



SOCIAL SCIENCES

Open Access Publications with Article Processing Charge (APC) Payment: a Brazilian Scenario Analysis

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Abstract: The expansion of open access publications has been correlated with specific government policies in many countries. The evolution in these cases is understandable within the framework of funding regulations. However, this is not the case for Brazil, where no regulation is currently in place. The unusually high percentage of open access publications in the Brazilian scientific community is analyzed here toward understanding which factors influence this growth and how similar effects may also impact other countries, particularly developing nations. We found that from 2012 to 2019 the Brazilian scientific community drifted to international open access journals. This transition is discussed in the framework of mega journals.

Key words: open access, article processing charge, Brazil, mega journals.

INTRODUCTION

The increase in subscription fees of scientific journals and cuts in the budgets of libraries reinforced the need to procure new methods of ensuring access to scientific outputs (Suber 2012).

Due to the resistance of commercial publishers – one of the most powerful interest groups in the scientific publications sphere –, boycotts were imposed by proponents of the change who advocated Open Access (OA) as a solution to scientific information access inequality (Epstein 2012). It is in this scenario as a response to the high prices paid by the libraries (Mann et al. 2009) that the OA movement arises for optimizing public access to information and eliminating the monopoly of these commercial publishers concerning the flow of information (Kamila & Biswas 2011).

The OA model was a revolution which provided a more democratic voice to the academic world, representing an initiative to offer free and immediate online access to academic literature (Gul et al. 2019). Thus, according to the Budapest Open Access Initiative, OA consists in free availability of the full texts of these articles on the public internet, permitting any users to read, download, copy, distribute, print, search, or link them as well as crawling them for indexing, passing them as data for software, or use them for any other lawful purpose without financial, legal, or technical barriers other than those inherent in gaining access to the internet itself (Budapest 2002). The original idea gathered support from a number of funding agencies, which then created policies requiring OA for publications generated from research funded by them.

The different variations of OA, which we specify in the next section, include immediate and delayed access, access just to read versus access with extensive reuse rights. Besides, OA may be provided with no charges to the authors and their institutions, or publishing charges can be levied to fund the publication. The abbreviation for such charges is APC, which can be interpreted as an article processing charge (Björk 2017).

The publishing companies responded to this movement by creating a number of complementary solutions. The publication by Björk and Solomon (Björk & Solomon 2014) identifies that the main publishers of subscription journals are entering the OA market in four ways: offering a hybrid option (articles are made openly available in a traditional journal, against the payment of an APC) for their subscription journals, creating new OA journals (often in partnership with societies), acquiring existing OA publishers, and completely converting subscription journals to OA. One of the issues of the hybrid journals are the double-dipping by collecting hybrid fees without adjusting their subscription fees for the articles (Björk & Solomon 2014). In practice, major publishers such as Elsevier, Sage, Wiley, Emerald Insight, Taylor and Francis, and others have introduced several OA platforms that have been clearly accepted by authors as well as reader communities given the sheer number of OA journals they offer (Gul et al. 2019). These big publishers are in the forefront of demanding APCs for OA publication journals (Shah & Gul 2013).

In addition of adapting traditional journals to include specifically OA papers, the publishing sector responded to the OA initiative creating new, exclusively OA journals. It is important to highlight the creation of mega journals within this category. This is a typology that describes

journals characterized by covering a wide array of disciplines (science, technology, medicine) through publishing an amassment of articles (more than 20 thousand annually), presenting low levels of rejection, and collecting processing charges (Caballero-Rivero et al. 2019). This type of journal has become the fastest growing segment of the OA journals market financed with APCs (Björk & Solomon 2014).

While some have identified mega journals with predatory behavior, this novel publication option offers new dissemination opportunities to academics, a broader ecology of scientific publishing by connecting different fields, and more opportunities for publications from developing countries (Siler et al. 2020). Consequently, it is not surprising that nearly half of the journals are American and British, but the new phenomenon is that most of their articles on the OA journals are from authors affiliated with institutions in peripheral countries (Huang et al. 2020). Although this is a global discussion, these findings nevertheless underscore the supremacy of consolidated journals published in central countries Rodrigues et al. (2020a), Vuong et al. (2020).

The Open Access movement has created a very diverse publication system. Researchers have identified some sub-types of OA (Piwowar et al. 2018), and we will detail those most commonly cited in the literature in the present study, which are: Gold open access, Green open access, and Hybrid open access. In Gold open access, articles are published in an OA journal, in which all articles are opened directly on its website. In practice, OA journals are most commonly defined by their inclusion in the Directory of Open Access Journals (DOAJ) (Archambault et al. 2014). Green OA refers to the self-archiving of a work by its author; be it a manuscript, a preprint version of a manuscript accepted for publication in

a scientific journal, or the published article itself. Good examples of such repositories are ArXiv, which began with physics but has since expanded its scope to cover a variety of research topics, and PubMedCentral, for biomedical and biological science research (Laakso et al. 2011).

Many of the traditional non-OA journals have adopted the hybrid OA format, through which articles are published in a subscription basis but are immediately free to read under an open license in exchange for an APC paid by the authors (Laakso & Björk 2013). The hybrid model was a response from commercial publishers which published journals consolidated in the market to the increase of OA journals. In both these models, APCs are imposed (Budzinski et al. 2020) for publishing articles. According to Pavan and Barbosa (Pavan & Barbosa 2018), the idea behind this hybrid system is to maintain the subscription model while attracting publications by authors from countries requiring OA.

According to Laakso & Björk (2012), the APC market is rapidly evolving and growing around 30% per year without quality loss from publications. The number of articles published by a sample composed exclusively of OA journals grew by 55% between 2010 and 2012, a growth which again did not correlate to any impact on quality. Archambault et al (Archambault et al. 2014) found that the increase in citations of articles published between 1996 and 2011 was 40.3% for OA papers and 27% for non-OA papers. The same study shows an exponential growth of Gold OA articles until 2012 with a growth rate of 24% per year, signifying a two-fold increase of published Gold OA articles every 3.2 years. With greater reading accessibility, OA also increases the citability of academic articles (Gul et al. 2019). The shift from closed to OA also has not negatively impacted citation patterns, indicating again a positive reception from the community (Bautista-Puig

et al. 2020). The analysis of dynamics from different OA formats also demonstrates that publisher-mediated (gold) OA is popular in Latin American and African universities, whereas its growth in Europe and North America has mostly been driven by repositories (Huang et al. 2020).

Considering the cost reduction of the digital era, together with the emergence of new Gold OA journals, there has been an increase in competitive pressure among publishers. This would presumably entail lower APC costs for OA publications; however, this has not yet been observed. In fact, hybrid journals may even possibly increase them, which vary substantially between different types of OA with a quite obscure pricing structure (Budzinski et al. 2020).

Although the publishing process has become less complicated and more efficient, subscription prices have not dropped; indeed, the exact opposite has occurred in recent years (Budzinski et al. 2020). Collins (Collins 2005) indicates that publishers are particularly reluctant to adopt new models as OA on their traditional publications and prefer to perpetuate the status quo, adopting such models only for novel journals. Consequently, their OA pricing strategies can be altered toward making this option unattractive to authors, delaying this change to prolong a perception of inevitability. These data were corroborated by Budzinski et al (Budzinski et al. 2020), who found that large publishers and hybrid journals have greater APCs.

While the original idea behind OA was making scientific discoveries available to everyone, the market response was to shift costs to the authors with a steady APC increase. In this case, it would be natural that the United States and European countries, where OA policies are already in place, would be the leaders in this type of publication. However, Shah and Gul (Shah & Gul 2013) demonstrated that, altogether with the

United States and Spain, Brazil leads the number of OA publications as well as journals.

Caballero-Rivero et al. (2019) indicated that 39% of the Brazilian production within the Web of Science (WoS) in the 2015-2018 period was in OA. Furthermore, the study by Minnitti et al. (2018) finds a significant growth in OA production indexed by the WoS especially between 2014 and 2016 regarding Latin America and Caribbean. Brazil was in the lead with its scientific output, representing 69.7% of the total documents in the region in absolute numbers.

The presence of Brazil in the list of countries leading OA publication (Wang et al. 2018, Robinson-Garcia et al. 2018) is quite surprising, since the country does not have a consolidated OA policy for its researchers (Pavan & Barbosa 2018). The active contribution within the Brazilian community can be partially attributed to its proactive OA initiatives driven by policies and interested researchers. Both the Instituto de Informação em Ciência e Tecnologia (IBICT) and the Scientific Electronic Library Online (SciELO) have been involved with the movement, leading most initiatives within the country (Meneghini et al. 2006, Costa & Leite 2008). Proof of this is that Brazilian universities present a higher average percentage of Gold OA than Green OA, as the only country where this happens (Robinson-Garcia et al. 2018). The country is a paradigmatic case, undoubtedly representing the result of a long-term OA policy and commitment to the national promotion of OA journals via the Scielo program (Meneghini et al. 2006). Recently, the type of OA journals and the amount expended in APCs have drawn the attention of the Brazilian scientific community (Costa et al. 2020, Rodrigues et al. 2020b, Pavan & Barbosa 2018). Here we explore the trend behind this increase of OA publication by Brazilian authors.

Considering the leading role played by Brazil in the number of OA publications (Archambault et al. 2014, Pavan & Barbosa 2018), as well as the indication that mega journals are a new path for international publications, this article aims to analyze the Brazilian scenario regarding OA to verify variations in the amount spent on APCs in the 2012-2019 period, what percentage of these publications are in mega journals, and how their use has evolved in Brazil.

The remaining sections of the paper goes as follows: the methods employed in this work are specified in the Materials and Methods section, while in the next section the results are presented, followed by the conclusions.

MATERIALS AND METHODS

We employed the Science Citation Index Expanded, Social Science Citation Index and Arts and Humanities Citation Index of the Web of Science Core Collection (WoS). The search was performed from May 1st to July 2nd, 2020. It included documents published as OA with Brazil as their address covering the 2012-2019 period. We selected only articles, reviews, and letters because they represent the most common types of documents published in OA and DOAJ Gold.

In order to assess the total amount spent in APCs, the journals charging for publications were separated by the Gold DOAJ option. The APC costs were obtained from the DOAJ. Articles published in hybrid OA journals which charge for publication were not included due to the fact that WoS identifies the status of the journal as a whole, but not of individual articles. Thus, the results obtained in other format of OA publications (bronze, published or accepted green) were not considered in this work.

After creating this database, the following steps were performed: first, the APC for each journal was collected from DOAJ. When its value

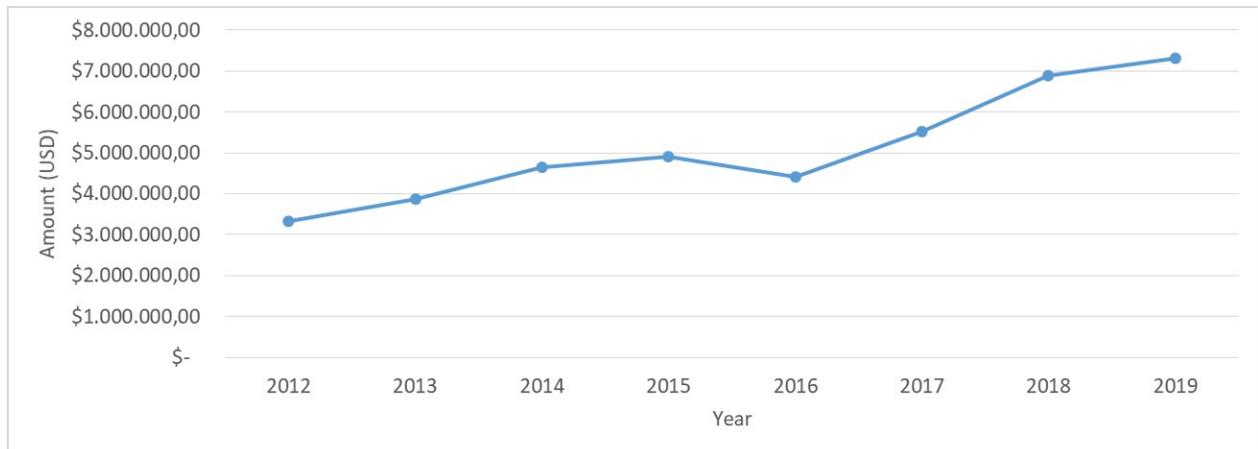


Figure 1. Evolution of the amounts spent on APCs in the 2012-2019 period. (Source: the authors).

was not available, it was considered to be zero. Submission fees were not considered. From the inquiry, we found that APCs are applied in the following currencies in the studied sample: USD, BRL, GBP, CHF and EUR. To unify the results, all currencies found were converted into US dollars at the exchange rate of April 30, 2020 as shown in Table I.

Table I. Conversion rate to dollars on 04/30/2020 (<https://cux.com/pt/eur-usd>).

Currency	Conversion Rate in Dollars
BRL	0.18
GBP	1.25
CHF	1.04
EUR	1.10

We employ the 2019 APC value of each journal in most of our analysis even though some journals changed their prices to correct for inflation. In the case of journals with APCs, the publications were separated into commercial and non-profit publishers. Publications from non-profit publishers from Brazilian and non-Brazilian organizations were considered separately.

RESULTS

We found that the number of articles published in Brazil in the Gold DOAJ format in the 2012-2019 period was 85,130. For that same period, Brazilian authors and research funders spent more than forty million dollars on APCs: U\$ 40,926,177.05. Figure 1 illustrates the evolution of the amounts spent with APCs. Value increases over the years except for 2016, where an approximately 10% decrease can be understood due to instabilities within the country. The steady increase from U\$ 3,336,486.90 in 2012 to U\$ 7,319,121.40 in 2019 represents 119%.

The growth in the total value expended with APCs in Brazil is consistent with the worldwide trends computed by Björk and Solomon (Björk & Solomon 2014), showing an increase from 2000 to 2011. The overall APC revenue worldwide was estimated to be approximately U\$182,000,000.00 in 2012, growing roughly 34% per year. This increase observed in Brazil is also observable in other countries, including the UK (Tickell et al. 2017).

Figure 2 illustrates the evolution of the average APC cost by the journals where Brazilian scientists published from 2012 to 2019. For the calculation, we added the APC cost of

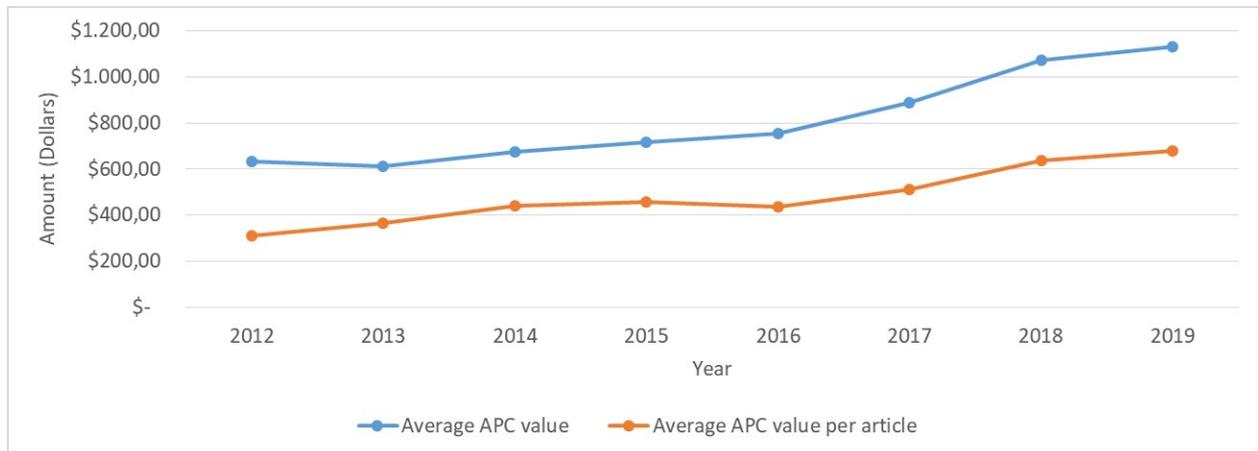


Figure 2. Average APC cost from journals and average amount spent on APCs per article in the 2012-2019 period. (Source: the authors).

any journal with at least one publication from Brazilian authors that year and divided by the total number of journals with Brazilian publications. In 2012, the average journal APC was U\$ 631.39. That amount became U\$ 1,131.35 in 2019, exhibiting a 79% increase. Our study maintained constant APCs for the same journals, therefore Figure 2 actually exhibits a drift of Brazilian authors to more expensive journals.

In order to evaluate the size of this change to more expensive journals, Figure 2 also shows the average APC cost per article obtained by dividing the total value expended with APCs by the total number of articles. We found that the average value of APC per article corresponded to U\$ 312.38 in 2012, and in 2019 this amounted to U\$ 677.32, representing a variation of 117%. This result, together with the average journal APC cost, indicates a real tendency to publish in more expensive journals and in a significant amount.

This evolution of total APC spending per article indicates a migration to higher APC value journals. In order to understand how this growth took place, we analyzed the profile of the publications in OA journals, separating it into two groups: articles published in journals from commercial and from non-profit publishers.

We considered as commercial publishers editorial and business groups as shown in Table II. In the case of non-profit publishers, we considered scientific societies, universities, colleges, associations, foundations, councils, research institutions, and others linked to the government or non-profit research agencies. These were furthermore divided into national publishers, as listed in Table III and Table IV, and international non-profit publishers, shown in Table V.

Figure 3 compares the total APC spending with articles published in journals from commercial and non-profit editorial groups from 2012 to 2019. From the U\$ 40,926,177.05 APC spending at the 2012–2019 period, U\$ 30,483,420.25 was paid to commercial publishers, that is, approximately 74% of the total amount. In contrast, APC spending on publications in non-profit organizations was U\$ 10,442,756.80. During the studied period, there was a 282% increase in the amount spent on APCs from commercial publishers. For non-profit publishers, there was a decrease of 42% regarding the initial value.

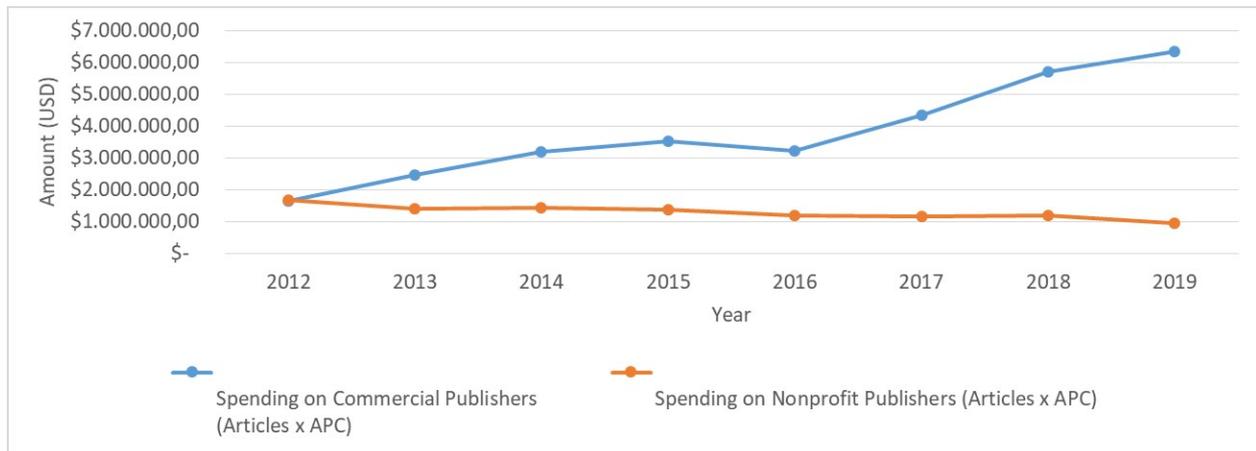


Figure 3. Total amounts spent on APCs from commercial Publishers and non-profit publishers in the 2012-2019 period. (Source: the authors).

Table II. Commercial publishers considered in the survey. (Web of Science 2012-2019).

Commercial publishers
Arán Ediciones, S. L.
BMC
BMJ Publishing Group
Elsevier
Frontiers Media S.A.
Hindawi Limited
IEEE
MDPI AG
Nature Publishing Group
PeerJ Inc.
Pensoft Publishers Public Library of Science (PLoS)
Sciendo
SpringerOpen
Wolters Kluwer

The comparison between the total amount spent on non-profit and for-profit publishers exhibits a considerable increase regarding publications from commercial publishers. To understand how this occurred, we examined the average APC of the journals in which there was

at least one publication by Brazilian authors and the average value of APC per article from 2012 to 2019, separating between commercial and non-profit publishing organizations.

Figure 4 presents the average APC cost by commercial publisher journals following these criteria. The APC profile from journals increased 50% between 2012 and 2019. However, this graph only indicates that at least one article was published in journals charging higher APCs. In order to understand if this shift is general, we also analyzed the average APC per article.

Figure 4 also shows the average amount paid on APCs and APC cost per article from Brazilian authors published by commercial publishers in the period, exhibiting a smooth and continuous increase. This increase indicates that the tendency toward journals with higher APCs is a global phenomenon and has not occurred only for specific cases.

We performed the same analysis for non-profit organizations. Figure 5 illustrates the average APC of non-profit organization journals with at least one Brazilian-authored paper published, presenting a smooth decrease of 23% over the years. Similarly, we observed a decline

Table III. National non-profit publishers considered in the survey. (Web of Science 2012-2019).

National non-profit publishers
Academia Brasileira de Ciências
Academia Brasileira de Neurologia (ABNEURO)
Associação Brasileira de Divulgação Científica
Associação Brasileira de Eng. Sanitária e Ambiental
Associação Brasileira de Metalurgia e Materiais (ABM)
Associação Brasileira de Cerâmica (ABC)
Associação Brasileira de Polímeros (ABPol)
Associação Brasileira de Olericultura
Associação Brasileira de Pós-Grad. em Saúde Coletiva
Associação Brasileira de Psiquiatria (ABP)
Associação Brasileira de Soldagem
Associação Brasileira de Tecnologia de Sementes
Associação Médica Brasileira
Associação Paulista de Medicina
Associação Universitária de Pesquisa em Psicopatologia Fundamental
Brazilian Society of Chemical Engineering
Brazilian Society of Endocrinology and Metabolism
Brazilian Society of Plant Breeding
Colégio Brasileiro de Parasitologia Veterinária
Colégio Brasileiro de Patologia Animal (CBPA)
Conselho Brasileiro de Oftalmologia
Eduem (Editora da Universidade Estadual de Maringá)
Embrapa Informação Tecnológica
Fundação APINCO de Ciência e Tecnologia Avícolas
Fundação de Amparo à Pesquisa do Estado de SP
Fundação Getulio Vargas
Fundação Oswaldo Cruz, Casa de Oswaldo Cruz
Fundação Zoobotânica do Rio Grande do Sul
Instituto Agrônomo de Campinas
Instituto de Pesca
Instituto de Tecnologia do Paraná (Tecpar)
Instituto Internacional de Ecologia
Instituto Nacional de Pesquisas da Amazônia
Instituto Oswaldo Cruz, Ministério da Saúde
Pontifícia Universidade Católica de Campinas

Table IV. National non-profit publishers considered in the survey. (Web of Science 2012-2019).

National non-profit publishers
Sociedade Botânica do Brasil
Sociedade Brasileira da Ciência das Plantas Daninhas
Sociedade Brasileira de Anestesiologia
Sociedade Brasileira de Cardiologia (SBC)
Sociedade Brasileira de Ciência do Solo
Sociedade Brasileira de Ciência e Tec. de Alimentos
Sociedade Brasileira de Cirurgia Cardiovascular
Sociedade Brasileira de Dermatologia
Sociedade Brasileira de Engenharia Agrícola
Sociedade Brasileira de Entomologia
Sociedade Brasileira de Física
Sociedade Brasileira de Fruticultura
Sociedade Brasileira de Genética
Sociedade Brasileira de Geologia
Sociedade Brasileira de Ictiologia
Sociedade Brasileira de Medicina do Esporte
Sociedade Brasileira de Medicina Tropical (SBMT)
Sociedade Brasileira de Microbiologia
Sociedade Brasileira de Oftalmologia
Sociedade Brasileira de Ortopedia e Traumatologia
Sociedade Brasileira de Pesquisa Odontológica
Sociedade Brasileira de Pneumologia e Tisiologia
Sociedade Brasileira de Química
Sociedade Brasileira de Reumatologia
Sociedade Brasileira de Urologia
Sociedade Brasileira para o Desenvolvimento da Pesquisa em Cirurgia
Sociedade de Investigações Florestais
Universidade Estadual de Londrina
Universidade Estadual de Maringá
Universidade Estadual Paulista
Universidade Federal de Campina Grande
Universidade Federal de Lavras
Universidade Federal de Minas Gerais
Universidade Federal de Santa Catarina
Universidade Federal de Santa Maria
Universidade Federal de São Paulo
Universidade Federal do Ceará
Universidade Federal do Rio de Janeiro
Universidade Federal Rural de Pernambuco
Universidade Federal Rural do Semi-Árido
Universidade de São Paulo

Table V. International non-profit publishers considered in the survey. (Web of Science 2012-2019).

International non-profit publishers
American Chemical Society
Escuela de Ciencias del Mar, PUC-Valparaíso
Florida Entomological Society
Optical Society of America (OSA)
Pan American Health Organization
The Royal Society of Chemistry

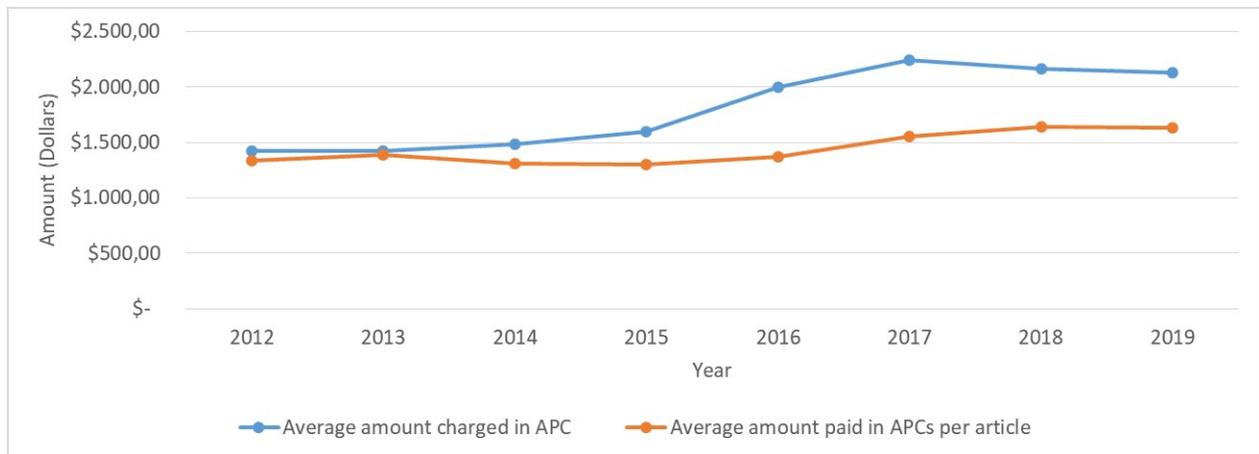


Figure 4. Average APC cost amount and average APC amount paid per article from journals maintained by commercial publishers in the 2012-2019 period (Source: the authors).

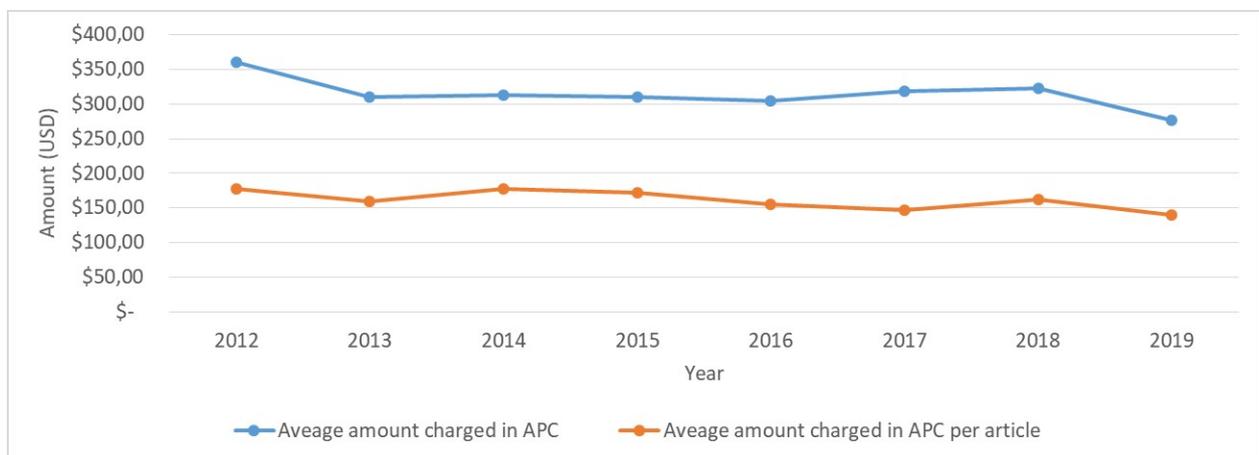


Figure 5. Average APC cost amount and average APC paid amount per article from journals maintained by non-profit entities in the 2012-2019 period. (Source: the authors).

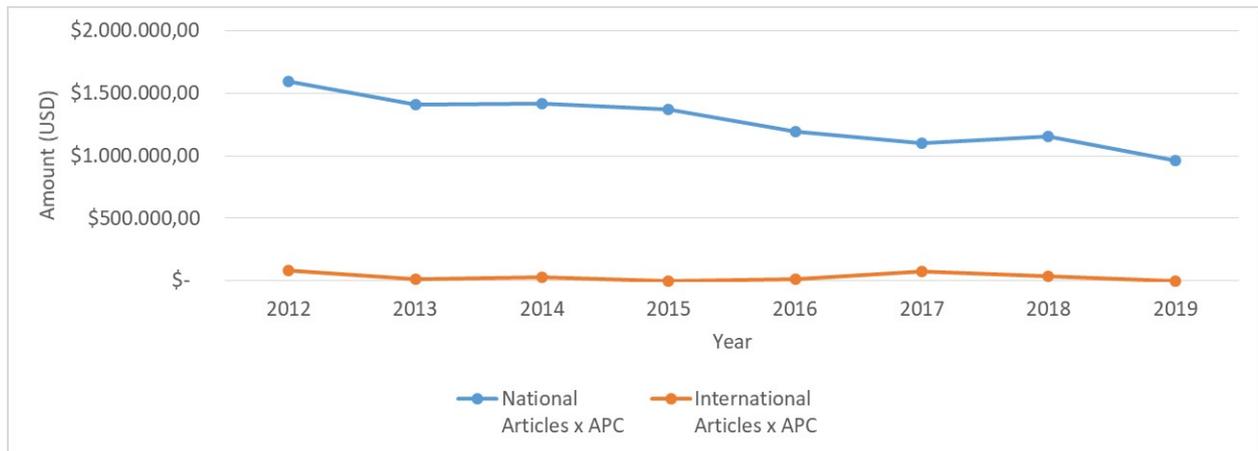


Figure 6. Total spending on publication APCs in journals maintained by national and international non-profit publishers. (Source: the authors).

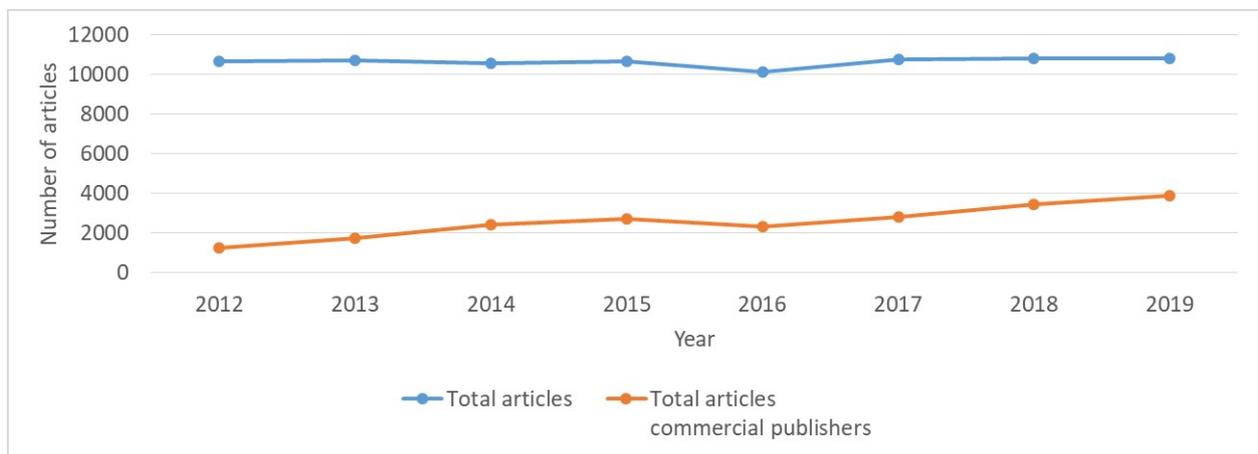


Figure 7. Total number of articles published from 2012 to 2019 (Web of Science 2012-2019) and total number of articles published from journals maintained by commercial publisher in the same period. (Source: the authors).

of 21% in the average APC per article regarding their initial value, as also visible in Figure 5.

Next, we analyzed if this drift from publishing in journals from non-profit organizations to commercial publishers correlates with the internationalization of Brazilian science. We observed that there is no Brazilian publisher within the list of commercial companies listed in Table II.

To understand the scenario of non-profit entities, we divided them between national and international organizations. Figure 6 shows the total value spent on APCs in journals published

by non-profit national and international organizations. We found that when looking only to non-profit organizations most of the amounts of APC costs were linked to national institutions amassing U\$ 10,205,701.8 over 2012 to 2019, while total APCs paid to international institutions was U\$ 237,055.00 in the same period.

This endogenous behavior of publishing most of the Brazilian scientific output in local journals of national impact is not surprising, and has already been observed in previous studies (Pavan & Barbosa 2018). This same characteristic is also found in other emerging

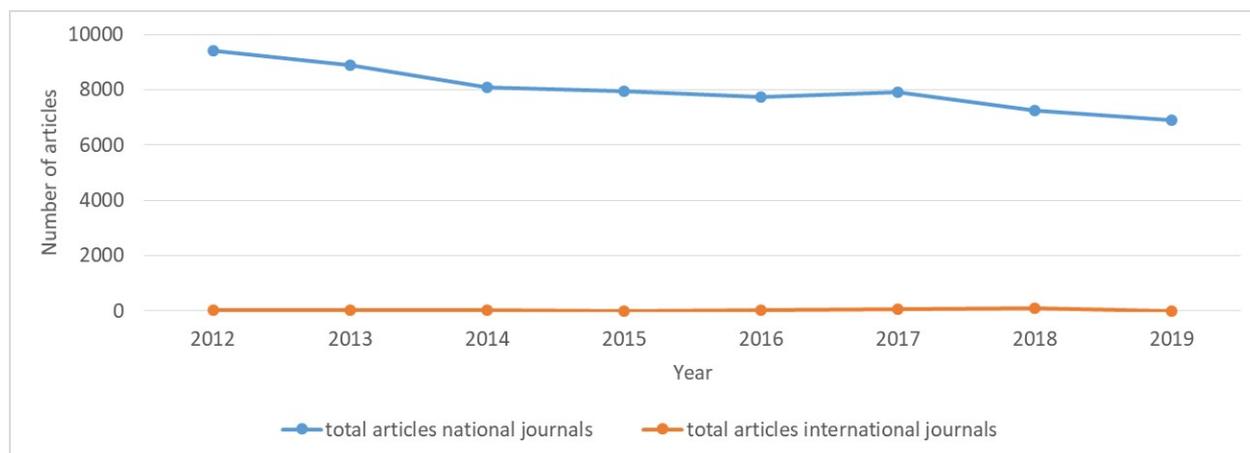


Figure 8. Total number of articles published from journals maintained by national and international non-profit publishers. (Source: the authors).

countries such as China and Russia, with endogenous levels around 80% (Strehl et al. 2016). McManus et al. (2020) also confirmed that there is a tendency to publish more articles in Brazilian journals in most research areas. The increase in APC expenditure over the years with commercial publishers while decreasing it with national non-profit organizations might be a sign of the internationalization of the Brazilian scientific community. To comprehend if this drift impacted the total number of papers produced annually, there was an evaluation of article output.

Figure 7 presents an increase the total number of papers published in commercial and non-profit publishers from 2012 to 2019 (blue line), except for a decrease in 2016. According to McManus et al. (2020), the drop in the number of articles in 2016 can be explained by three reasons: the global reaction to Plan S which made authors look for alternative journals to publish their works, the costs with APC and the lack of funding to cover them in Brazil, or the increase in postgraduate courses in Brazil without a budget increase. In fact, in 2015 and 2016 postgraduate courses lost 75% of the

maintenance funding from CAPES, except for scholarships.

The number of publications were separated between commercial and non-profit publishers. Figure 7 also shows the evolution of publication numbers in journals from commercial publishers (orange line), exhibiting a 211% increase from 2012 to 2019, again with the exception of 2016. The number of articles published in journals from non-profit Brazilian organizations, illustrated in Figure 8, indicates that this type of publication dominates the Brazilian output in OA. While the total number of published papers in commercial publishers is 20,663, it rises to 64,443 in national non-profit organizations journals altogether with 324 in international ones, demonstrating that non-profit organizations published three times the amount of the former. However, this output presents a 27% decrease regarding the initial value when comparing to the observation for commercial publishers.

When comparing national and international journal publications, we observe that while we spend higher APC costs in international publications, more articles are published in national journals. This

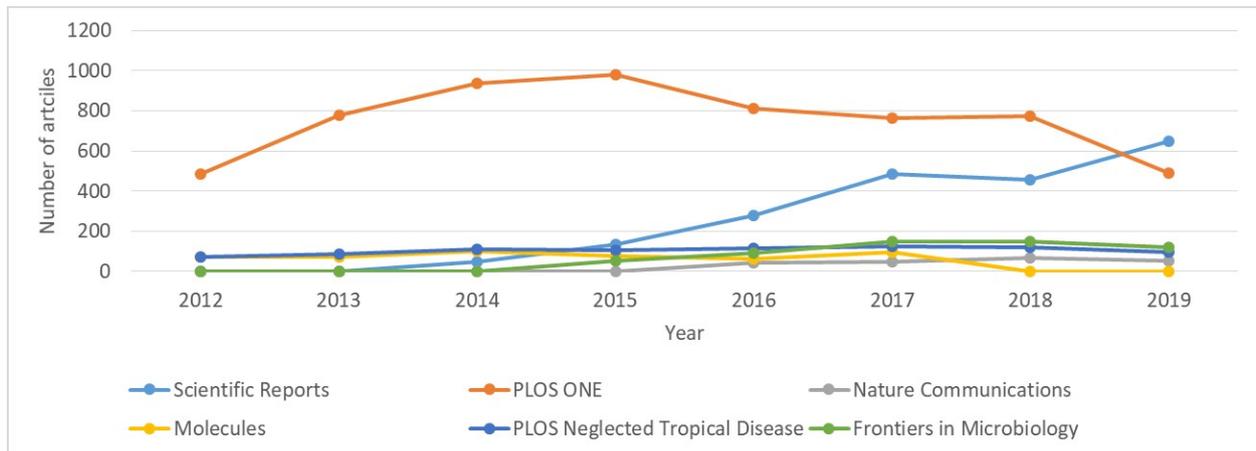


Figure 9. Total publications from the six most expensive journals considering values spent with commercial publishers (Source: the authors).

happens because national journals have lower APCs when compared with international publications (Rodrigues et al. 2020a).

In order to understand this drift to commercial publishers over the aforementioned period, we analyzed the number of publications in commercial journals in which Brazil spends more with publication charges over the 2012-2019 period. The six journals with higher expenditure are: Scientific Reports, PLoS One, Nature Communications, Molecules, PLoS Neglected Tropical Disease, and Frontiers in Microbiology. We observed that, within the commercial publishers, the journals with higher APCs are mostly the periodicals with a larger number of publications. Figure 9 illustrates how the number of articles at these journals changed over time.

At the top of the list are PLoS One and Scientific Reports, both open access journals published by the Public Library of Science and Nature Research, respectively. Both are considered mega journals. While PLoS One exhibits an initial increase in the number of papers followed by a plateau and a small decrease, Scientific Reports presents a continuous rise correlating with the decrease

in publications at PLoS One. The large number of publications in mega journals can be explained by a number of factors. One of the competitive advantages is their impact factor, an indicator of published scientific production repercussion. Both PLoS One and Scientific Reports have a high impact factor. The variation of their impact factor is illustrated in Figure 10 (Clarivate 2020). It shows an increase of the Scientific Reports impact factor followed by a plateau and a smooth decrease, while PLoS One only presents a smooth decrease.

The evolution of APCs in these two mega journals goes as follows: PLoS One dominated the mega journals universe for 10 years, and has seen its impact factor drop over time – in 2019, the index was 2.740 (Clarivate 2020), compared to 4.4 in 2010 (Marques 2010). According to information from the Official PLoS One (PlosOneBlog 2015) website, its APCs remained a consistent (US\$ 1,350.00) from 2009 to 2014, rising to US\$ 1,495.00 in 2015. Currently, the PLoS One APC is US\$ 1,595, presenting little variation over time. The Scientific Reports APC stands currently at US\$ 1,870 (Springer 2020).

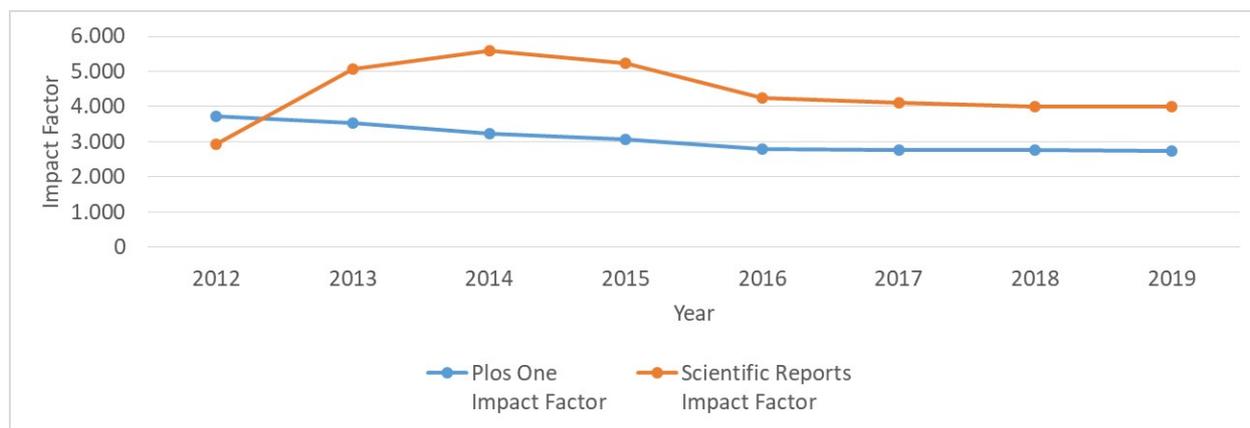


Figure 10. Impact factor evolution from PLoS One and Scientific Reports in the 2012-2019 period. (Source: Incites 2012-2019).

DISCUSSION AND CONCLUSIONS

In Latin American countries, particularly in Brazil, the government is the primary source for research and funding, and should be responsible for distributing the results. The Brazilian government evaluates research based on publications and their quality, which is measured in part through their impact factor.

Traditionally, universities and societies created the national journals that have been used to present research developed within Brazil. Over the years, in addition to the quantity of papers, the agencies also evaluated the impact of the journals where they were published. Scielo (Meneghini et al. 2006, Pavan & Barbosa 2018) brought higher standards to national publications in OA, which allow these journals to gain international visibility by appearing in platforms such as the Web of Science. This process might be interpreted as a way to publish research of greater impact.

In this impact-centered scenario, mega journals appear as an interesting solution. They offer a larger and quicker acceptance rate than traditional international journals. This alternative system enabled greater quality and visibility (Rodrigues et al. 2020a). In

some cases, this process led to international collaborations (Frenken et al. 2010, Santin et al. 2016, Alvarez et al. 2017). The act of publishing research in a recognized journal represents an essential part of the work of a researcher (Rodrigues et al. 2020a).

Our results indicate that over the years the Brazilian scientific community has been increasingly publishing in OA journals with APCs. This growth has a particular behavior. Scientists have migrated from national to international journals, specifically to journals with higher impact and more expensive APCs. This corroborates the findings of Caballero-Rivero et al. (2019), where publication in international OA mega journals constitutes a prominent practice in Brazil, as well as depositing articles previously published in OA journals to a repository, with national publications in this model being a very important channel for disseminating research results.

Minnitti et al. (2018) also found significant growth in WoS-indexed OA production between 2014 and 2016 in Latin America and the Caribbean being led by Brazil, whose scientific output represents 69.7% of total documents in the region in absolute numbers. In fact, the internationalization of Brazilian journals has

been increasing in recent decades, and the strategies used by editors involve actions as English language use, publication of articles by foreign authors, indexing in international databases, aiming toward greater impact, and including the presence of foreign researchers as associate editors, members of editorial committees, and / or ad hoc reviewers (Santin et al. 2016).

As pointed out by Appel & Albagli (2019), it is important to understand how APCs, considered a trend in OA practices of publishers, fit in the context of Brazil and other Latin American and Caribbean countries which traditionally depend on public resources and financing for the maintenance of its scientific publication systems. The scarcity of studies questioning journal funding policies is also evident, as there is of studies questioning resource allocation to enable authors to publish in foreign journals, presumably of greater circulation and impact.

Similarly, Rodrigues et al. (2020a) demonstrate that the high percentage of OA articles in Brazil is a result of their publication in Brazilian journals, most of which are open without APCs and financed by universities, research, and government institutions. The creation of OA Brazilian journals were amplified by the Scielo platform (Meneghini et al. 2006, Pavan & Barbosa 2018), which gave visibility and standards to a number of Brazilian journals while requiring them to be OA with the support of the electronic software "Sistema Eletrônico de Editoração de Revistas" (SEER) created by Instituto Brasileiro de Informação em Ciência e Tecnologia (IBICT).

Recently, the creation of mega journals, mainly PLoS One in the USA and Scientific Reports in the United Kingdom, combined with an incentive from Brazilian funding agencies for publication in international journals with higher impact factor, led to a drift from the

Brazilian journals to the international, higher impact journals. This drift was confirmed by our data from non-profit national publishers to international high impact commercial publishers. In addition to reputation, the quality and speed of the review process or publication time of the mega journals can also be considered (Budzinski et al. 2020) as one of the reasons for the increase in Brazilian articles at these larger periodicals.

This work sought to analyze APC spending in Brazil in the 2012-2019 period and its possible implications for Brazilian research. The findings exhibit a greater expenditure on more costly APCs from commercial publishers, as well as a migration from publications paid to publishers from non-profit entities to commercial publishers. About this issue, it is important to highlight the endogenous behavior of the Brazilian researcher who chooses, in most cases, to publish in national journals with a lower impact factor (McManus et al. 2020). Indeed, there is an indication of change in this behavior given signs of an internationalization of Brazilian research, with a migration of the best works to international and higher-value journals.

Low APCs or total lack of costs from Brazilian journals contrast with prices charged by commercial, mainly international publishers, which is around U\$ 1,500.00 for each article. Besides, the relevance of the mega journals introduces a new player into the publishing system, with novel rules and costs (Rodrigues et al. 2020a). PLoS One and Scientific Reports were the mega journals with the most published articles and highest APC values found in this research.

Thus, our results delineate an internationalization of Brazilian research, a kind of research migration within scientific publication systems where peripheral countries as Brazil submit their best research to major commercial publishers

and, in return, are required to pay high fees to access them (McManus et al. 2020), confirming that there has been an increase in abroad Brazilian publications in all areas.

Summarily, our results suggest that the creation of mega journals, a response from the editorial sector to the OA movement, created an opportunity for the scientific community from developing and middle-income countries to publish internationally. This tendency, however, it is not free from criticisms because it comes with an increasing price for the APC.

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Bárbara Neves Alencar and Márcia Barbosa conceptualised the study, Bárbara collect the data. Both analyzed the results and contributed to writing the paper.

