entry of OA publishing has created new niches and opportunities for less-wealthy scholars and institutions to contribute to the academic corpus. Some topics and fields of study may have intellectual importance to certain communities that are relatively less economically marketable. In turn, the OA publishing market is comprised of numerous overlapping geographic, linguistic, and economic niches.

2.5. Journal Size

The size of a journal can also influence pricing. Journals publishing more papers tend to be more well known and may thus contribute to an article's visibility. Further, for authors, size can signal legitimacy from fellow authors who have published in the journal in the past.

2.6. Academic Disciplines

Historically, publishers have charged libraries more for subscriptions to medical and natural science journals than humanities or social science journals (Liu & Gee, 2017). This reflects both the size of the readership and the higher costs of publishing and editing. Financial gaps between the natural sciences and humanities have widened over time (Rose-Wiles, 2011), although it is to be determined if and how these disciplinary differences are also applicable to the OA publishing market.

[2] For example, the current webpage template for MDPI journals advertises "Rapid publication"—with median review times rounded to the nearest tenth of a day—as a selling point for each journal.

3. METHODS

Data on current open access scholarly journals were acquired from the Directory of Open Access Journals (DOAJ). The DOAJ was founded in 2003 by the nonprofit Infrastructure Services for Open Access (IS4OA). The DOAJ is also an index of OA journal legitimacy, as journals must adhere to set criteria to be included. Journals submit self-reported data for inclusion on the list, which is vetted and verified by DOAJ staff. Notably, the DOAJ only indexes "Gold" OA journals—those which solely publish OA articles. Gold OA journals may require authors to pay an APC, or they may have other funding mechanisms that enable authors to publish without an APC.[3] In 2015, the DOAJ introduced the DOAJ Seal of Approval for Open Access Journals to reward journals that adhere to practices deemed particularly meritorious: DOI usage, submission of metadata, digital archiving, machine-readable licensing, generous Creative Commons licensing, granting authors full copyright. In turn, the DOAJ provides a list of legitimate and distinguished OA journals. The data set for this study was downloaded from the DOAJ website in December 2018, when the database included 12,127 journals. The DOAJ data set enables a large-scale analysis of variables that influence price levels in individual journals.

3.1. Dependent Variables

Our analysis includes two dependent variables. The first dependent variable is a dummy variable of whether the journal charges APCs and/or submission fees to authors (APC-BASED).

The second dependent variable is *total publication costs* for authors (TOTAL COST). Total publication costs are the sum of APCs and submission fees at a journal. USD was the most common currency in which publishers levied APCs. For APCs levied in other currencies, world currency exchange rates as of December 10, 2018 were used to convert APCs to USD equivalents. In a hedonic price analysis, the dependent variable is taken as the natural logarithm value, which also diminishes the skewness of the distribution of prices.

3.2. Independent Variables

The 2017 Clarivate JIF values for DOAJ journals were collected from the Journal Citation Reports website (Clarivate Analytics, 2018). Due to the exclusivity of the JIF, an additional dummy variable was created denoting *whether a journal has a JIF*. We created an additional *Scopus coverage* dummy variable for journals listed on the scopus.com website in July 2019 (Scopus, 2019). Scopus coverage entails searchability, visibility, and legitimacy, which are all valuable attributes for academic journals.

Publisher type was coded based on the listed affiliation of a journal's main publisher in the DOAJ database. Large for-profit publishers were defined as those listed by Larivière et al. (2015) as major oligopolistic publishers—Emerald, Reed-Elsevier, SAGE, Springer Nature, Taylor & Francis, Wiley-Blackwell, and Wolters Kluwer. Any journal published by those publishers was coded as being published by a large for-profit publisher. Small for-profit publishers were operationalized as any for-profit publisher that is not linked to the aforementioned oligopolistic publishers. Any publisher affiliated with a college or university was coded as such. However, if the journal was explicitly published by a university press, this was distinguished separately from those journals published by the university as a whole. Professional

[3] "Diamond" and "Platinum" OA are terms sometimes used to describe "Gold" OA journals that do not directly charge authors APCs for publication (see Martín-Martín, Costas, van Leeuwen, & Delgado López-Cózar, 2018).

associations were coded as publishers with a clear mission to serve members of a certain profession, most commonly academic disciplines. Some journals are published jointly between different types of institutions. For example, professional associations sometimes partner with for-profit publishers to publish society journals (Bergstrom, 2001). To categorize *publisher type* in our analyses, we used the DOAJ's official listing of the journal publisher, even though publishing is sometimes a joint effort between different types of institutions. A limitation of the DOAJ data set is that it does not identify hybrid publishing arrangements between multiple institutions. Future research could investigate the complexities of shared journal responsibilities and ownership between different institutions in scholarly publishing.

Journal language(s) were taken from the DOAJ data set. For a full list of the most common languages and multilingual combinations in DOAJ-listed journals, see the Appendix. *Peer review duration*, the *DOAJ Seal of Excellence* award, and first listed *academic disciplinary affiliation* for journals were also taken from the DOAJ list. *World Bank Economic* and *Geographic* regions (World Bank, 2019) were coded based on the officially listed location of each journal's publisher in the DOAJ data set. Although the location of a journal's publisher is not necessarily reflective of a specific journal's geographic focus or roots, publisher country provides one proxy for a journal's location in the political economy of science.

Journal size was operationalized as the total number of published articles in 2018. This data was retrieved from Crawford's (2019) Gold Open Access 2013–2018 (GOA4) data set (V2).

To check for potential multicollinearity, we estimated variance inflation factors (VIF) for each variable used in the OLS regressions in Tables 3–4. VIF values suggested no excessive multicollinearity.

4. RESULTS

4.1. Characteristics of DOAJ-listed Journals

Table 1 reports tabulations of journal characteristics included in the DOAJ data set for both total journals and total articles.

Roughly 73% of journals listed by the DOAJ do not charge authors any submission or publication fees. The remaining 27% of journals levy authors some sort of APC, ranging from US$0.014 to US$5600. However, this statistic understates the prevalence of the APC-based publishing model. When considering the total number of published *articles*, 57% of articles are published in APC-based journals. Likewise, although only 10% of DOAJ journals have a JIF, 44% of articles are published in journals with a JIF. As shown in Table 1, the differences in percentage values between total journals and total articles suggest that journals published in wealthier, higher status institutions and regions tend to publish more articles.

Figure 1a illustrates the distribution of prices among APC-based OA journals included in the DOAJ database. Notably, 32.9% of APC-based DOAJ-listed journals levy fees of US$200 or less. However, even relatively low-cost APCs may still be burdensome for less-wealthy researchers—particularly in developing countries—to cover.[4]

[4] Scholars working in developing countries are relatively likely to resort to personal funds to cover APCs (Solomon & Björk, 2012). Notably, 57.1% of APC-based DOAJ journals claim some sort of fee waiver or reduction for scholars from developing countries. The accessibility and generosity of these waivers and how often scholars in developing countries submit and publish work in more-expensive journals using waivers are issues for further inquiry. Gadagkar (2008) expressed concern regarding APC-based publishing systems with waivers for less-wealthy researchers, pointedly asking, "why should anyone want to survive on charity?" These issues are important for understanding if and how APC-based OA publishing facilitates the inclusion or exclusion of scholars in less-wealthy countries.

Table 1. Summary of DOAJ journal characteristics (n = 12,127)

	Total journals	Total articles
Journal APC		
Non-APC journal	72.7%	43.2%
APC journal	27.3%	56.8%
Journal Impact Factor		
Journal has JIF	10.1%	43.6%
Journal does not have JIF	89.9%	56.4%
Journal language		
English only	46.9%	68.2%
Partial English	31.1%	20.7%
No English	22.0%	11.1%
Journal publisher organization type		
Large for-profit publisher	12.1%	22.2%
Not-for-profit organization	7.8%	8.1%
University press	3.1%	2.3%
Professional association	5.0%	8.2%
Small for-profit	13.3%	26.2%
University	41.7%	21.6%
Uncategorized	17.0%	11.1%
DOAJ Seal		
DOAJ Seal	11.3%	33.0%
No DOAJ Seal	88.7%	67.0%
World Bank geographic region		
East Asia & Pacific	15.1%	7.4%
Europe & Central Asia	50.5%	60.8%
Latin America & Caribbean	19.0%	12.0%
Middle East & North Africa	4.9%	3.5%
North America	6.6%	12.4%
South Asia	2.9%	3.1%
Sub-Saharan Africa	1.0%	0.8%

Table 1. (*continued*)

	Total journals	Total articles
World Bank economic region		
High	51.3%	68.3%
Upper middle	31.9%	22.2%
Lower middle	16.6%	9.3%
Low	0.3%	0.2%
First listed journal subject		
Medicine	22.4%	36.3%
Social sciences & humanities	49.3%	24.8%
Science	21.6%	33.6%
Uncategorized	6.7%	5.2%

Figure 1b illustrates the distribution of APCs based on total articles published. Notably, roughly 20% of OA articles in the DOAJ data set involve APCs of at least US$2,000. Further, there is an exponential increase in prices from US$2,000 to US$5,000 in the top decile of published articles in DOAJ journals.

Among journals listed on the DOAJ, journals with a JIF are relatively rare. Only about 10% of total journals in the data set had a JIF as of 2017. Among the 1,228 DOAJ journals with a JIF, JIFs ranged from 0.02 to 23.33, with a mean of 2.28 and median of 1.69. There was overlap between journals awarded JIFs and those awarded the DOAJ Seal of Approval for Open Access Journals. Of the 1,375 journals in the data set awarded the DOAJ seal, 455 also had a JIF. Accordingly, status endowments in academic publishing are correlated but do not necessarily completely overlap. In 2018, DOAJ journals also varied in output or size, ranging from one article to 18,833, with 15 articles at the 25th percentile, a median of 26 articles, and 49 articles at the 75th percentile.

4.2. Article Processing Charges (APCs)

4.2.1. Factors conducive to APC-based publishing models

Table 2 reports odds ratios from logistic regression analyses of factors associated with a journal publishing with an APC-based business model.[5] The dependent variable in Table 2 is whether a journal charges an APC (APC-BASED), as opposed to publishing articles with no direct cost to authors.

JIF, journal language, journal license, publisher type, geographic region, economic region, peer review duration, and disciplinary orientation all exhibited significant effects on the likelihood of a DOAJ-listed journal publishing with APCs. In the full multivariate model (Model 10), journals with official JIFs were roughly 2.6 times more likely to adhere to an APC-based business model than journals without a JIF. Similarly, journals awarded the

[5] The total *n* values reported in the models in Tables 2–4 may slightly differ due to missing values in the DOAJ, Scopus and/or Crawford's (2019) Gold Open Access 2013–2018 (GOA4) data sets.

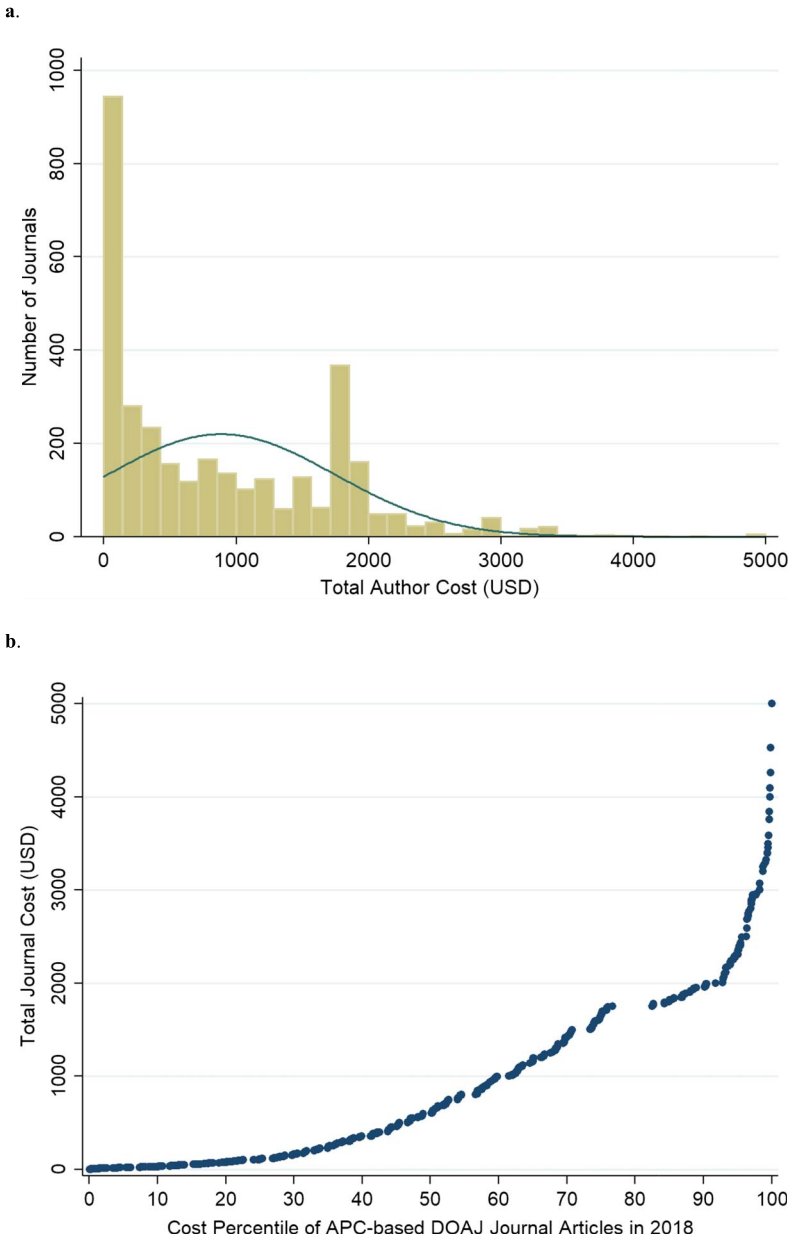

Figure 1. (a). Distribution of APC levels for APC-based DOAJ journals (n = 3,305). (b). Distribution of APC levels for articles published in APC-based DOAJ journals in 2018 (n = 702,739 published articles).

DOAJ Seal were about 3.1 times more likely to charge APCs than other DOAJ journals. English-only journals were most likely to involve APCs, partially and non-English journals were only about half as likely to charge authors APCs. Overall, institutions with stronger market institutional logics (e.g., for-profit publishers) are most likely to offer journals that charge APCs, whereas institutions with stronger professional or public service institutional logics are more likely to offer non-APC OA journals. Analogously, the prevalence of APC journals varied according to World Bank geographic and economic regions of publishers, as well as disciplinary orientations of journals. Larger journals are also significantly more likely to adopt an APC-based publishing model.

Table 2. Logistic regression analysis of factors affecting likelihood of APC-BASED DOAJ-listed journals (odds ratios)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Journal Impact Factor												
JIF (yes/no)	8.076*** (.538)											2.589*** (.244)
Scopus coverage												
Scopus coverage (yes/no)		4.462*** (.201)										1.432*** (.093)
Journal language												
English only			[omitted]								[omitted]	[omitted]
Partially English			.182*** (.101)								.181*** (.011)	.517*** (.041)
No English			.142*** (.100)								.170*** (.014)	.509*** (.049)
Publisher type												
Large for-profit				[omitted]								[omitted]
Not-for-profit organization				.084*** (.009)								.217*** (.029)
University press				.129*** (.018)								.415*** (.067)
Professional association				.150*** (.016)								.360*** (.050)
Small for-profit				.600*** (.045)								.845 (.079)
College/university				.064*** (.004)								.235*** (.024)
Unclassified				.101*** (.008)								.339*** (.035)
DOAJ Seal												
DOAJ Seal					9.952*** (.649)							2.826*** (.244)

World Bank geographic region					
East Asia & Pacific	.705*** (.064)			1.056 (.124)	.964 (.135)
Europe & Central Asia	.979 (.077)			1.669*** (.138)	.879 (.094)
Latin America & Caribbean	.108*** (.013)			.808 (.112)	.478*** (.077)
Middle East & North Africa	.460*** (.058)			.929 (.136)	.664* (.114)
North America	[omitted]			[omitted]	[omitted]
South Asia	.749* (.104)			.322*** (.056)	.120*** (.025)
Sub-Saharan Africa	2.157*** (.428)			4.794*** (1.100)	3.301*** (.841)
World Bank economic region					
High income		[omitted]		[omitted]	[omitted]
Low income		.186** (.113)		.190* (.130)	.354 (.262)
Lower middle income		.712*** (.040)		2.098*** (.210)	3.448*** (.411)
Upper middle income		.230*** (.013)		.462*** (.034)	.746*** (.068)
Peer review duration					
Average peer review weeks			1.020** (.007)		.995 (.009)
Average peer review weeks (squared)			.999*** (.000)		1.000 (.000)
Journal size					
Total 2018 Publications (log)			1.823*** (.042)		1.347*** (.039)

Table 2. (*continued*)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Journal subject												
Medicine										[omitted]		[omitted]
Interdisciplinary										.573*** (.048)		1.336** (.143)
Social Sciences & Humanities										.147*** (.008)		.395*** (.029)
Natural Sciences										.672*** (.037)		.697*** (.051)
Constant	.290*** (.007)	.237*** (.006)	.813*** (.022)	2.197*** (.124)	.273*** (.006)	.539*** (.040)	.576*** (.151)	.360*** (.024)	.049*** (.004)	.926* (.036)	.647*** (.049)	.646* (.116)
***R*-squared**	.077	.079	.121	.179	.101	.068	.058	.005	.059	.108	.163	.321
n	12121	12120	12121	12121	12121	12121	12121	12094	11199	12107	12121	11184

*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed tests). Standard errors are in parentheses.

4.2.2. JIF journals

Table 3 analyzes pricing levels (TOTAL COST) for DOAJ journals with an official JIF.

Among journals with JIFs, journals with a higher JIF charge higher APCs. In the full model, the logged JIF coefficient is 0.629, which indicates the elasticity of total cost regarding the JIF. That is, for a 1% increase in the value of a JIF, the APC of a journal increases by 0.629%. This shows the high sensitivity of APCs to JIFs. In contrast, once accounting for all other factors in the multivariate model, Scopus coverage exhibits a nonsignificant relationship with journal pricing in the JIF journals-only analysis.

DOAJ journals publishing solely in the English language are most costly. Journals published by large for-profit publishers are the most costly publisher type, followed closely by small for-profit publishers. Journals published by university presses, professional associations, universities, and other not-for-profit organizations are least costly. North-America-based journals are most costly, followed by Latin America and Caribbean journals and Europe and Central Asia. Journals published in East Asia and Pacific and Middle East and North Africa were least costly. Journals affiliated with high-income countries are most costly, followed by upper middle, lower middle and low-income countries. These findings should be interpreted in light of the dearth of journals with JIFs in developing economic and geographic regions. Lastly, medical journals are relatively costly, followed by natural sciences journals. Social sciences and humanities journals were least costly.

4.2.3. Article Processing Charge (APC)-based journals only

Among the 3,310 DOAJ journals that levy APCs, the median APC is US$600 and the mean APC is US$889. Table 4 examines the variables that influence TOTAL COST, limited to the subset of DOAJ journals that levy APCs.

Once again, journals possessing a JIF are significantly costlier. Although most trends and relationships are similar between Table 3 (JIF-only journals) and Table 4 (all APC-based journals), there are notable differences. Because Table 4 reports results from a broader population of articles than Table 3, Scopus coverage exhibits a significant positive relationship with journal price. As Table 4 involves many journals without JIFs, it makes sense that there would be a greater relative premium placed on Scopus coverage. Another important difference between Tables 3 and 4 is the smaller coefficients for the relationship between journal size and price. Because Table 4 involves a less-exclusive sample of the DOAJ than Table 3, it includes a larger number of downmarket journals. Larger OA journals—in terms of articles published—may tend to be less selective, and thus charge lower prices.

Peer review practices are also related to journal pricing levels. Peer review duration has a curvilinear association with journal pricing. Model 8 in Table 4 includes both the average weeks for journal peer review and the squared value of that variable. Journals with fast or slow peer review processes were relatively less costly. Figure 2 illustrates the curvilinear relationship—using the lowess smooth function in Stata 14.2—suggesting that the "optimal" peer review duration for OA journal pricing is roughly 12–13 weeks.

These results suggest that both unusually rapid and unusually slow peer review are conducive to lower journal value, if not also quality. However, in the full model reported in Model 10, the relationship between peer review and duration is significantly positive and no longer curvilinear, suggesting that only journals with unusually rapid peer review tend to be relatively inexpensive.

Table 3. OLS regression analysis of factors affecting prices (TOTAL COST) for all DOAJ-listed journals (JIF journals only)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Journal Impact Factor												
JIF (LN)	2.808*** (.167)											.629*** (.192)
Scopus coverage												
Scopus coverage (yes/no)		2.185*** (.199)										.249 (.186)
Journal language												
English only			[omitted]								[omitted]	[omitted]
Partially English			−3.524*** (.261)								−3.078*** (.295)	−1.157*** (.286)
No English			−4.873*** (.684)								−4.587*** (.665)	−1.810** (.619)
Publisher type												
Large for-profit				[omitted]								[omitted]
Not-for-profit organization				−3.571*** (.339)								−2.312*** (.323)
University press				−1.275* (.566)								−.423 (.511)
Professional association				−3.018*** (.291)								−1.926*** (.309)
Small for-profit				−.210 (.220)								−.360 (.214)
College/university				−3.664*** (.300)								−1.569*** (.323)
Unclassified				−3.059*** (.322)								−1.467*** (.307)
DOAJ Seal												
DOAJ Seal					2.651*** (.180)							.761*** (.186)

World Bank geographic region					
East Asia & Pacific	−1.913*** (.504)			−1.431** (.485)	−1.748*** (.437)
Europe & Central Asia	−.050 (.304)			.229 (.287)	−.548* (.278)
Latin America & Caribbean	−3.444*** (.399)			.234 (.535)	−.427 (.485)
Middle East & North Africa	−3.762*** (1.064)			−3.139** (1.014)	−3.340*** (.899)
North America	[omitted]			[omitted]	[omitted]
South Asia	−2.944*** (.648)			.250 (1.673)	−1.107 (1.486)
Sub-Saharan Africa	−2.972*** (.730)			−.824 (.786)	−.346 (.706)
World Bank economic region					
High income		[omitted]		[omitted]	[omitted]
Low income		5.431* (2.182)		−5.312* (2.264)	−3.048 (1.997)
Lower middle income		−2.845*** (.571)		−3.326* (1.582)	−1.794 (1.392)
Upper middle income		−3.027*** (.244)		−1.638*** (.366)	−.723* (.330)
Peer review duration					
Average peer review weeks			.041 (.031)		.027 (.025)
Average peer review weeks (squared)			−.002*** (.001)		−.001* (.000)
Journal size					
Total 2018 publications (log)			.872*** (.077)		.456*** (.073)
Journal subject					
Medicine				[omitted]	[omitted]

Table 3. (*continued*)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Interdisciplinary										−1.480*** (.338)		.514 (.292)
Social Sciences & Humanities										−2.999*** (.298)		−1.006*** (.274)
Natural Sciences										−.957*** (.204)		−.429* (.172)
Constant	1.961*** (.194)	3.321*** (.168)	5.408*** (.094)	6.119*** (.131)	3.893*** (.180)	5.493*** (.286)	5.431*** (.098)	5.215*** (.354)	.933** (.365)	5.748*** (.145)	5.599*** (.269)	3.579*** (.571)
***R*-squared**	.188	.090	.156	.221	.152	.132	.126	.083	.096	.081	.236	.424
n	1221	1220	1221	1221	1221	1221	1221	1221	1198	1218	1221	1195

Table 4. OLS regression analysis of factors affecting prices (TOTAL COST) for APC-based OA journals (APC-based journals only)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Journal Impact Factor												
JIF (yes/no)	1.357*** (.060)											.287*** (.041)
Scopus coverage												
Scopus coverage (yes/no)		.770*** (.059)										.209*** (.036)
Journal language												
English only			[omitted]								[omitted]	[omitted]
Partially English			−2.380*** (.060)								−1.232*** (.061)	−.735*** (.058)
No English			−2.921*** (.077)								−1.411*** (.076)	−.954*** (.071)
Publisher type												
Large for-profit				[omitted]								[omitted]
Not-for-profit organization				−2.042*** (.098)								−1.168*** (.081)
University press				−1.118*** (.126)								−.462*** (.098)
Professional association				−1.224*** (.097)								−.592*** (.080)
Small for-profit				−.705*** (.051)								−.547*** (.040)
College/university				−3.193*** (.057)								−1.091*** (.065)
Unclassified				−2.318*** (.067)								−.990*** (.060)
DOAJ Seal												
DOAJ Seal					1.317*** (.057)							.029 (.038)

Table 4. (*continued*)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
World Bank geographic region												
East Asia & Pacific						−2.768***					−.239**	−.136
						(.096)					(.091)	(.082)
Europe & Central Asia						−.430***					−.142*	−.220***
											(.062)	(.058)
Latin America & Caribbean						2.180***					.121	.007
						(.138)					(.121)	(.110)
Middle East & North Africa						−2.526***					−.492***	−.309**
						(.142)					(.118)	(.106)
North America						[omitted]					[omitted]	[omitted]
South Asia						−2.358***					−.229	−.550***
						(.150)					(.138)	(.127)
Sub-Saharan Africa						−2.175***					−.250	−.044
						(.179)					(.147)	(.134)
World Bank economic region												
High income							[omitted]				[omitted]	[omitted]
Low income							−2.184***				−.764	−.653
							(.610)				(.569)	(.483)
Lower middle income							−3.016***				−2.137***	1.587***
							(.049)				(.081)	(.080)
Upper middle income							−2.135***				−1.457***	−.963***
							(.054)				(.069)	(.064)

Peer review duration												
Average peer review weeks								.072*** (.010)				.025*** (.005)
Average peer review weeks (squared)								−.001*** (.000)				−.001*** (.000)
Journal size												
Total 2018 publications (log)									.263*** (.022)			.051*** (.014)
Journal subject												
Medicine										[omitted]		[omitted]
Interdisciplinary										−1.740*** (.094)		−.364*** (.060)
Social Sciences & Humanities										−1.930*** (.067)		−.440*** (.045)
Natural Sciences										−.601*** (.060)		−.282*** (.036)
Constant	5.597*** (.031)	5.080*** (.034)	6.543*** (.024)	7.188*** (.035)	5.549*** (.032)	6.933*** (.077)	6.775*** (.022)	5.307*** (.096)	4.989*** (.088)	6.695*** (.040)	6.977*** (.058)	6.928*** (.090)
***R*-squared**	.133	.293	.448	.537	.138	.371	.582	.016	.043	.230	.652	.748
n	3310	3310	3310	3288	3310	3310	3310	3310	3122	3305	3310	3117

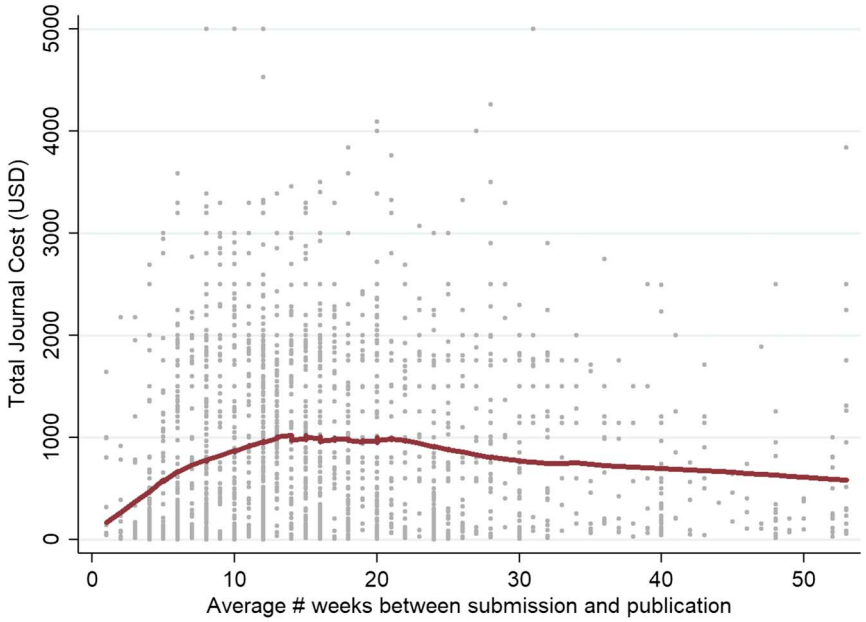

Figure 2. Peer review duration and OA journal pricing (APC-based journals only).

4.3. Stratification in Publishing Niches

Status endowments—if not also quality—are differentially distributed across different publisher characteristics. Table 5 reports the proportional distribution of various journal attributes among journals with a JIF or the DOAJ Seal.

English-only journals are highly overrepresented among both journals with a JIF, the DOAJ Seal, and Scopus coverage. Journals published by large for-profit publishers are strongly overrepresented among journals with these valued characteristics. Small for-profit publishers are also relatively overrepresented but fare especially well with attaining the DOAJ Seal. In contrast, journals published by professional associations fare reasonably well with the JIF and Scopus but are relatively unlikely to receive the DOAJ Seal. The other remaining publisher categories (not-for-profit, university press, university, uncategorized) are relatively less likely to publish journals with a JIF, the DOAJ Seal, or Scopus coverage.

Journals published in traditionally central regions in science—North America and Europe and Central Asia—are relatively more likely to receive a JIF or the DOAJ Seal. These are also high-income regions. All other regions lagged behind, with the exception of Sub-Saharan Africa.[6] Large for-profit publishers are disproportionately represented among journals with a JIF and Scopus coverage, suggesting that such publishers tend to occupy relatively upscale niches in the academic publishing hierarchy. However, even after accounting for status endowments in the multivariate models in Tables 2–4, significant price differences remain by publisher type, language, region, and discipline.

[6] Among the relatively low number of DOAJ-listed journals (119) published in Sub-Saharan Africa (which accounts for less than 1% of DOAJ journals), such journals are relatively likely to receive a JIF, the DOAJ Seal, or Scopus coverage. Given the strong overperformance of Sub-Saharan Africa in this regard and given its relatively small publishing footprint in the DOAJ database, this surprising finding may be a result of concerted inclusion efforts. For example, in 2006 Thomson Reuters began efforts to expand WoS to better recognize contributions from underrepresented regions (Testa, 2009).

Table 5. Distribution of journal status endowments by journal characteristics

	Journal Impact Factor	DOAJ Seal	Scopus coverage
Language			
English only (*n* = 5683)	18.5%	22.2%	42.1%
Partial English (*n* = 3774)	4.1%	2.6%	13.8%
No English (*n* = 2670)	0.8%	0.6%	5.8%
Publisher type			
Large for-profit publisher (*n* = 1467)	34.0%	35.4%	62.5%
Not-for-profit organization (*n* = 949)	9.2%	7.6%	21.4%
University press (*n* = 381)	7.6%	7.1%	24.4%
Professional association (*n* = 609)	20.7%	5.4%	30.4%
Small for-profit publisher (*n* = 1611)	16.9%	36.4%	45.4%
University (*n* = 5051)	2.3%	2.0%	11.2%
Uncategorized (*n* = 2059)	4.9%	1.9%	18.1%
World Bank geographic region			
East Asia & Pacific (*n* = 1834)	3.0%	1.2%	12.2%
Europe & Central Asia (*n* = 6118)	14.3%	20.1%	35.4%
Latin America & Caribbean (*n* = 2308)	5.3%	0.5%	9.6%
Middle East & North Africa (*n* = 594)	1.5%	1.0%	18.0%
North America (*n* = 803)	14.6%	8.2%	31.3%
South Asia (*n* = 351)	8.0%	0.6%	17.9%
Sub-Saharan Africa (*n* = 119)	17.6%	33.6%	30.3%
World Bank economic region			
High income (*n* = 6218)	16.2%	20.8%	38.2%
Upper middle income (*n* = 3872)	4.9%	2.0%	14.8%
Lower middle income (*n* = 2008)	1.5%	0.2%	5.9%
Low income (*n* = 31)	6.5%	0.0%	16.1%

5. DISCUSSION

The open access academic publishing market is multifaceted, with numerous different economic, institutional, academic, and social niches. Even though APC-based and non-APC OA journals occupy different academic and market niches in contemporary science, similar factors influence both whether a journal charges authors an APC and price levels for APC-based journals.

The influence of the JIF—both with merely having a JIF and possessing a higher JIF—underscores the importance and value of citation metrics and third-party evaluation in contemporary science. Whether one perceives the JIF as an arbitrary status symbol, a legitimate signal of quality, or somewhere in between, it clearly is of value. Similarly, the value of Scopus coverage also suggests the value of institutional recognition, cataloging, and search engines. Accordingly, publishers and scientists often attempt to bolster or protect the status endowments bestowed by quantitative metrics such as the JIF. *Reactivity* is the process of people or organizations altering behavior in reaction to evaluation (Espeland & Stevens, 2007). For many publishers and journals, achieving eminence and status endowments such as the JIF often involves strategic action, sometimes of questionable academic merit and ethics (Martin, 2016; Wilhite et al., 2019). Some publishers have more resources to maintain prominence and institutionalized esteem for their journals than others. This is one of many mechanisms underpinning cumulative advantage processes (Merton, 1968) in academic publishing.[7]

Journals published by large for-profit publishers were most costly, followed by smaller for-profit publishers, who may employ similar market-oriented institutional logics to less lucrative economic and academic niches. Our results align with Schönfelder (2018), who, using OpenAPC data, also found that journals with high JIFs and published by large for-profit publishers tend have relatively higher APCs. Universities and other nonprofit organizations published the least costly journals on the whole, indicative of a strong professional logic and weaker market logic. The relatively moderate prices of journals published by university presses and professional associations suggest hybrid market-professional institutional logics. University presses market products for sale but also receive support and subsidies from their affiliated universities (Somin, 2019).[8] Professional associations are usually nonprofit organizations but also often rely on journals as a source of institutional revenue.[9] Our results show that even after accounting for measures of prestige, journals published by large for-profit publishers are relatively costly (also see Bergstrom, 2001). Publishing institutions with stronger market-oriented logics publish costlier journals, even after accounting for journal quality. In contrast, our results also suggest that journal ownership by universities and nonprofit organizations is most conducive to low-cost publishing in current academic publishing markets. Whether relatively higher costs paid to for-profit publishers are a product of a meritocratic market, a necessary evil, or deadweight losses are open and normative questions for academics and scientific stakeholders to consider.

Results showed that English-language journals occupy relatively lucrative niches in the scholarly publishing market. Over the 19th and 20th centuries, English emerged as the predominant

[7] Davis (2018) chronicled how the Clarivate WoS suppressed (i.e., removed indexing and JIF) small specialist journals for citation patterns and behaviors that were tolerated—if not rewarded—when conducted by higher status journals and publishers. Davis argued, "the only apparent fault of the suppressed journals was that they suffered from a general lack of citation interest."

[8] The recent controversy over the proposed discontinuation of the US$1.7 million subsidy from Stanford University to Stanford University Press illustrates the financial and academic influences of a university on a university press (Kafka, 2019; McKie, 2019). Both the subsidy and the academic values of the university influence different academic output and market niches than could be pursued by a profit-seeking independent publisher operating solely with market logics. Academic presses generally report to university chief academic officers, as opposed to market-oriented institutions and people (Kassulke, 2019). Relatedly, Cambridge University Press representatives suggested that the influence of academic logics and goals of their parent university contribute to different OA strategies and outcomes vis-à-vis large commercial publishers such as Elsevier and Wiley (Schonfeld, 2019).

[9] In some cases, professional associations partner with for-profit publishers as a means of raising revenue through society journals. For example, Elsevier currently has a section of its website dedicated to catering to professional and academic societies: https://www.elsevier.com/books-and-journals/societies.

language in science, and it now often functions as a *lingua franca* in academic communication (Gordin, 2015). In turn, the current preeminence of English in academia appears to render English-language scholarly journals more economically valuable than journals published in other languages. Evaluative biases in favor of English institutions in science have also been identified. Recent research argued that major scholarly journal databases—such as WoS and Scopus—overrepresent English-language journals, tend to exclude non-English journals and possess geographic biases (Chavarro, Ràfols, & Tang, 2018; Mongeon & Paul-Hus, 2016). Given the importance of such indexing for legitimacy and value for academic journals, this is a mechanism that can exacerbate both economic and academic inequalities between English and non-English journals.

Supporting non-English academic journals is also often a means of promoting language use and community, particularly for languages vulnerable to being overlooked or supplanted in professional and social contexts by English. A recent analysis found that countries with the highest OA publishing rates—including many developing nations—are supported financially by governments and other institutions that encourage OA publishing and local scholarship (Van Noorden, 2019). Thus, it makes sense that for many non-English journals, market institutional logics will be relatively absent. For example, SciELO is a popular database with the primary mission of supporting and promoting academic work in Latin America (Packer, 2009). OA journals published via university-based publishers and the SciELO database contribute to a relative preponderance of non-APC or low-cost Portuguese and Spanish journals situated in Latin and South America (Appel & Albagli, 2019; Robinson-Garcia, Costas, & van Leeuwen, 2019). Analogously, publishing and institutional infrastructure supports a preponderance of non-APC journals in Scandinavian countries (Björk, 2019). Some low-income countries such as Bangladesh have also begun developing infrastructure to support affordable local OA publishing (Irfanullah, 2019). Establishing adequate infrastructure is vital for scientific development (Star, 1999) and often entails unique challenges in the global South (Furlong, 2014). A lack of academic infrastructure is a factor inhibiting OA publishing—especially low-cost or non-APC OA—in some less-wealthy countries.

Academic publishing can involve institutional (DiMaggio, 1988) and social (Mair & Martí, 2006) entrepreneurship, as well as Scientific/Intellectual Movements (SIMs) (Frickel & Gross, 2005), where actors strategically attempt to influence fields and/or create new professional niches in accordance with their interests. These interests can include social, professional, and/or economic goals (e.g., language preservation and promotion, academic community development, profit) driven by a variety of institutional logics. Some journals are founded with the goals of profit or prestige-seeking, whereas others are founded with altruistic intentions by zealous scholars solely attempting to publicize research in obscure or undervalued academic areas (Björk, Shen, & Laakso, 2016; Moore, 2019; Price & Puddephatt, 2017). The vast diversity in institutional logics and publishing philosophies is apparent in the different market niches of DOAJ journals.

As an additional idiosyncrasy of the OA publishing market, larger journals tend to be more expensive. Economies of scale may not entirely apply to OA publishing, at least not on the demand side on the market. Larger journals may possess more legitimacy and visibility and have more value. Further, more popular journals may also reject a relatively higher proportion of journals, which entails additional costs in OA publishing.

Even after accounting for journal language and the economic status of a publisher's home country, the geographic location of publishers was influential on journal pricing. A relative dearth of DOAJ journals from less-developed countries is notable. Even though the low

barriers to entry in online publishing can enable increased participation from traditionally excluded groups and regions (Suber, 2012), economic and geographic stratification remain in contemporary OA publishing. The APC-based model of OA publishing appears to be relatively more accessible to scholars situated in wealthier countries and institutions (Siler et al., 2018). The overrepresentation of Latin American journals in the DOAJ database suggests the importance of strong publishing institutions, especially in less-lucrative locales and niches that may not attract profit-oriented publishers. However, supporting strong publishing institutions also requires levels of economic and scholarly resources that not all regions or countries may possess.

Examining the relationship between journal pricing and academic disciplines also reveals differences. Journals in medicine are most costly, followed by journals in the natural sciences, and social science and humanities journals are least costly. These price differences are likely caused in part by the convention in medicine and natural sciences of hiring professional editors to oversee journals, which is less common in the social sciences and humanities. However, the relative dearth of funds in less pecunious disciplines can also underpin varying demand curves and willingness to pay on the demand (scholar) side of the market, which can also impact pricing decisions. For example, physical geography journals are roughly twice as costly as human geography journals (Coomes et al., 2016). Due to in part lower funding levels relative to medicine and natural sciences, there has been trepidation from some scholars in the social sciences and humanities regarding transitions to APC-based OA publishing (AcSS, 2019; Denbo, 2019; Meyer, 2018). APC differences between academic disciplines may also reflect economic differences between what de Solla Price (1963) dubbed "Big Science" and "Little Science," as some academic research entails collaboration via large-scale organizations, whereas other scholarly work involves individual or small-group efforts. Big Science is more prominent in medicine and the natural sciences, and Little Science tends to be more common in the social sciences and humanities.

The economic status of the demand side of the market is a factor that influences market entry and pricing levels in academic publishing. The lucrativeness of certain academic markets also can explain why some scholarly communities are more likely to be served by for-profit publishers vis-à-vis not-for-profit institutions.[10] Large for-profit publishers generally occupy upscale market niches, publishing a disproportionate number of prestigious journals. Strong market logics can potentially have academic benefits. For example, Willinsky (2005) chronicled that society publishers were risk averse with founding new journals during the late 20th century, creating opportunities for for-profit publishers to establish new journals and academic fields while expanding market share.

A limitation of our research is that journals listed in the DOAJ represent an incomplete sample of total academic journals on the market. The DOAJ listings exclude the sizable population of journals with questionable or unestablished legitimacy. In 2014, stricter quality controls were introduced by the DOAJ and 3,776 journals were subsequently removed from the list (Marchitelli, Galimberti, Bollini, & Mitchell, 2017). Less than 1% of journals and publishers present in the DOAJ are also present in either Beall's or Cabell's blacklists of alleged "predatory" journals (Strinzel, Severin, Milzow, & Egger, 2019). Being listed in the DOAJ database is

[10] As an example of a large for-profit publisher conducting business with a less-wealthy academic community, Elsevier founded *Scientific African* in 2018 (Akinwotu, 2018). The US$200 *Scientific African* APC is a fraction of the prices charged for Elsevier OA journals marketed in the developed world. This could entail an altruistic act of corporate social responsibility and/or a long-term strategy to establish a foothold in a nascent market with potential for future economic growth and upward mobility.

an accomplishment and sign of legitimacy. Many journals exist without the interest, prominence, quality, and/or wherewithal to be listed in the DOAJ database. The relative dearth of DOAJ journals from lower income countries and peripheral geographic regions suggests that economic resources and geographic scholarly networks are influential with establishing visibility and institutional legitimacy in academic publishing.

6. CONCLUSION

Just as there is substantial variation in the academic, social, and economic niches of OA journals, the OA academic journal market possesses many different sources of economic value. With this wide variety in journals, OA publishing can entail different social and economic experiences for different scholars and communities. Both objective publishing costs and social characteristics are related to the pricing levels and strategies of different OA journals. As scholars and academic stakeholders assume increasing responsibility for deciding which journals to support, considering sources of publication costs is important for determining the economic and academic meritoriousness of journal expenditures. In many ways, the OA publishing market reproduces inequalities long present in the traditional print journal market. Status endowments such as the JIF are significantly associated with profit-oriented publishing. The economics of OA publishing are intertwined with the professional reward structures of science. Highly valued journals in professional fields tend to carry concomitant economic value in the OA publishing market. There are ethical implications of this in contexts where some scholars and institutions have more access to economic resources than others.

This article provides a current snapshot of the OA publishing market, showing various social and professional influences on journal pricing. However, the trends reported in the article are not necessarily immutable, especially because the OA publishing market is constantly changing and expanding. In the future, the market—and sources of economic value—may change based on the agency, activism, and/or rent-seeking of the various personal and institutional stakeholders of academic publishing. Stewart Brand famously observed the paradox that "information wants to be free," but also "information wants to be expensive, because it's so valuable" (Fenichel & Skelly, 2015). OA publishing has helped information to be free but has also created new sources of economic value and profit in science.

AUTHOR CONTRIBUTIONS

Kyle Siler: conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, software, validation, visualization, writing—original draft, writing—review and editing. Koen Frenken: conceptualization, formal analysis, funding acquisition, methodology, project administration, resources, supervision, writing—review and editing.

COMPETING INTERESTS

The authors have no competing interests.

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DATA AVAILABILITY

The main data set for the article is available at: https://doi.org/10.6084/m9.figshare.10008974.v1. Because JIFs are proprietary data owned by Clarivate, variables related to the JIF were redacted from the public data set.

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APPENDIX: MOST COMMON JOURNAL LANGUAGES OF DOAJ-LISTED OA JOURNALS

Journal language(s)	Total	% of Total
English	5683	46.86
Spanish; Castilian	702	5.79
Indonesian	590	4.86
English, Portuguese, Spanish; Castilian	495	4.08
Portuguese	489	4.03
English, Indonesian	467	3.85
English, Spanish; Castilian	428	3.53
English, Portuguese	217	1.77
English, French	208	1.72
Portuguese, Spanish; Castilian	197	1.62
English, Turkish	177	1.46
Russian	151	1.25
Persian	147	1.2
English, French, Portuguese, Spanish; Castilian	116	0.96
English, Russian	111	0.92
English, Russian, Ukrainian	107	0.88
English, Italian	91	0.75
English, Polish	82	0.67
French	76	0.62
English, German	75	0.61
English, Serbian	71	0.59
English, French, Spanish; Castilian	52	0.43
Croatian, English	48	0.4
English, French, Italian, Portuguese, Spanish; Castilian	47	0.39
Arabic, English, Indonesian	46	0.38
Turkish	38	0.31
English, French, German, Italian, Spanish; Castilian	33	0.27
English, French, Italian	32	0.26
Catalan; Valencian, English, Spanish; Castilian	29	0.24
Italian	28	0.23
Arabic, English	27	0.22

(*continued*)

Journal language(s)	Total	% of Total
Chinese	27	0.22
English, Romanian; Moldavian; Moldovan	27	0.22
Chinese, English	26	0.21
Czech, English, Slovak	26	0.21
English, French, German	24	0.2
English, French, German, Italian, Portuguese, Spanish; Castilian	22	0.18
English, French, Italian, Spanish; Castilian	21	0.17