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Dr. Ludo Waltman
Editor, Quantitative Science Studies

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Dear Dr. Waltman

Attached please find our revised manuscript on Article processing charges and the geographic diversity of author communities (MS No. QSS-2020-0068). We very much appreciate the referee feedback, which was comprehensive and extremely useful, and the opportunity to submit a revision.

Below we detail the changes we made to our manuscript in response to the referee comments and your own; we begin with the more substantive issues in the Editor's summary, then respond in turn to each referee's individual comments.

Although the requested revisions required some additional text, we have managed to keep the manuscript to an efficient ~4700 words. We did have to add some additional figures and tables, however. If you feel the current manuscript has too many supporting elements, we have identified several we feel could be shifted to the Appendix. Please also note we have changed the title to draw more attention to the Mirror-Parent ecosystem and our more focused inference (*"Assessing the effect of article processing charges on the geographic diversity of authors using Elsevier's 'Mirror Journal' system"*).

Thank you again for your efforts, and we look forward to hearing from you soon.

Best regards,

Emilio M. Bruna
University of Florida

Editor's Summary

1. In the revision, please carefully consider the comments provided by the reviewers. In particular, reviewer 3's comment on the distinction between publishing in a mirror journal and OA publishing in the hybrid parent journal is of major importance and needs to be carefully addressed.

   We have completely revised the analyses, interpretation, and presentation in in light of this suggestion. We began identifying all of the articles in the Parent journals that were Open Access (OA), then using permutation tests to compare author diversity in OA Mirror journals with that of OA articles in the Parent Journal. Although there was no difference in geographic diversity, there were differences in how the different countries and regions were represented in each group. We therefore kept these two groups of OA articles separate for subsequent comparisons; the new manuscript presents the results:

   (i) Parent OA vs. Mirror OA
   (ii) Mirror OA vs. Parent non-OA, and
   (iii) Parent OA vs. Parent non-OA

2. It seems essential to cover in your analysis not only the distinction between publishing in a parent journal and publishing in a mirror journal, but also the distinction between OA and non-OA publishing in the parent journal.

   The overall conclusions regarding OA and author diversity remained, regardless of which group of OA articles was being compared with the non-OA articles in Parent journals. However, the collective results of the three comparisons yielded – as suspected by Reviewer 3 – some important insights the both the Mirror journal ecosystem and the potential factors shaping decisions made by authors regarding journal selection.

   Again – our thanks to Reviewer 3 for pointing out that authors can pay for OA publication in Parent journals. Reshaping our manuscript in response to this feedback made for a more interesting and robust study.

3. Furthermore, in different ways the three reviewers all make the point that there are various confounding factors that may affect your findings and their interpretation. In the light of the comments provided by the reviewers, the conclusion that your results "provide compelling evidence that APCs are a barrier to Open Access publication for scientists from the Global South" seems too simple and needs further qualification.

   We have addressed this request in two ways. First, we have made the "confounding factors" more prominent in several ways. They are now highlighted more explicitly in the introduction (e.g., line 122) and we edited our original text in the discussion to reinforce the limitations of our analyses. We also went through the manuscript carefully to find and tone down the language used to summarize our conclusions (e.g., "strongly suggest", l. 297). We hope we that these changes provide a more balanced and nuanced presentation of both the complexity of the problem and the inference that can be drawn from the results of our analyses.

Reviewer: 1

While this reviewer is entirely sympathetic with the observation that APCs are a barrier to publication for scientists in the Global South, they do not think the methodology used to come to that conclusion in this article is appropriate or well founded. This is because the authors (a) the sample sizes are too small and disproportional, and (b) the authors fail to take into account a number of potential confounding factors.

1. The limitation to 41k articles in 38 mirror journals that allow to compare OA and PW represents a very limited sample size. Once authors from the USA and China are subtracted from that number, the figure must be even lower.

   We respectfully argue that whether a sample size is “small” or “large” depends in part on the question being asked, the extent to which a sample is representative, and the inference being drawn. And of course, large sample sizes don’t automatically mean analyses and the resulting inference are more robust. For example, some prior studies exploring author geography and open access often had large sample sizes, but didn’t include non-OA journals for comparison. Even the few that *did* include non-OA journals recognized that the inference that could be drawn was limited by the fundamental differences between the OA and non-OA journals being compared.

   Our study is unique in having disciplinarily matched control journals, and we feel the advantages of this robust design – including the opportunity to draw stronger inference than previous studies – more than compensate for any potential limitations due to sample size. Of course, the extent to which these conclusions can be extrapolated beyond the focal journals depends in part on whether these articles are broadly representative of OA/non-OA papers. Given that many of the geographic patterns we observed are qualitatively similar to those of other studies, and the breadth of disciplines covered by the focal journals, we are cautiously optimistic that they can be.

   In our revision we have attempted to place our sample sizes, the advantage of our sampling design, and our design’s relative strengths and weaknesses in a broader context. We have also revised the phrasing of our conclusions to reflect the issued raised by the referee.

2. It is also unclear why European authors were not excluded. Certainly those muddy the waters just as much as authors from the USA and China.

   In retrospect we should definitely have provided a more thorough explanation for why authors from the USA and China should be excluded (based on how ‘dominant’ categories influence these indices). We now do so (line 198), and also include the results of simulations demonstrating why we excluded authors only from China and the USA (Appendix Fig 2). Briefly, these countries have by far the greatest relative impact on Diversity, and they are the only countries whose numerical dominance skews the Evenness component to such an extent that their exclusion actually *increases* Diversity.

3. Then there is the huge discrepancy between the figures for PW and OA journals: "The 38 OA mirror journals published 984 articles from their inception through the date 174 we downloaded the article records. During the same interval, their respective PW

journals published 40330 articles." So the authors are comparing 984 OA articles with a figure in PW journals that is roughly 40x higher. That cannot allow for a solid comparison, given the distribution of these 984 OA articles over the numbers of authors and countries involved. The chance for randomness is simply too great when such small samples are involved.

While the ratio of OA and non-OA articles is highly unbalanced, our statistical analyses were not. This is because we conducted our analyses using bootstrapping, which has a long- and well-established history as a powerful statistical tool for dealing with unbalanced designs (we now include citations of scientometric studies using it). In our bootstrap design each of the 1000 replicated samples of non-OA articles was identical in size to the number of OA articles. Furthermore, the sampling was structured such that we sampled a number of non-OA articles from each Parent journal that was identical to the number of articles we had from each respective Mirror journal. This assured that the results would not be dominated by the journals that had published the most OA articles.

(NB: it is worth noting that unbalanced sampling was not the only reason we used bootstrapping – it is also ideally suited to cases where the underlying distribution of the statistical parameter of interest (e.g., Simpson's Index) is unknown.

4. The regions considered here do not fall neatly in the North-South divide assumed in the hypotheses. Countries in the East Asia & Pacific region and the Middle East and North Africa region in Table 4 represent about 30% of single authored papers in PW journals and 25% in OA journals. However, countries in these regions are hugely different in terms of income, and it is probably not insightful to lump them together like this.

   It is true that the "Global South" and World Bank Income categories do not overlap perfectly with the World Bank Geographic Regions, and that within most regions there are groups that are high income and Medium/Low income [though one or the other is generally more prevalent]. The combination of Income and Region, however, can generally be used to predict presence in either the Global South or Global North. We think analyzing and presenting results with these groupings is valuable because (i) doing so allows for comparison with other studies, (ii) assignment to categories within these groups is straightforward and transparent, and (iii) that there are strong geographic patterns despite each region having multiple income groups is telling.

   In considering our response to this comment, however, we realized that – given our goal of investigating the association between APCs and author geography – it would also be valuable to also present results based on the representation of OA and non-OA authors by Elsevier's waiver categories, which do not overlap perfectly with Income Classifications in informative ways. Doing so reinforces our conclusion that waivers do little to increase the representation of authors from the countries they are designed to support. We thank the author referee for pushing us to think more about how these results are presented.

5. The nature of the disciplines served by these journals is not addressed. This is important because there are considerable differences between disciplines in terms of access to funds for OA, not only in the Global North but also in the Global South. Table 1 shows that 12 of the 38 journals sampled are in the medical sciences. Only one is in SSH (Research Policy), 2 in physics, 4 in chemistry, etc. The outsized share of medical journals in the sample size is important to note, because even in many countries of the so-called Global South, researchers have access to funding from philanthropies in the global North (Wellcome,

Gates, HHMI...)... Also, no account has been taken of the regional communities served by some of these journals. The European Journal of Obstetrics & Gynecology and Reproductive Biology may be found to serve a very specific European audience.

Because we were working within the confines of the Mirror-Parent ecosystem, our ability to draw inference about individual disciplines was somewhat limited – as the referee points out, the journal collection has large number of biomedical science journals (though other disciplines are not as underrepresented as argued: when categorizing by Web of Science (WOS) category, the counts are N =19 Life Sciences and Biomedicine, N = 7 Physical Sciences, and N= 12 Technology/Policy). Furthermore, we actually *did* correct for any potential journal-related differences in author geography or OA uptake with our paired bootstrapping design. Even if *The European Journal of Obstetrics & Gynecology and Reproductive Biology* did serve a largely European audience, that would not be a problem because *we sampled the same number of articles from the Parent and Mirror versions.* If the authorship was geographically limited (NB: it wasn't) it might not tell us about the authors in the global south, but it would still be informative regarding whether authors in that region had a preference for OA.

Finally. we were somewhat mystified by the assertion that researchers in Global South conducting biomedical research have greater access to funding to pay for APCs, as this is not supported either by the literature we cited our results (with the exception of some small funding hotspots, e.g., São Paulo state in Brazil). Even then, as we explore in the discussion, coauthorship with authors based in high-income countries makes authors illegible for partial or complete APC waivers.

Finally, the authors acknowledge that waivers are possible, but these do not seem to have been taken into account in establishing the conclusions. Admittedly, that information may not be available, but it might have a significant impact on influencing the figures for OA publication.

Here again we are somewhat confused, as we dedicated several paragraphs of the discussion to the way in which APC waivers (or the lack thereof) could have influenced our results and the implications of our results for publisher APC policies. We also dedicated much of the "Future Directions" paragraphs to suggesting future research explicitly focus on APC policies.

Reviewer: 2

1. The scope of this particular study, that of journals of a single commercial publisher, is too limited to be much of interest when considering the diverse and complex publication behaviour of authors in the developing regions.

   There are tradeoffs in deciding whether to focus on a single publisher – even if that publisher is a behemoth such as Elsevier – or expanding the scope to include multiple ones. The strength of focusing only on this publisher is in the unique opportunity presented by comparing Parent Mirrors and their OA mirrors, and the strong inference one can draw from having eliminated many of the confounding variables associated with comparing journals with completely different editorial boards, criteria for acceptance, and research foci.

   Furthermore, while we did focus on journals published by "only" a single publisher, the 38

journal pairs span a tremendous range of disciplines. The referee's comment seems to imply that authors across this disciplinary range actually make decisions regarding where to submit articles (in general), and choices regarding OA/non-OA papers (in particular), based on the identity of publishers. While researchers in this field may spend long hours and devote considerable energy to publisher-based analysis, there is no evidence in the literature that authors do. Indeed, we suggest (based on the existing research and drawing from our own personal experience as authors and editors) that most authors actually have fairly limited knowledge or interest in who the publisher of a given journal is.

2. The reviewer find the methods section to be too narrative and a bit clumsy to read. Facts & Figures should be presented in tabular form so as to clearly highlight the geographic spread of countries as well as extent of individual country's contributions regardless of it's significance.

   We have gone through the Methods section carefully to streamline the writing and smooth out the descriptions of our analyses. Although the analyses are complex and hence require some admittedly tedious explanation, we hope the current version is easier to easier to read.

   As for the presentation of results, we opted for figures rather than detailed tables because we feel they are easier to interpret. All of our code and data will be publicly archived upon acceptance, and include the code with which one can generate tables of the data presented in figures. At the Editor's discretion we will gladly place these tables in the Appendix to make the exact numbers more readily accessible to readers.

3. The reviewer was doubtful of the awareness of OA mirror journals due to low OA education in this clime especially Africa. Notably, GS and Africa in particular is a heterogenous society.

   It is certainly likely that authors are less aware of mirror journals, though we are not sure we agree awareness should necessarily be lower in Africa – where OA is both actively promoted by institutions / governments and more critical to individual researchers. Indeed, it may well be much higher than in other parts of the world. All of the mirror and parent journal pairs are prominently cross-advertised on their respective websites, so regardless of where an author is based and whether or not they are familiar with them, we believe they are equally likely to learn about mirror journals when preparing their submissions.

4. The authors failed to mention Xia's study on APCs of Mega Journals and Predatory Journals especially in terms of geographic spread.

   We were aware of this work but didn't cute it to avoid conflating mirror journals with predatory journals. We did, however, include citations of Xia's very relevant work on scholar attitudes and behaviors regarding OA publishing.

5. The subject focus might have been a contributing factor as well in terms of overall contribution from GS or does the subject community focus on local sources as outlets for their research?

   It is absolutely true that authors in some subject areas might be preferentially opting to publish in local outlets, for instance if doing so results in greater community impact. That is the advantage of comparing mirror and parent journals – presumably authors in parent-

mirror pairs are facing similar choices regarding where to publish. In addition by structuring our bootstrap sampling to reflect the number of publications in each journal, the effects decisions made by any one research focus will not by 'overwhelm' those of others simply by chance.

6. Finally, it was disappointing that these authors failed to consult sufficient literature from and by authors in the GS. And was surprised when Ezema & Onyancha (2017) was cited, despite being African voices....what about other voices from the GS as the title suggests since it emphasized and focused on GS extensively.

   We are unable to see how the referee concludes that we failed to consult literature from the Global South or present the perspective of voices from different GS regions. **Our original submission cited 11 papers by with lead authors based in the Global South**[1]: 5 from Latin America, 4 from Africa, and 2 from Asia. The second version goes even further, adding 1 additional citation from Asia and 3 more from Latin America.

Reviewer 3

I want to congratulate the authors for discovering the group of 38 Elsevier mirror journals as a new promising source of information to study the effect of the article processing charge (APC) based open access business-model on geographical representation of article authors. Based on the concerns raised in the previous literature, the aim of this study is to provide evidence that OA journals charging APCs have reduced representation of authors from the Global South. The study clearly addresses a very significant problem from the point of view of the future development of sustainable open access publishing models, including APC waiver programs, as well as OA policies, such as the Plan S.

1. In my view, the problem, aim, design, data, methods and results are very clearly reported. With regard to the data, I would like to know what is the rationale for using both Web of Science and Scopus data, and how possible differences in the two datasets were handled.

   To be perfectly frank, the use of both SCOPUS and WOS was driven by a combination of data access, indexing, and the functionality of the packages used to organize the data. Because most of the mirror journals are new, they are not yet indexed in any of the WOS databases; because they are Elsevier journals they are in SCOPUS. Without going into too many details, we prefer the format of author/address data in WOS, and package `Refspliter` for processing records. We downloaded as much as was available in WOS and all records from SCOPUS; SCOPUS records were processed with `bibliometrix`. We then compared all records from journals that were indexed in both databases, compared the results (no of records per journal, etc.), and compared the identification of first authors and their address. We discovered that for the journals in common, the records downloaded from the two databases were identical. However, we also found that ~5% of records from SCOPUS were being assigned an incorrect 1st author address when processed (see: https://tinyurl.com/y873v4jc). In the end we decided to simply manually verify all 1st author/ 1st author address for records we were *only* able to download from SCOPUS. It took a while,

[1] **Latin America:** Appel et al. 2019 , Ciocca & Delgado 2017, Espin et al. 2017, Nuñez et al 2019, Pavan and Barbosa 2018, **Africa:** Ezema & Onyancha 2017, Iyandemye & Thomas 2019. Matheka et al. 2014, Ncayiyana 2005, **Asia:** Wang et al. 2015, Xu et al. 2020.

but was straightforward and worth the effort.

2. The indicators and statistical methods (bootstrapping) are appropriate but I trust that other reviewers are better experts than I am to judge their validity. Nevertheless, I suggest that the authors very briefly point-out the prior application of these indicators in bibliometrics, e.g. to study multidisciplinarity.

   Excellent suggestion, we have done so.

3. My critical remarks concern mainly the underlying presumptions of the study concerning the difference between parent and mirror journals, and the factors influencing pre-submission decisions. As regards the terminology, I hope the authors consider using “parent” and “mirror” instead of paywalled (PW) and APC-charging open access (OA) journals. It might be a good idea to mention mirror journals in the title.

   We now use Parent / Mirror throughout, and have altered the title to mention Mirror journals.

4. The presumption that “there is no cost to authors publishing in the subscription-only ‘parent journals’” is not entirely true. To publish open access articles in the set of journals studied in this paper, researchers can opt either to pay APC to the hybrid parent journal, or pay APC to the fully OA mirror journal. Elsevier provides APC prices for both parent and mirror journals (see the list below). Typically the list price is, with some exceptions, more or less the same in both versions. If 5-10% of the hybrid journal content is OA (https://doi.org/10.7717/peerj.4375), around 2000-4000 of the >41000 articles from the parent journals could be OA articles, for which the authors may have paid APC (full or discount). The authors need to consider and discuss how their results and conclusions are affected by the fact that articles published in the parent journals may also involve APC. In fact, three groups of authors (with possibly different geographical structure) could be distinguished in the analysis: 1) authors of OA articles in mirror journals, 2) authors of OA articles in parent journals, and 3) authors of closed articles in parent journals.

   This insight was invaluable, and we can’t thank the referee enough for catching our oversight (we’re also impressed by how accurate their estimate of the number of OA papers in Parent journals was). We have completely redone the analyses to compare the two OA groups first to each other, then to the non-OA articles in the Parent journals (i.e., the three groups the referee describes above). The results are more or less the same when comparing Mirror and OA-Parent with non-OA articles in Parent journals, but there were a few interesting and informative differences.

5. Then the question is, what determines why some authors chose to publish closed articles (free of charge) in the parent journals instead of OA (APC) in the parent or mirror journal, and why some authors chose to publish OA with APC in the mirror journal instead of the parent? Researchers who prefer OA may achieve this goal in both the parent and mirror journal but they may choose to publish in the mirror journal if the selection of a full OA journal rather than hybrid is mandated by the funding agency or institution. But the funder requirements are complicated. Coalition S, for example, does not support publication in hybrid or mirror journals unless they are part of a transformative arrangement. Yet the researchers may not clearly understand what journals actually are Plan S compliant. If Elsevier specifically targeted mirror journals to authors who need to meet funder requirements, should we also expect the geographical structure of mirror journal authors to reflect that of researchers with access to competitive research funding? Could this explain the large share of authors from high-income countries?

This is the central and perhaps most challenging question – what explains the results? All of the issues raised are relevant, including that the central factor underpinning decisions could vary from location to location. We have laid out several hypotheses, and some – though not all – are based on potential author responses to funder mandates / Plan S. However, we prefer to limit speculation for the precisely the reasons laid out by the referee (plus we obviously have limited insights to Elsevier's marketing strategy – presuming they have one) . Instead, we hope that our results and hypotheses spur further work, especially targeted surveys of authors that allow for comparisons across countries and funders.

6. The authors also discuss the APC waiver programs and highlight their apparent failure to increase representation of researchers from low-income countries and the Global South: "perhaps the most surprising result of our study was the extent to which authors from low-income countries were underrepresented". But this is observed in the case of both the parent and mirror journals, so I am left wondering if this finding is specific to the set of parent/mirror journals or does it hold true of Elsevier journals more generally? It may also influence the geographic structure of authors that Elsevier has made read & publish agreements allowing researchers from certain countries and institutions to publish OA free of charge or with discount in all or some of the parent and mirror journals.

   As for the question above, this is really important, challenging to address, and potentially beyond the scope of this study. We have no reason to believe the authorship of these journals is significantly different from that of other titles – the identity of the most prolific countries certainly isn't. However, even testing this possibility is challenging for the very reasons that this study is unique – there are no "control" journals for comparison. The one possibility is to dredge across all Hybrid journals and see if the communities publishing OA and non-OA articles differ. Though beyond the scope of this study, our results serve as a baseline against which to compare the results of such a survey. Note, however, that even such an analysis would also have some major limitations. Given the high APCs of many hybrid journals, authors for whom OA publication is a priority may well opt for other outlets with lower APCs.

   Regardless, our results – even if they are "limited" to these journals – provide not only insights into our focal question of financial barriers, they also suggest testable hypotheses and describe methodological approaches of value to other researchers interested in Open Access publishing.

7. On paper, the parent and mirror journals may seem perfect copies with regard to editorial and peer-review standards as well as quality and prestige. In practice, the concept of mirror journal is - I dare say - very little known and poorly understood among the researchers. The mirror version may be regarded simply as a new OA journal or a secondary subseries, and the status, impact and prestige of the mirror compared to the parent remains uncertain.

   We think the lack of familiarity is a major issue, as are concerns regarding how others might perceive their quality. Because the mirrors aren't indexed, and IF is still an important element of submission decisions, it may be that the 2 OA distributions "even out" over time. We have gone through the manuscript to clarify these possibilities, as well as to ensure that we temper our conclusions with this temporal caveat.

8. These considerations may affect the geographical representation of authors, especially as some countries and institutions have incentive structures based on the Journal Impact and

prestige. China is a well-documented example (http://doi.org/10.29024/sar.15).

We mentioned this in the original submission as a potential reason why China had proportionately more OA than non-OA articles. Pulling out the “OA in Parent” articles resulted in even stronger support for “prestige” being a key driver – when Chinese authors do opt for OA publication, it appears that they heavily favor OA publication in the established OA journal than OA publication in the newer, IF-less Mirrors.

9. In all, this is a ground-breaking study in the sense that, as far as I know, there are no previous studies of the mirror journals. Nevertheless, the concept of mirror journals remains poorly understood in both bibliometric research and the research community. This paper should not only take advantage of this new information source but also help the readers to better understand the difference between mirror and parent journals. Already in the introduction, a stronger effort should be made to discuss the role of APCs as the central mechanism underlying the authors’ pre-submission decisions, compared to the complex combination of factors, such as funder mandates, publisher agreements and perceived prestige. That APC is an option in both the parent and mirror journals has to be clarified. Consequently, it also needs to be more carefully considered what is the added value of the parent/mirror -distinction for this study, and more generally to study of APC-based OA publishing model. We still have very little knowledge and experience of publishing in the mirror journals, which is a reason also for treating the results as early indications and for interpreting them with much caution.

   Thank you for the encouraging summary; we have revised the introduction and discussion in light of these recommendations.
