Estimating the Financial Value of Scientific Journals and APCs using Visibility Factors: A New Methodological Approach

Gali Halevi; Rodrigo Sánchez-Jiménez; Vicente P. Guerrero-Bote; Félix De-Moya-Anegón

Recommended citation:
Halevi, Gali; **Sánchez-Jiménez, Rodrigo**; **Guerrero-Bote, Vicente P.**; **De-Moya-Anegón, Félix** (2024). "Estimating the financial value of scientific journals and APCs using visibility factors: A new methodological approach". *Profesional de la información*, v. 33, n. 5, e330512.
https://doi.org/10.3145/epi.2024.0512

Article received on October 15th 2024
Approved on October 23rd 2024

Gali Halevi ✉
https://orcid.org/0000-0003-3478-8804
SCImago Lab
Granada, Spain
gali.halevi@scimago.es

Rodrigo Sánchez-Jiménez
https://orcid.org/0000-0002-3685-7060
Universidad Complutense de Madrid
Facultad de Ciencias de la Documentación
Santísima Trinidad, 37
28010 Madrid, Spain
rodsanch@ucm.es

Vicente P. Guerrero-Bote
https://orcid.org/0000-0003-4821-9768
Universidad de Extremadura
Facultad de Ciencias de la Documentación y la Comunicación
Badajoz, Spain
guerrero@unex.es

Félix De-Moya-Anegón
https://orcid.org/0000-0002-0255-8628
SCImago Lab
Granada, Spain
felix.moya@scimago.es

Abstract

Not all scientific journals that offer open access publication charge the same Article Processing Charges (APC), even within the same publishing group. The hypothesis is that this variation is related to the journal's prestige and impact indicators, which reflect the value the journal provides to authors. This study examines the relationship between these indicators and proposes a method to estimate the APC that should correspond to each journal. Additionally, based on the estimated APC and the articles published over the past five years, a method is proposed to determine the value of a journal. Using these values, the relationship between the estimated APC and the published APC is analyzed, along with the distributions of estimated APCs and journal values. The average and cumulative values are also studied by publisher and by the most developed countries. Finally, a significant correlation is observed between the cumulative estimated journal values and the scientific output of countries.

Keywords

APC, Article Processing Charge, Open Access, Journals, Journal Value Estimation, Journal Quality, Metrics, Economic Value, Journal Prestige, Impact Indicators, SJR, Scientometrics, Market Estimates, Academic Publishers, Publishing Houses, Countries, Rankings.

1. Introduction

The academic publishing industry has seen a significant shift with the rise of Open Access (OA) publishing, where Article Processing Charges (APCs) have become a primary source of revenue for many journals. APCs are fees charged to authors for making their research freely accessible to readers. However, the variation in APCs across journals has raised questions about their fairness, transparency, and justification. While some journals charge high APCs, others with similar reputations may have significantly lower fees, prompting the need for a deeper understanding of how APCs are determined and whether they align with a journal's quality and impact.

This study explores two central hypotheses related to the economics of APCs and journal valuation. The first hypothesis posits that not all APCs should be uniform, but instead, they should reflect the journal's quality, as indicated by key metrics like impact factor, reputation, and editorial standards. By examining these quality indicators, it may be possible to estimate appropriate APC levels for different journals, ensuring a more rational pricing structure in the scholarly publishing landscape.

While some journals charge high APCs, others with similar reputations may have significantly lower fees, prompting the need for a deeper understanding of how APCs are determined and whether they align with a journal's quality and impact

The second hypothesis addresses the relationship between APCs and the overall value of a journal. It suggests that a journal's value could be tied to the APC revenue it can generate over a standard amortization period of 5 years. Even for journals that do not currently charge APCs, estimating potential APCs based on quality indicators and the number of citable papers can provide a basis for determining the journal's financial worth.

This study aims to contribute to the ongoing debate on APC pricing and journal valuation by proposing a framework for aligning APCs with journal quality and exploring the broader financial implications for journal ownership and acquisition.

This study aims to contribute to the ongoing debate on APC pricing and journal valuation by proposing a framework for aligning APCs with journal quality and exploring the broader financial implications for journal ownership and acquisition

2. Research Questions

1. How do Article Processing Charges (APCs) vary across journals, and what factors influence these variations?
2. To what extent do APCs correlate with journal quality indicators such as impact factor, citation rates, and editorial standards?
3. Can APCs be accurately estimated based on a journal's quality indicators, and if so, which indicators are the most predictive?
4. Are there specific journal metrics (e.g., citation impact, rejection rate) that have a stronger correlation with APC pricing than others?
5. How can the potential APC revenue of a journal be used to estimate its financial value over a standard amortization period of 5 years? What role does the number of citable articles published by a journal in the last 5 years play in determining its sale value?
6. For journals that do not currently charge APCs, how can their potential APC value be estimated using quality indicators?
7. Is there a significant difference between the estimated APC value of subscription-based journals and open access journals?
8. How can aligning APCs with journal quality contribute to a more transparent and equitable pricing structure in the scholarly publishing industry?
9. What impact would this alignment have on authors, particularly in terms of their ability to pay APCs in high-quality journals?

3. Hypotheses

First: Article Processing Charges (APCs) vary and should not be the same for all journals. APCs should align with the quality of the journal, meaning they should be based on specific quality indicators. If this is true, APCs could be estimated by looking at the journal's quality metrics.

Second: The value of a journal should be linked to the APC revenue it can generate over a 5-year amortization period. Even though not all journals charge APCs, if APCs can be estimated using quality indicators, the journal's value can be calculated by considering the number of citable articles published in the past 5 years.

4. Literature Review

The emergence of Article Processing Charges (APCs) as a key element in Open Access (OA) publishing has spurred considerable debate and research on the relationship between APCs, journal quality, and the economic sustainability of OA models. This literature review explores various studies on the dynamics of APCs in open access, their correlation with journal quality, institutional strategies for managing APC costs, and the broader implications for the scholarly publishing ecosystem.

4.1. APCs and Journal Quality

A fundamental issue in the open access debate is whether APCs reflect the quality and prestige of journals. **Björk and**

Solomon (2012) compared the scientific impact of OA and subscription journals, showing that OA journals can achieve similar levels of scientific prestige despite charging APCs. In a later study, **Björk and Solomon** (2015) found a relationship between APCs and journal quality indicators, such as the Journal Impact Factor (JIF) and SCImago Journal Rank (SJR), suggesting that higher-quality journals tend to charge higher APCs. This view is supported by **Guerrero-Bote and Moya-Anegón** (2012), who developed the SJR2 indicator to better measure scientific prestige, and their work illustrates how quality metrics can be used to justify APC pricing models.

Despite the correlation between APCs and quality, other studies have questioned whether APCs truly reflect journal impact. **Schönfelder** (2020) argued that APC pricing often mirrors the legacy of subscription-based models rather than being based on the true scientific impact of a journal. This has led to concerns about the transparency and fairness of APC pricing across the OA ecosystem, especially for early-career researchers and institutions with limited financial resources.

4.2. Institutional Approaches to Managing APCs

The transition to an open-access publishing environment has created financial challenges for institutions, especially as they balance the costs of APCs with traditional subscription fees. **Pinfield *et al.*** (2016) examined institutional strategies for managing the "total cost of publication," which includes both APCs and subscription fees in a hybrid OA environment. They found that institutions are adopting various approaches, such as APC funds, offsetting agreements, and transformative agreements, to handle the growing financial burden of APCs.

Transformative agreements, which allow institutions to shift from subscription payments to covering APCs for open access, are increasingly seen as a solution to the financial challenges of the OA transition. These agreements aim to reduce the "double-dipping" effect, where institutions pay both subscription fees and APCs. **Rousseau *et al.*** (2021) suggest that calculating the monetary value of scientific publications can help institutions make informed decisions about how to allocate resources between subscriptions and APC payments.

Transformative agreements, which allow institutions to shift from subscription payments to covering APCs for open access, are increasingly seen as a solution to the financial challenges of the OA transition. These agreements aim to reduce the "double-dipping" effect, where institutions pay both subscription fees and APCs

4.3. Global Trends in APC Pricing

APC pricing varies significantly across disciplines, regions, and publishers. **Haustein *et al.*** (2024) provided a recent analysis of global APC trends, estimating the total amount paid to six major publishers for APCs between 2019 and 2023. Their findings indicate that the OA market continues to grow rapidly, with APCs becoming a significant revenue stream for large commercial publishers like *Elsevier*, *Wiley*, *Springer-Nature* and others.

The distribution of APC costs also reflects broader inequalities in the global academic system. **Rodrigues *et al.*** (2020) highlighted the rise of new OA publishers, which offer lower-cost alternatives for authors, particularly in the Global South. However, **Suber** (2012) warned that despite the growth of low-cost OA options, the high APCs charged by established publishers could exclude underfunded researchers from participating fully in the global scientific conversation.

4.4. Transparency and Future Directions

The lack of transparency in APC pricing remains a key challenge for the open access movement. **Borrego** (2023) reviewed the state of APC pricing transparency, finding that many publishers do not clearly explain how APCs are calculated or justify their pricing strategies. This has led to calls for standardized APC pricing models that are more closely tied to journal quality indicators and publication costs. As the market for OA continues to evolve, researchers and institutions will need more clarity on how APCs are determined and how to best manage the financial burden of open access publishing.

4.5. Conclusion

The literature on APCs highlights the complexity of open access publishing and the ongoing debates surrounding the pricing of APCs, journal quality, and the financial sustainability of the OA model. While there is a clear relationship between APCs and journal quality, as shown by **Björk and Solomon** (2015) and others, issues of transparency, fairness, and affordability persist. Institutional strategies, such as transformative agreements, offer potential solutions, but the global academic community continues to grapple with how to

> While there is a clear relationship between APCs and journal quality, issues of transparency, fairness, and affordability persist. Institutional strategies, such as transformative agreements, offer potential solutions, but the global academic community continues to grapple with how to balance the costs and benefits of open access publishing in an equitable way

balance the costs and benefits of open access publishing in an equitable way. Future research will need to focus on creating more transparent and sustainable APC models to support the continued growth of open access.

5. Data and Method

To estimate APC values, we used data from the *Scopus*™ database alongside publicly available journal indicators from the *SCImago Journal & Country Rank* (SJR). We also used a list of 2,755 journals with publicly available APCs from *Elsevier* (downloaded on 20/10/2024 from *Elsevier's Pricing Policies* at *https://www.elsevier.com/about/policies-and-standards/pricing*), as well as publicly available data on 1,892 journals from *Wiley* (downloaded on 20/10/2024 from *https://authorservices.wiley.com/author-resources/Journal-Authors/open-access/article-publication-charges/index.html*), 2,784 journals from *Springer Nature* (downloaded on 20/10/2024 from *https://www.springernature.com/gp/open-science/journals-books/journals*) and 1013 journals from Sage (downloaded on 20/10/2024 from *https://uk.sagepub.com/en-gb/eur/sage-choice-journal-and-pricing-exceptions*).

Using the journal ISSN, we matched journals from four publishers with those listed in the *Journal & Country Rank* (SJR) database, creating a dataset of 8,444 journals along with their corresponding SJR indicators. From the SJR portal, we selected three commonly used metrics: SJR, JIF2 (Journal Impact Factor with a 2-year citation window), and JIF3 (Journal Impact Factor with a 3-year citation window). In addition to using the most recent data (2023), we also calculated the average values of these indicators over the previous five years (2019-2023), effectively generating six total indicators.

We focused our analysis on journals that had both listed APCs from *Elsevier* and available SJR indicators, narrowing the dataset down to 6,994 journals (see Table 1 for a detailed breakdown). After estimating the APC for each journal, we calculated its potential financial value by multiplying the estimated APC by the number of citable papers it published over the past five years.

Table 1: Distribution of Journals by Publisher, Number of Available Journals with Price and Calculated SJR.

Publisher	Total	With price	In *Scopus*	With SJR	With price and SJR
Elsevier	2755	2691	2504	2443	2392
Wiley	1892	1835	1632	1594	1576
Springer	2784	2635	2258	2215	2128
Sage	1013	1013	917	898	898
Total	8444	8174	7311	7150	6994

To investigate how Article Processing Charges (APCs) relate to the twelve journal quality indicators, we used scatter plots to visualize the data. Each scatter plot showed APCs on one axis and a specific journal indicator (like SJR or JIF) on the other.

We then applied four different types of trend lines to each plot to model potential relationships between APCs and the indicators:

1. *Linear Trend Line*: This assumes a direct, constant rate of change between APCs and the indicator. If the relationship is linear, the APC increases or decreases at a consistent rate as the indicator value changes.
2. *Logarithmic Trend Line*: This suggests that APCs change rapidly at first but then level off as the indicator value increases. It's useful for relationships where changes in APCs become less significant as journal quality increases.
3. *Exponential Trend Line*: This assumes that APCs increase or decrease at an increasing rate as the indicator value rises. If the relationship is exponential, small changes in the journal's quality could result in large changes in APCs.
4. *Power Trend Line*: This models relationships where APCs change at a rate proportional to the value of the indicator raised to a power. It suggests a more complex relationship, where the APC changes faster or slower depending on the magnitude of the indicator.

Each of these trend lines helps to identify the best-fitting mathematical relationship between APCs and the indicators, allowing us to predict APCs based on journal quality metrics. This process generated a total of 48 trend lines (12 indicators × 4 trend lines), each with corresponding equations and determination coefficients. The trend line with the highest determination coefficient was selected as the best fit for estimating APCs.

6. Results

After analyzing the scatter plots for the 12 measures, several patterns emerged. The percentile-based versions of the indicators consistently showed a poorer fit with APCs compared to the original, unadjusted indicator values. The exception was the exponential fit, which overall was the least effective model. This suggests that the actual differences in the original indicators —reflecting expected journal impact— are more relevant in explaining APC variations than the percentile rankings themselves. When comparing model fits for different indicator types, distinct trends became apparent. For the percentile-based measures, the *Exponential Model* provided the best fit across the board. In contrast, for the original indicators (both 2023 data and 5-year averages), *Power Models* generally offered the strongest fit.

Specifically, for the two SJR-based measures, the *Power Model* fits the data best. For the 2-year and 3-year JIF-derived measures, three out of four performed better with the *Power Model.* In the case of the 3-year JIF, the *Power Model* was very closely matched by the *Linear Model*.

These findings suggest that while percentile-based approaches are less effective at explaining APC differences, the original indicator values —especially when analyzed through *Power Model* fits— provide a stronger explanation of APC variation trends.

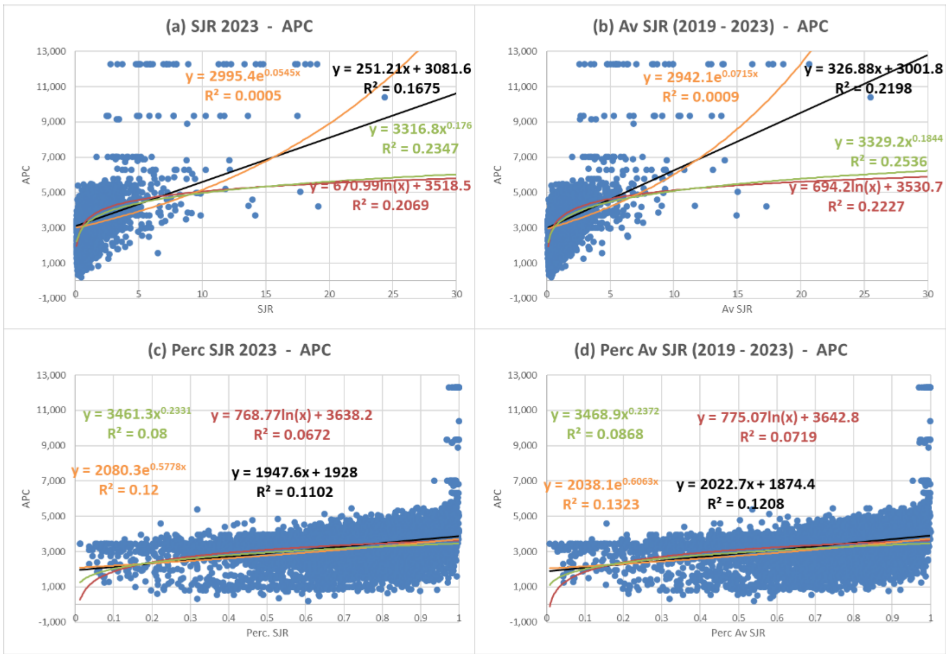

Figure 1: Scatter Plots of the 6994 Journals and their Corresponding: SJR (a), Average of SJR (2019-2023) (b), Percentile Rank of the SJR (c), and Percentile Rank of the Average of SJR (2019-2023) (d), with Four Trend Lines (linear, Logarithmic, Exponential, and Potential) with their Corresponding Equations and Coefficient of Determination.

In all three figures, but especially in Figures 2 and 3, several groups of journals clearly deviate from the general trend. It appears that the *Journal Series* and *editorial structures* significantly influence APC distribution, even more than a journal's *Prestige*, *Impact*, or *Influence*. None of the 12 measures used effectively predict APCs for certain clusters of journals.

The most noticeable deviations are seen around the \$7,000, \$9,300 and \$12,290 APC levels in all graphs (as seen in Figure 1). The group with the highest APCs is composed of 33 journals from the *Nature Series*, which share a price but are very different in terms of any of the impact indicators. The second group, is mainly associated with molecular biology journals, particularly those in the *Cell* series (e.g., *Cell Stem Cell*, *Cell Metabolism*, *Cell Host and Microbe*). The third group appears linked to the *Trends in* series. Other outliers are visible around prominent publications such as *The Lancet*. In these cases, the pricing of APCs is largely disconnected from the indicators used in the analysis.

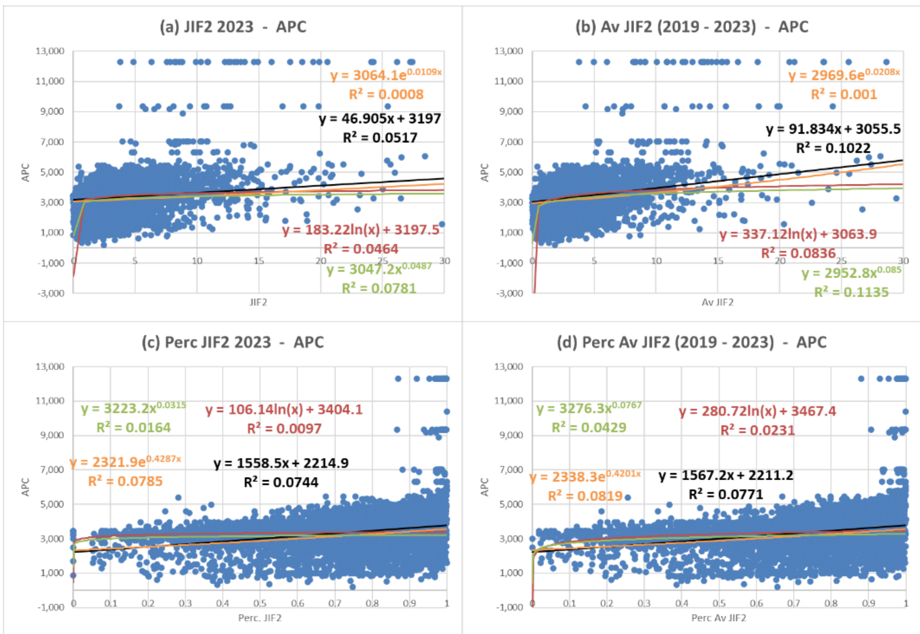

Figure 2: Scatter Plots of the 6994 Journals and their Corresponding: JIF2 (a), Average of JIF2 (2019-2023) (b), Percentile Rank of the JIF2 (c), and Percentile Rank of the Average of JIF2 (2019-2023) (d), with Four Trend Lines (linear, Logarithmic, Exponential, and Potential) with their Corresponding Equations and Coefficient of Determination.

A common pattern across all three figures is that the averages of the indicators over the past five years perform better than metrics from the most recent year. This applies to both the percentile-based measures and the original metrics. In every trend line, the 5-year averages provide a better or equal fit compared to the annual values. Additionally, the 5-year averages are more robust, as single-year metrics can fluctuate significantly in some cases. Overall, using averages appears to be a more reliable approach for fitting APC values in the current dataset.

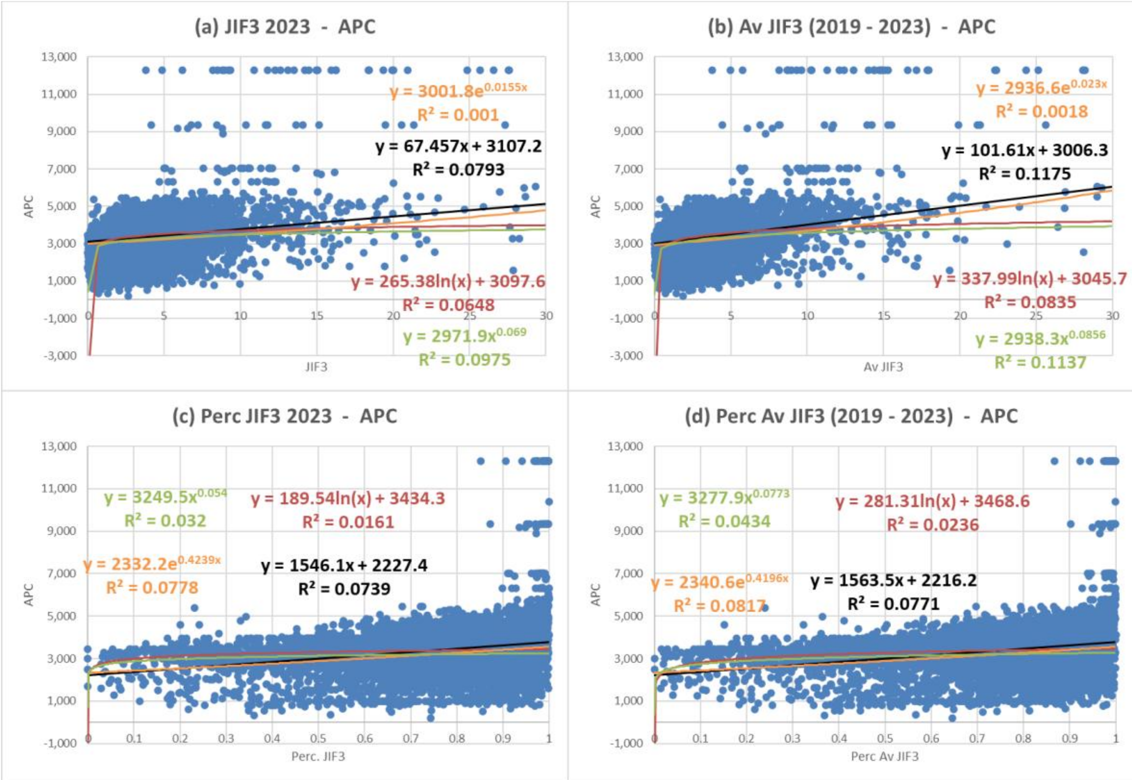

Figure 3: Scatter Plots of the 6994 Journals and their Corresponding: JIF3 (a), Average of JIF3 (2019-2023) (b), Percentile Rank of the JIF3 (c), and Percentile Rank of the Average of JIF3 (2019-2023) (d), with Four Trend Lines (Linear, Logarithmic, Exponential, and Potential) with their Corresponding Equations and Coefficient of Determination.

The trend lines with the highest determination coefficients are based on the SJR indicator. Of the four SJR-based measures, the 5-year average SJR yields the highest values. The trend line with the best fit, having the highest determination coefficient (0.2536), is the *Power Trend Line*, with the following equation:

$$\text{Equation 1: } y = 3329.2\, x^{0.1844}$$

where y is the estimated APC and x is the average SJR over the last 5 years (2019-2023)

Studying prices is a meaningful way to assess value, especially in scientific publishing. As noted by **Rousseau *et al.*** (2021),

“The price to make one's article open access could be seen as a proxy for the expected total discounted future value of publishing this study.”

Therefore, analyzing current market prices provides a reasonable approach to estimating and evaluating the value of scientific publications.

In a recent study, **Haustein *et al.*** (2024) highlighted an important point:

"The relationship between APC price and journal prestige warrants further attention, especially as publishers appear to justify fee increases based on prestige rather than costs."

While examining production costs and their differences from APCs is important, our focus is on the relationship between prices and the value of scientific publications.

The same study also reports significant growth in APC revenues and observes that “higher-priced journals tend to attract more authors,” or conversely, “journals that attract more authors have the highest APCs.” This concentration of authors around specific journals is likely tied to the demand for publication in first-quartile journals, a trend driven by global scientific evaluation systems and science and technology policies (**De-Moya-Anegón**, 2020).

It is crucial to introduce the possibility of assessing value using models that are based on factors other than perceived prestige. Doing so would allow for a deeper exploration of the dynamics between pricing and value, potentially aligning more closely with the goals of science and technology policies. Using *Impact Indicators*, which reflect the effectiveness of knowledge dissemination, could be a valuable alternative for evaluating scientific journals. These indicators align with the core mission of scientific journals —to disseminate knowledge effectively.

Building on this idea, we can use the model derived from Equation 1 to estimate APCs for individual journals. Since the SJR indicator is based on network centrality, the model suggests that a journal's scientific prestige is linked to the impact it has on other publications, supporting the concept of effective knowledge dissemination (**Guerrero-Bote; Moya-Anegón**, 2012).

Figure 4 illustrates the relationship between the actual APCs of journals and the estimated APCs based on the proposed model. While most journals follow the general trend, there are some groups that deviate from the overall pattern. The scatter plot also shows a cluster of journals that do not charge APCs, with their estimated APCs behaving independently of their average SJR.

The figure highlights four distinct clusters where the estimated APCs do not align well with the actual APCs. These clusters are clearly visible in opposite quadrants of the plot. Journals with higher APCs tend to have higher estimated APCs, which correspond to a higher average SJR. Conversely, journals with no APCs typically have lower estimated APCs, reflecting a lower average SJR.

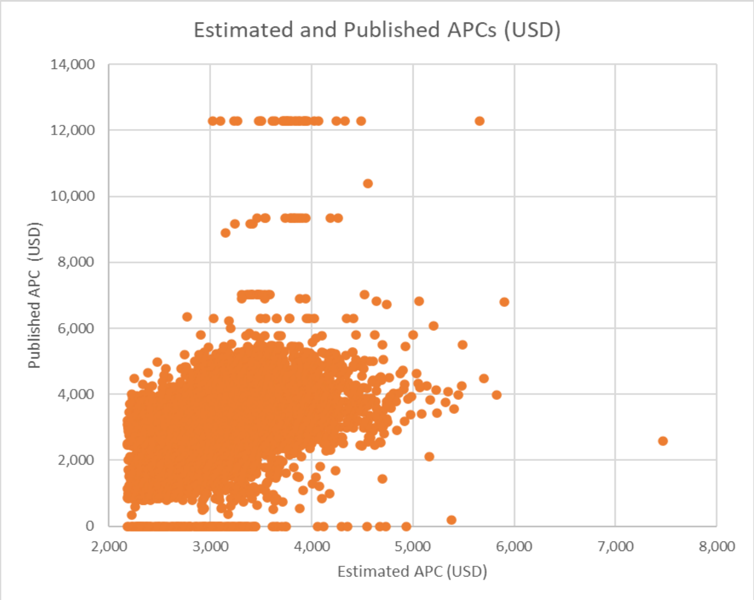

Figure 4: Scatter Plot of the List of Journals with their APC (in USD) and Estimated APC.

We can extend the model to include all publications with available SJR data, providing a broader overview. Figure 5 illustrates the distribution of estimated APCs across all journals, forming a right-skewed curve. Generally, the number of journals decreases as the estimated APCs increase. Half of the journals have estimated APCs ranging between $2,401 (25th percentile) and $3,126 (75th percentile). The lowest estimated APC is around $2,177, while the highest is approximately $7,467.

It's important to note that these estimates tend to be higher than actual APCs because the model doesn't account for journals without academic value or those that offer free publishing options.

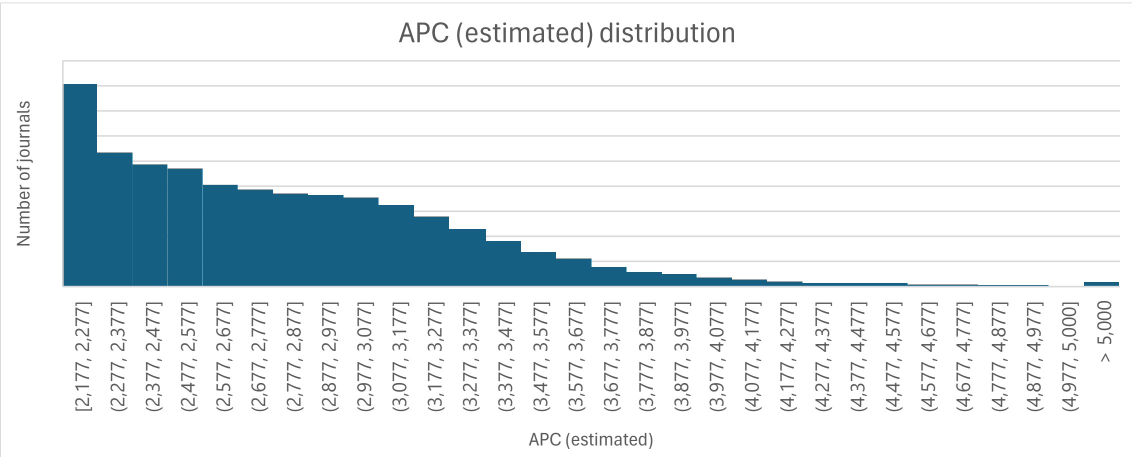

Figure 5: Histogram Showing the Number of Journals with the Estimated APC.

Using a similar approach, we can estimate the value of journals by multiplying their estimated APC by the number of citable papers they've published over the past five years. Figure 6 presents the rank distribution of both estimated APCs and journal values. The size of the journals, measured as the number of citable documents published during the last 5 years is clearly the dominant factor in explaining journal value. On the other hand, the uneven distribution of journal output is influenced by factors such as prestige and impact. High-impact journals tend to attract more authors, publish more papers, and charge higher APCs.

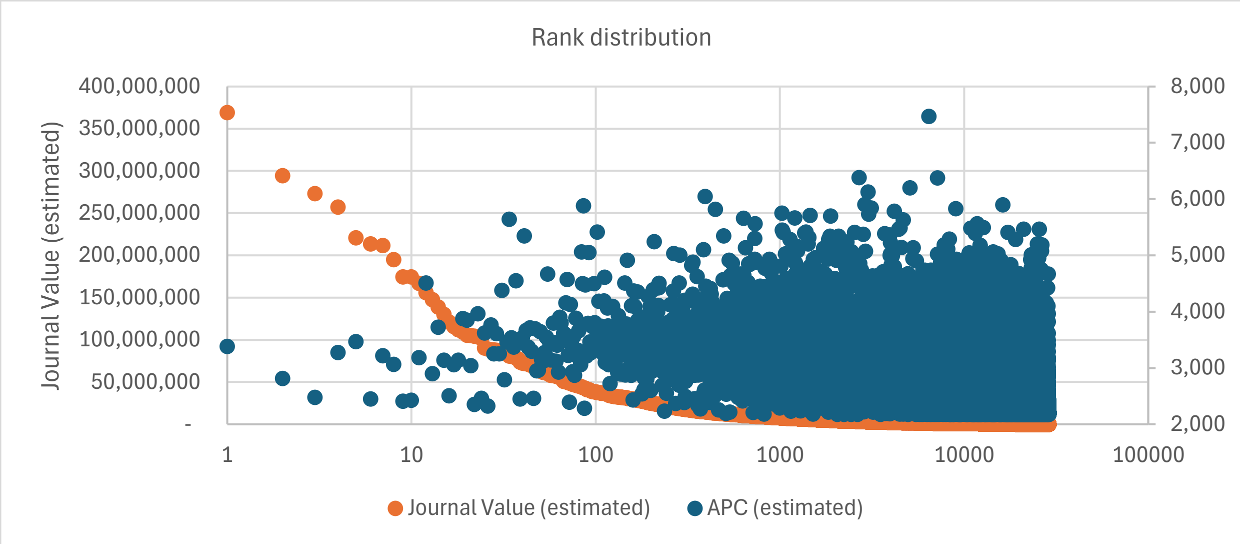

Figure 6: Rank Distribution of the Estimated APC and the Estimated Journal Value.

Schönfelder (2020) found a weak but significant correlation between APC prices and SNIP. In her study, the two most important factors that explained APC prices were impact and business model. We compared the performance of widely used indicators against the SJR-based model shown in earlier figures across subsets of journals in full open access and hybrid status. While our goal is to identify a single metric to estimate the value of editorial structures at different aggregation levels, we recognize that considering journal business models can provide additional insights for sectoral studies or individual decision-making. Some minor adjustments were made to the original dataset to include only journals for which all indicators were calculated, resulting in 6,981 publications available for testing.

Table 2 presents the coefficients of determination for six different indicators across the Open Access subset, the Hybrid subset, and the full set of journals for *linear, power, logarithmic*, and *exponential* fits. Percentile-based measures were excluded, as they underperformed compared to the original indicators. However, we included both the 2023 SJR and the average SJR over the 2019-2023 period for comparison.

A key finding is that models based on specific subsets fit data significantly better, supporting the idea that specialized models can be valuable for focused pricing studies. However, we lack data on the business models for many journals, notably the 1,013 *Sage* journals, which are absent from these subsets. For the full set of journals, *Power Law* models fit best across all indicators, except for the *H-index,* which is better explained by a *linear model*. For the Full Open Access subset, the *logarithmic model* provides the best fit, while for the Hybrid journals subset, the *linear model* performs better. Across all cases, the model with the highest coefficient of determination is based on the *average SJR (2019–2023).*

The H-index also shows a strong fit for the full journal set. Interestingly, the best CiteScore percentile underperforms compared to the standard CiteScore, suggesting that category-based comparisons may be less effective at capturing price differences associated with journal impact. Likewise, SNIP and the CiteScore percentile consistently showed the poorest fits, possibly because they are designed for cross-field comparisons, while APC pricing is heavily influenced by scientific disciplines (**Björk; Solomon**, 2015).

Despite these nuances, the SJR-based model continues to represent a strong and reasonable approach for estimating APCs.

Table 2: Coefficients of Determination for CiteScore (2023), SNIP (2023), SJR (2023), H Index, CiteScore (best percentile 2023) and SJR Avg. (19-23) for Linear, Logarithmic, Power Law and Exponential Models.

	All journals				Open Access				Hybrid			
	Lin.	Log.	Pow.	Exp.	Lin.	Log.	Pow.	Exp.	Lin.	Log.	Pow.	Exp.
CS 23	0.0830	0.1558	0.1794	0.0004	0.0260	**0.2721**	0.2569	0.0060	**0.3686**	0.2495	0.2870	0.2228
SNIP 23	0.0301	0.1147	0.1296	0.0008	0.0113	0.1556	0.1344	0.0053	0.2292	0.1603	0.1837	0.1230
SJR 23	0.1675	0.2067	**0.2345**	0.0005	0.0113	**0.4055**	0.3647	0.0056	**0.4177**	0.2947	0.3338	0.3266
H index	**0.2509**	0.2130	0.2288	0.1496	0.2371	0.2411	0.2579	0.1472	0.2386	0.1677	0.1813	0.2012
CS B.P.	0.0954	0.0668	0.0771	0.0999	0.1726	0.1484	0.1646	0.1776	0.1099	0.0753	0.0855	0.1155
SJR AVG	0.2197	0.2224	**0.2534**	0.0009	0.0949	**0.4330**	0.4025	0.0050	**0.4401**	0.3144	0.3568	0.3255

Figure 7 displays the distribution of the estimated journal values based on the proposed model. The distribution is highly skewed with a long tail, resembling a *Power-Law* distribution. This skew likely reflects the presence of a small number of journals with very high publication output, combined with the tendency of high-impact journals with higher APCs to attract a larger share of publications. This concentration of output in a few high-impact journals contributes to the skewed pattern observed.

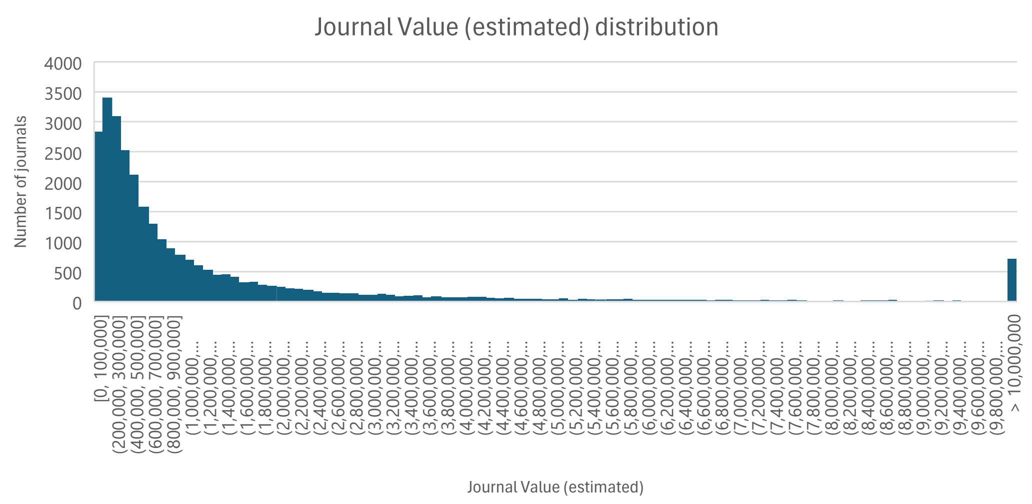

Figure 7: Histogram Showing the Number of Journals with the Estimated Journal Value.

Using the estimated values of the journals, we can explore higher levels of aggregation. Table 3 presents the cumulative estimated values by major publisher (a more detailed version is available as SP1 in the annex). For clarity, we refer to the publishing group as a whole, rather than its individual imprints, which offers another insightful level of analysis.

When aggregating the potential value of publications, publishing groups with the highest output generally maintain their positions in the ranking of accumulated value. One striking observation is the wide variation in average estimated values per journal, even within the top 20. For example, the *Public Library of Science* (*PLoS*) averages $46,652,453 per publication, while *Emerald Publishing* averages $713,528. These differences are heavily influenced by the average number of citable papers published by each group's journals.

The top 20 publishers by accumulated estimated value continue to be dominated by traditional scientific publishers, but newer players have made significant inroads. *MDPI, Frontiers*, and to a lesser extent *Hindawi*, have achieved high potential value through their APC-driven strategies and large output volumes (**Rodrigues *et al.***, 2020). Additionally, both *Elsevier* and *Wiley* have experienced sharp increases in estimated APC revenue from 2022 to 2023 (**Borrego**, 2023).

Table 3: Accumulated Estimated values by Main Publisher (top 20).

Main Publisher	Journals	Output (5 years)	Accumulated Estimated Value	Average Estimated Value
Elsevier	2,523	2,962,229	10,198,931,943	4,042,383
Springer Nature	2,481	2,060,874	6,539,301,815	2,635,752
John Wiley & Sons	1,567	1,060,410	3,585,495,510	2,288,127
MDPI	237	1,038,215	3,274,506,567	13,816,483
Taylor & Francis	2,379	683,625	2,062,951,507	867,151
Frontiers Media SA	96	368,369	1,261,537,863	13,141,019
IEEE	207	340,057	1,213,057,435	5,860,181
American Chemical Society	76	304,949	1,114,271,306	14,661,465
Wolters Kluwer Health	458	320,507	1,036,209,990	2,262,467
SAGE	984	320,008	1,000,458,084	1,016,726
Oxford University Press	432	262,362	924,641,094	2,140,373
Royal Society of Chemistry	61	182,530	636,506,785	10,434,537
Institute of Physics Publishing	80	115,897	365,441,756	4,568,022
American Physical Society	15	99,049	360,916,338	24,061,089
Hindawi	193	120,546	360,690,010	1,868,860
BMJ Publishing Group	63	94,836	331,204,917	5,257,221
Public Library of Science	7	95,974	326,567,169	46,652,453
Cambridge University Press	374	100,994	313,803,160	839,046
Emerald Publishing	377	89,926	269,000,214	713,528
Science China Press	98	96,348	265,439,887	2,708,570

Table 4 presents the accumulated estimated values by region and country. The term *"journals"* refers to the number of publication outlets managed by publishers based in each country. Both the accumulated and average estimated values are calculated from the citable publications these journals have produced over the past five years. In contrast, *"output"* refers to the number of papers produced by researchers affiliated with institutions in those countries. This allows us to compare the scientific output of a country with the value of its scientific publishing infrastructure, serving as a proxy for understanding the relationship between a country's research activity and its publishing industry.

The results show that the publishing industries in Germany, the United States, the United Kingdom, the Netherlands, and Switzerland account for 84.4% of the global estimated value of scientific publishing. Furthermore, the ratio of accumulated value to scientific output is significantly higher in these countries compared to the rest of the world. This suggests that their publishing infrastructure captures a disproportionately large share of value relative to their scientific contributions. This imbalance is illustrated more clearly in Figure 8. (Full data can be found in SP2 in the annex).

Table 4: Accumulated Estimated Values by Region and Country.

Region	Country	Journals	Accumulated estimated value	Output	Average estimated value
Northern America	United States	6,936	13,545,664,356	729,585	1,952,950
Western Europe	United Kingdom	6,534	11,697,557,386	244,718	1,790,260
Western Europe	Netherlands	2,154	4,728,942,794	73,617	2,195,424
Western Europe	Switzerland	876	4,563,277,483	57,482	5,209,221
Western Europe	Germany	1,595	2,583,863,655	205,505	1,619,977
Asiatic Region	China	946	1,296,577,553	1,053,662	1,370,589
Western Europe	France	559	449,053,649	123,701	803,316
Asiatic Region	India	497	436,667,091	309,213	878,606
Western Europe	Italy	655	313,754,615	156,992	479,015
Asiatic Region	Japan	425	293,018,772	136,190	689,456
Latin America	Brazil	443	287,950,985	89,798	650,002
Eastern Europe	Russian Federation	567	271,983,706	107,514	479,689
Asiatic Region	South Korea	335	263,382,408	102,876	786,216
Western Europe	Spain	782	242,020,287	124,502	309,489
Western Europe	Ireland	74	211,418,524	21,566	2,857,007
Eastern Europe	Poland	571	209,353,195	58,631	366,643
Northern America	Canada	302	176,919,466	130,671	585,826
Pacific Region	New Zealand	115	165,283,879	18,618	1,437,251
Asiatic Region	Singapore	222	160,896,601	28,807	724,759
Middle East	Iran	320	133,929,595	74,304	418,530

Figure 8 presents a scatter plot comparing countries' scientific output with the estimated accumulated value of their scientific journals. Several patterns become more evident in this visualization, and new insights also emerge. Most European countries, with some important exceptions, such as the Scandinavian countries, are positioned above the regression line, indicating that their scientific journals hold greater accumulated value relative to their output. In contrast, most Asian, African, and Middle Eastern countries are positioned below the line, suggesting their publishing output is not as highly valued in comparison.

In Latin America, the situation is more mixed, with both patterns distinctly present, reflecting diverse conditions within the region. Overall, the figure reveals two clearly differentiated situations, likely due to long-standing differences in scientific traditions across these regions.

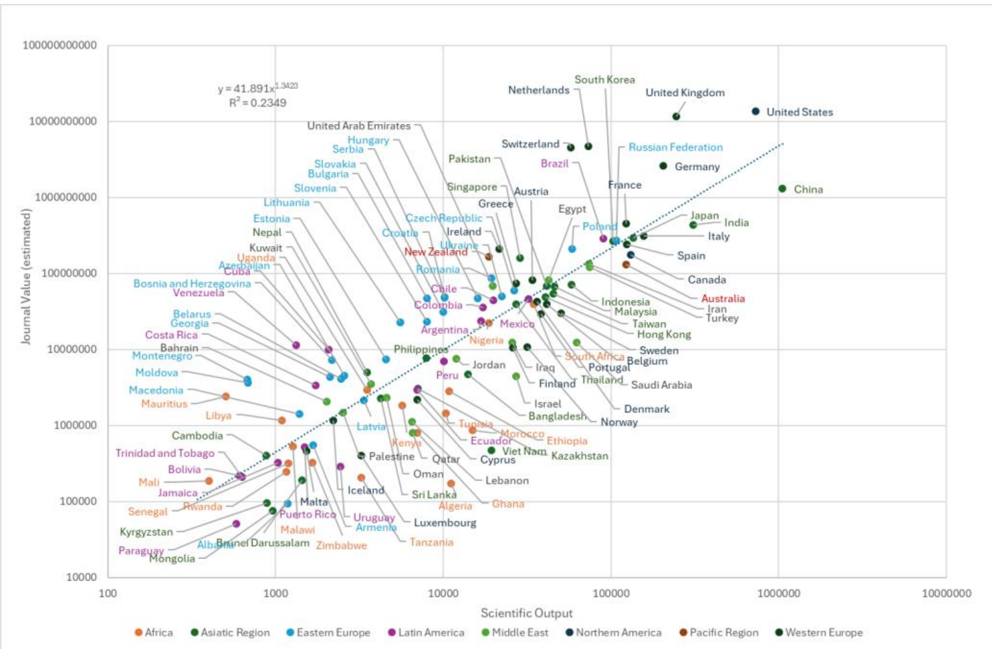

Figure 8: Scatter Plot of the Scientific Output Against the Estimated Accumulated Value of the Countries' Scientific Journals.

7. Discussion and Conclusions

The method proposed for estimating APCs offers a valuable tool for guiding decisions in the scientific publishing landscape, particularly when it comes to optimizing the use of limited resources. As the cost of Article Processing Charges (APCs) continues to rise, researchers, institutions, and funders are under increasing pressure to make financially responsible choices that maximize the impact of their publications. The ability to estimate APCs using a model based on journal metrics, such as the average SJR over the last five years, offers a practical approach to evaluating the value of journals, thereby assisting in both the planning and execution of research dissemination strategies.

The ability to estimate APCs using a model based on journal metrics, such as the average SJR over the last five years, offers a practical approach to evaluating the value of journals, thereby assisting in both the planning and execution of research dissemination strategies

APCs play a critical role not only in funding allocation but also in the management of grant applications. As noted by **Halevi and Walsh** (2021), in fields like biomedical science, researchers often divert large portions of their research funds toward APCs for high-cost, for-profit journals. This diversion can significantly reduce the amount of funding available for the research itself, potentially undermining the very purpose of public funding. In this context, having a reliable method for predicting APCs is essential, as it enables researchers to allocate their resources more efficiently, ensuring they get the most out of their publication investments.

By making more informed choices, researchers can better justify their spending decisions to funders, presenting a clear strategy for maximizing the dissemination and impact of their work.

Beyond individual researchers, the implications of APC estimation models extend to institutional decision-making, particularly for academic libraries and other entities involved in subscription and open-access agreements. Libraries invest significant resources in supporting open access, often through transformative agreements that allow their affiliated researchers to publish a set number of open-access articles. However, not all journals are equally effective as platforms for disseminating scientific knowledge, and not all are priced similarly. This variability underscores the importance of tools that can help libraries evaluate the journals they invest in, ensuring that their budget is spent on the most impactful and cost-effective outlets. Moreover, as transformative agreements become more common, there is increasing pressure on libraries to balance author requests with budgetary constraints. In many institutions, these requests are handled on a "first come, first serve" basis, a method that may not align with the institution's broader strategic goals.

The model we propose offers a way to move beyond this ad-hoc approach. By providing an evidence-based framework for evaluating the economic potential and dissemination effectiveness of journals, institutions can make more strategic decisions regarding which APCs to cover and how to prioritize author requests. This shift could result in a more equitable and efficient distribution of resources, benefiting both researchers and the broader scientific community.

Furthermore, the increasing dominance of open access in scientific publishing makes the need for such tools even more pressing. With more journals adopting open access models and the costs associated with APCs continuing to rise, there is a growing need to evaluate the economic and academic value of these journals. Our model, which leverages the average SJR over five years, offers a reliable indicator for assessing the potential value of a journal, particularly in relation to its cost.

In conclusion, the estimated APC model serves as a practical and effective tool for evaluating the economic and academic potential of scientific journals. Its utility spans multiple levels, from individual researchers managing grant funds to institutions navigating the complexities of subscription and open access agreements. As the academic publishing landscape continues to evolve, such models will become increasingly important in ensuring that the dissemination of scientific knowledge is both efficient and financially sustainable. By integrating this approach into their decision-making processes, stakeholders across the scientific community can better align their investments with their strategic goals, ultimately improving the impact and accessibility of research outputs.

Our model, which leverages the average SJR over five years, offers a reliable indicator for assessing the potential value of a journal, particularly in relation to its cost

8. Limitations

The model used for estimating the value of scientific journals is not without its limitations, largely due to the specific dataset and editorial practices it relies on. First, the dataset represents pricing strategies from a particular group of publishers, which means that commercial decisions specific to those groups may heavily influence the prices used in the model. These commercial strategies, which can vary significantly across different publishers and regions, could skew the accuracy and generalizability of the results. While we have identified some patterns related to corporate decisions, other unexplored patterns driven by similar factors may also exist, potentially affecting the reliability of our findings when applied to other publishing contexts.

Another limitation involves the model's exclusion of transformative agreements. These agreements, which combine traditional subscription-based access with open access provisions, are becoming increasingly prevalent in the scholarly publishing world. However, they are not factored into the model's calculations. The model is focused on estimating the potential value of publications based on APCs and journal output but does not account for the pricing flexibility and access options that transformative agreements introduce. As a result, the real-world impact of such agreements on APCs and journal value remains unexamined.

Additionally, the model that we propose does not differentiate between fully open access and hybrid journals —those that offer both subscription-based and open-access options. This distinction is an important factor in understanding APC structures, and should be taken into account when dealing with individual journals or while performing specialized studies.

In summary, while the model provides a useful framework for estimating the value of scientific journals, its applicability is constrained by its reliance on specific commercial datasets and the exclusion of transformative agreements. These limitations suggest the need for further research and refinement of the model to improve its accuracy and generalizability across the broader scientific publishing landscape.

References

Björk, Bo-Christer; Solomon, David. (2012). "Open access versus subscription journals: a comparison of scientific impact". *BMC Medicine,* v. 10, n. 1, pp. 73. *https://doi.org/10.1186/1741-7015-10-73*

Björk, Bo-Christer; Solomon, David. (2015). "Article processing charges in OA journals: relationship between price and quality". *Scientometrics,* v. 103, n. 2, pp. 373-385. *https://doi.org/10.1007/s11192-015-1556-z*

Borrego, Ángel. (2023). "Article processing charges for open access journal publishing: A review". *Learned Publishing,* v. 36, n. 3, pp. 359-378. *https://doi.org/10.1002/leap.1558*

De-Moya-Anegón, Félix. (2020). "Letter. Research evaluation entities cause a shift of publication to Q1 journals". *Profesional de la información,* v. 29, n. 4, pp. e290431. *https://doi.org/10.3145/epi.2020.jul.31*

Elsevier Pricing Policies. (2024). *https://www.elsevier.com/about/policies-and-standards/pricing*

Guerrero-Bote, Vicente P.; Moya-Anegón, Félix. (2012). "A further step forward in measuring journals' scientific prestige: The SJR2 indicator". *Journal of Informetrics,* v. 6, n. 4, pp. 674-688. *https://doi.org/10.1016/j.joi.2012.07.001*

Halevi, Gali; Walsh, Samantha. (2021). "Faculty Attitudes Towards Article Processing Charges for Open Access Articles". *Publishing Research Quarterly,* v. 37, n. 3, pp. 384-398. *https://doi.org/10.1007/s12109-021-09820-x*

Haustein, Stefanie; Schares, Eric; Alperin, Juan Pablo; Hare, Madelaine; Butler, Leigh-Ann; Schönfelder, Nina. (2024). "Estimating global article processing charges paid to six publishers for open access between 2019 and 2023". *arXiv preprint arXiv:2407.16551*. *https://doi.org/10.48550/arXiv.2407.16551*

Pinfield, Stephen; Salter, Jennifer; Bath, Peter A. (2016). "The "total cost of publication" in a hybrid open-access environment: Institutional approaches to funding journal article-processing charges in combination with subscriptions". *Journal of the Association for Information Science and Technology,* v. 67, n. 7, pp. 1751-1766. *https://doi.org/10.1002/asi.23446*

Rodrigues, Rosângela Schwarz; Abadal, Ernest; de Araújo, Breno Kricheldorf Hermes. (2020). "Open access publishers: The new players". *PloS One,* v. 15, n. 6, pp. e0233432. *https://doi.org/10.1371/journal.pone.0233432*

Rousseau, Sandra; Catalano, Giuseppe; Daraio, Cinzia. (2021). "Can we estimate a monetary value of scientific publications?". *Research Policy,* v. 50, n. 1, pp. 104116. *https://doi.org/10.1016/j.respol.2020.104116*

Schönfelder, Nina. (2020). "Article processing charges: Mirroring the citation impact or legacy of the subscription-based model?". *Quantitative Science Studies,* v. 1, n. 1, pp. 6-27. *https://doi.org/10.1162/qss_a_00015*

SCImago Journal & Country Rank (SJR). (n.d.). *https://www.scimagojr.com*

Suber, Peter. (2012). *Open Access*. The MIT Press. *https://doi.org/10.7551/mitpress/9286.001.0001*

Supplementary Material S1: Accumulated Estimated Values by Editors with Outputs Over 5.000 Papers in the 2019-2023 Period.

Main publisher	Journals	Output (5 years)	Accumulated Estimated Value	Average Estimated Value
Elsevier	2,523	2,962,229	10,198,931,943	4,042,383
Springer Nature	2,481	2,060,874	6,539,301,815	2,635,752
John Wiley & Sons	1,567	1,060,410	3,585,495,510	2,288,127
Multidisciplinary Digital Publishing Institute (MDPI)	237	1,038,215	3,274,506,567	13,816,483
Taylor & Francis	2,379	683,625	2,062,951,507	867,151
Frontiers Media SA	96	368,369	1,261,537,863	13,141,019
IEEE	207	340,057	1,213,057,435	5,860,181
Wolters Kluwer Health	458	320,507	1,036,209,990	2,262,467
SAGE	984	320,008	1,000,458,084	1,016,726
American Chemical Society	76	304,949	1,114,271,306	14,661,465
Oxford University Press	432	262,362	924,641,094	2,140,373
Royal Society of Chemistry	61	182,530	636,506,785	10,434,537
Hindawi	193	120,546	360,690,010	1,868,860
Institute of Physics Publishing	80	115,897	365,441,756	4,568,022
Cambridge University Press	374	100,994	313,803,160	839,046
American Physical Society	15	99,049	360,916,338	24,061,089
Science China Press	98	96,348	265,439,887	2,708,570
Public Library of Science	7	95,974	326,567,169	46,652,453
BMJ Publishing Group	63	94,836	331,204,917	5,257,221
Pleiades Publishing	161	92,010	244,380,412	1,517,891
Emerald Publishing	377	89,926	269,000,214	713,528
Walter de Gruyter	459	87,860	241,037,651	525,136
American Institute of Physics	26	69,858	224,649,719	8,640,374
Thieme	100	56,151	157,295,220	1,572,952
World Scientific	125	46,933	132,327,855	1,058,623
Chinese Medical Journals Publishing House Co Ltd	64	45,226	106,547,682	1,664,808
Dove Medical Press	57	39,969	128,620,536	2,256,501
Mary Ann Liebert	93	38,674	122,765,129	1,320,055
IOS Press	83	38,296	108,552,013	1,307,856
Bentham Science Publishers	140	36,332	101,501,853	725,013
American Medical Association	14	34,361	149,126,035	10,651,860
Optica Publishing Group	4	33,908	114,337,790	28,584,448
Inderscience Publishers	232	33,047	84,328,112	363,483
American Society for Microbiology	15	30,354	108,812,679	7,254,179
American Association for the Advancement of Science	17	28,912	140,617,041	8,271,591
Karger	101	27,515	85,240,946	843,970
Brill	413	27,239	67,466,084	163,356
American Astronomical Society	4	22,614	87,446,592	21,861,648
American Psychological Association	68	21,817	77,446,287	1,138,916
American Society of Civil Engineers	35	20,751	66,990,255	1,914,007
KeAi Communications Co	108	20,569	69,206,930	640,805
EDP Sciences	38	19,764	65,647,363	1,727,562
Association for Computing Machinery	64	19,759	66,067,639	1,032,307
National Academy of Sciences	1	19,597	85,827,932	85,827,932
Copernicus Publications	40	19,498	71,694,691	1,792,367
Magnolia Press	4	16,037	47,071,431	11,767,858
Trans Tech Publications Ltd	4	15,955	39,133,922	9,783,481
American Society of Mechanical Engineers	31	15,672	47,231,759	1,523,605
JMIR Publications Inc.	22	15,095	50,006,772	2,273,035
AME Publishing Company	39	14,979	44,775,130	1,148,080
Tech Science Press	17	13,537	38,370,901	2,257,112
Springer Publishing Company	33	13,393	38,435,617	1,164,716
Chinese Academy of Sciences	18	13,102	36,790,808	2,043,934
Johns Hopkins University Press	91	12,669	33,129,533	364,061
Spandidos Publications	7	12,553	39,775,008	5,682,144
Akademiai Kiado	46	12,371	34,351,024	746,761
Optica Publishing Group (formerly *OSA*)	10	12,138	40,548,246	4,054,825
American Association for Cancer Research Inc	8	12,095	51,174,909	6,396,864
PeerJ Inc	2	12,034	38,571,870	19,285,935
American Physiological Society	14	11,396	39,848,257	2,846,304
American Institute of Mathematical Sciences	26	11,277	34,146,204	1,313,316
Institute of Advanced Engineering and Science (IAES)	7	11,156	29,429,943	4,204,278
Acta Materialia Inc	3	9,837	38,090,238	12,696,746
Edizioni Minerva Medica	28	9,723	27,474,987	981,250
Media Sphera Publishing Group	24	9,574	22,599,504	941,646
American Meteorological Society	11	9,546	35,839,241	3,258,113
eLife Sciences Publications	1	9,492	42,485,838	42,485,838

Company of Biologists Ltd	5	9,033	33,395,248	6,679,050
CSIRO	25	8,995	26,641,264	1,065,651
American Society for Biochemistry and Molecular Biology Inc.	3	8,647	32,859,639	10,953,213
Pensoft Publishers	29	8,508	25,091,946	865,240
IWA Publishing	13	8,414	24,083,771	1,852,598
Ivyspring International Publisher	4	8,383	29,974,145	7,493,536
MA Healthcare Ltd	18	8,125	21,205,896	1,178,105
Society for Industrial and Applied Mathematics	17	8,099	28,911,877	1,700,699
The Royal Society	6	8,052	27,255,993	4,542,665
Tsinghua University Press	21	8,003	27,886,626	1,327,935
American Mathematical Society	18	7,946	25,595,611	1,421,978
SPIE	12	7,897	22,931,759	1,910,980
Termedia Publishing House Ltd.	24	7,755	21,962,025	915,084
IGI Global Publishing	76	7,636	19,879,013	261,566
International Society for Horticultural Science	1	7,609	18,182,860	18,182,860
Massachusetts Medical Society	2	7,472	43,637,808	21,818,904
American Phytopathological Society	4	7,370	23,411,139	5,852,785
Impact Journals	3	7,280	25,546,719	8,515,573
Duke University Press	53	7,145	19,751,640	372,672
OpenJournals Publishing AOSIS (Pty) Ltd.	32	6,921	18,731,803	585,369
Human Kinetics Publishers Inc	26	6,859	21,557,275	829,126
ICE Publishing Ltd	35	6,818	19,929,798	569,423
Institution of Chemical Engineers	3	6,796	22,515,607	7,505,202
National Research Council of Canada	13	6,779	20,396,858	1,568,989
Via Medica	19	6,730	18,359,740	966,302
University of Chicago Press	51	6,629	19,824,183	388,709
Royal Society Publishing	4	6,545	24,181,514	6,045,378
Higher Education Press	19	6,542	19,017,733	1,000,933
Techno Press	16	6,493	19,552,251	1,222,016
Deutscher Apotheker Verlag	2	6,420	14,203,131	7,101,565
Verduci Editore Srl	1	6,335	19,515,172	19,515,172
Slack, Inc	13	6,323	18,389,744	1,414,596
American Institute of Aeronautics and Astronautics	9	6,288	19,970,293	2,218,921
American Academy of Pediatrics	4	6,215	22,258,998	5,564,750
Microbiology Society	6	6,203	20,757,842	3,459,640
International Scientific Information, Inc	4	6,198	17,713,506	4,428,377
IEEE Industrial Electronics Society	1	6,188	25,353,699	25,353,699
John Benjamins Publishing Company	89	6,134	16,092,932	180,819
American Thoracic Society	4	6,115	25,969,759	6,492,440
Begell House	34	6,100	16,348,829	480,848
Scientific Scholar	10	6,059	16,463,221	1,646,322
Portland Press Ltd	8	6,051	20,659,568	2,582,446
MIT Press	33	6,008	19,051,786	577,327
Science and Information Organization	1	5,993	15,261,566	15,261,566
Endocrine Society	3	5,988	21,992,075	7,330,692
International Institute of Anticancer Research	3	5,986	18,193,719	6,064,573
American Association of Neurological Surgeons	6	5,933	20,284,715	3,380,786
Wichtig Publishing Srl	8	5,910	17,406,118	2,175,765
INFORMS Institute for Operations Research and the Management Sciences	14	5,890	24,952,582	1,782,327
Tsinghua University	5	5,807	16,250,453	3,250,091
MyJoVE Corporation	1	5,754	16,947,466	16,947,466
Jaypee Brothers Medical Publishers (P) Ltd	13	5,723	14,619,840	1,124,603
Annual Reviews Inc	50	5,712	25,795,537	515,911
Intellect Publishers	80	5,694	13,538,605	169,233
Brieflands	21	5,679	14,598,232	695,154
European Respiratory Society	5	5,567	21,122,512	4,224,502
American Society for Clinical Investigation	2	5,561	24,329,311	12,164,655
Chinese Optical Society	3	5,454	14,286,847	4,762,282
Indian Academy of Sciences	4	5,437	14,646,167	3,661,542
AIMS Press	7	5,404	15,463,365	2,209,052
Society for Neuroscience	2	5,364	21,035,651	10,517,826
Tehran University of Medical Sciences	29	5,355	13,620,828	469,684
American Heart Association Inc	1	5,190	20,087,797	20,087,797
University of Chicago	30	5,182	17,627,435	587,581
Materials China	3	5,166	13,487,863	4,495,954
Chinese Society of Agricultural Engineering	2	5,155	14,894,510	7,447,255
Association for Research in Vision and Ophthalmology Inc	3	5,148	17,837,698	5,945,899
Russian Academy of Sciences	20	5,148	12,722,470	636,123
Universidad Nacional de Colombia	29	5,044	12,239,602	422,055

Supplementary Material S2: Accumulated Estimated Values by Region and Country.

Region	Country	Journals	Accumulated estimated value	Output	Average estimated value
Africa	Algeria	1	174026	11112	174026.27
Africa	Ethiopia	8	2806540	10825	350817.50
Africa	Ghana	4	804892	7002	201223.04
Africa	Kenya	7	1833006	5688	261857.99
Africa	Libya	1	1169578	1087	1169577.88
Africa	Malawi	1	532951	1274	532951.49
Africa	Mali	1	188257	402	188256.75
Africa	Mauritius	2	2407913	507	1203956.32
Africa	Morocco	3	866128	14893	288709.44
Africa	Nigeria	23	22304129	18763	969744.72
Africa	Rwanda	1	244090	1165	244090.32
Africa	Senegal	2	317329	1190	158664.43
Africa	South Africa	110	39190330	34686	356275.73
Africa	Tanzania	2	205331	3231	102665.57
Africa	Tunisia	2	1433997	10394	716998.43
Africa	Uganda	1	2933990	3515	2933989.64
Africa	Zimbabwe	2	326475	1653	163237.34
Asiatic Region	Bangladesh	11	4681168	14042	425560.77
Asiatic Region	Brunei Darussalam	2	190980	1435	95489.90
Asiatic Region	Cambodia	1	406485	878	406484.85
Asiatic Region	China	946	1296577553	1053662	1370589.38
Asiatic Region	Hong Kong	42	49123595	40524	1169609.41
Asiatic Region	India	497	436667091	309213	878605.82
Asiatic Region	Indonesia	168	70986826	58256	422540.63
Asiatic Region	Japan	425	293018772	136190	689455.93
Asiatic Region	Kazakhstan	10	3074947	7090	307494.69
Asiatic Region	Kyrgyzstan	1	96013	884	96012.85
Asiatic Region	Malaysia	118	67698747	46004	573718.20
Asiatic Region	Mongolia	2	76086	964	38043.17
Asiatic Region	Nepal	6	4948993	3521	824832.20
Asiatic Region	Pakistan	80	68958860	41519	861985.75
Asiatic Region	Philippines	27	7635361	7950	282791.15
Asiatic Region	Singapore	222	160896601	28807	724759.46
Asiatic Region	South Korea	335	263382408	102876	786216.14
Asiatic Region	Sri Lanka	9	2293980	4224	254886.67
Asiatic Region	Taiwan	106	54163878	45174	510979.99
Asiatic Region	Tajikistan	1		344	0.00
Asiatic Region	Thailand	76	39182897	27113	515564.44
Asiatic Region	Viet Nam	2	471877	19355	235938.55
Eastern Europe	Albania	2	93959	1180	46979.39
Eastern Europe	Armenia	2	553451	1676	276725.55
Eastern Europe	Azerbaijan	15	4486397	2568	299093.10
Eastern Europe	Belarus	16	4128934	2459	258058.40
Eastern Europe	Bosnia and Herzegovina	21	7249840	2166	345230.48
Eastern Europe	Bulgaria	81	47504649	8008	586477.15
Eastern Europe	Croatia	163	48984343	10154	300517.44
Eastern Europe	Czech Republic	231	59976575	26437	259638.85
Eastern Europe	Estonia	35	7451890	4543	212911.15
Eastern Europe	Georgia	7	4334077	2109	619153.90
Eastern Europe	Hungary	106	47353734	16084	446733.34
Eastern Europe	Latvia	16	2155107	3367	134694.20
Eastern Europe	Lithuania	76	22656781	5569	298115.53
Eastern Europe	Macedonia	8	1430048	1393	178755.94
Eastern Europe	Moldova	11	3662507	687	332955.14
Eastern Europe	Montenegro	7	4000802	682	571543.13
Eastern Europe	Poland	571	209353195	58631	366643.07
Eastern Europe	Romania	211	86649467	19445	410660.98
Eastern Europe	Russian Federation	567	271983706	107514	479689.08
Eastern Europe	Serbia	100	47796533	10221	477965.33
Eastern Europe	Slovakia	82	30873296	10041	376503.61
Eastern Europe	Slovenia	91	23382100	8004	256946.16
Eastern Europe	Ukraine	127	50022601	22448	393878.75
Latin America	Argentina	88	23532704	16775	267417.09
Latin America	Bolivia	1	217884	608	217884.46
Latin America	Brazil	443	287950985	89798	650002.22
Latin America	Chile	130	44409905	19833	341614.65
Latin America	Colombia	150	35851224	17309	239008.16
Latin America	Costa Rica	13	3359755	1736	258442.72

Latin America	Cuba	26	10033257	2082	385894.52
Latin America	Ecuador	8	2935164	7025	366895.55
Latin America	Jamaica	2	326459	1033	163229.38
Latin America	Mexico	124	46095528	32245	371738.13
Latin America	Paraguay	1	50559	584	50559.20
Latin America	Peru	24	7007378	10060	291974.07
Latin America	Puerto Rico	2	521172	1496	260586.17
Latin America	Trinidad and Tobago	1	210347	630	210347.06
Latin America	Uruguay	4	287512	2434	71877.89
Latin America	Venezuela	28	11484190	1330	410149.63
Middle East	Bahrain	2	2062407	2018	1031203.64
Middle East	Egypt	93	82341683	42639	885394.44
Middle East	Iran	320	133929595	74304	418529.98
Middle East	Iraq	21	12337623	25871	587505.86
Middle East	Israel	17	4470009	27231	262941.68
Middle East	Jordan	18	7493584	11941	416310.23
Middle East	Kuwait	4	3493462	3696	873365.44
Middle East	Lebanon	7	1122889	6529	160412.68
Middle East	Oman	2	2317245	4608	1158622.71
Middle East	Palestine	4	1474580	2532	368644.98
Middle East	Qatar	3	804325	6544	268108.45
Middle East	Saudi Arabia	15	12365162	62751	824344.15
Middle East	Turkey	279	120837299	74748	433108.60
Middle East	United Arab Emirates	107	67811570	19744	633752.99
Northern America	Canada	302	176919466	130671	585826.05
Northern America	United States	6,936	13545664356	729585	1952950.45
Pacific Region	Australia	220	131837982	123585	599263.55
Pacific Region	New Zealand	115	165283879	18618	1437251.12
Western Europe	Austria	90	81277897	34075	903087.75
Western Europe	Belgium	149	39089359	41362	262344.69
Western Europe	Cyprus	8	2204685	7024	275585.69
Western Europe	Denmark	60	42571334	36312	709522.24
Western Europe	Finland	45	10501017	25954	233355.94
Western Europe	France	559	449053649	123701	803316.01
Western Europe	Germany	1,595	2583863655	205505	1619977.21
Western Europe	Greece	77	74651018	27132	969493.74
Western Europe	Iceland	4	1170339	2215	292584.69
Western Europe	Ireland	74	211418524	21566	2857007.07
Western Europe	Italy	655	313754615	156992	479014.68
Western Europe	Luxembourg	3	400925	3234	133641.73
Western Europe	Malta	4	462452	1528	115613.06
Western Europe	Netherlands	2,154	4728942794	73617	2195423.77
Western Europe	Norway	39	10778509	31630	276372.02
Western Europe	Portugal	93	29149439	38219	313434.83
Western Europe	Spain	782	242020287	124502	309488.86
Western Europe	Sweden	50	29842793	50264	596855.86
Western Europe	Switzerland	876	4563277483	57482	5209220.87
Western Europe	United Kingdom	6,534	11697557386	244718	1790259.78