PERSONAL VERSION

The publishing delay in scholarly peer-reviewed journals

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Abstract:

Publishing in scholarly peer reviewed journals usually entails long delays from submission to publication. In part this is due to the length of the peer review process and in part because of the dominating tradition of publication in issues, earlier a necessity of paper-based publishing, which creates backlogs of manuscripts waiting in line. The delays slow the dissemination of scholarship and can provide a significant burden on the academic careers of authors.

Using a stratified random sample we studied average publishing delays in 2700 papers published in 135 journals sampled from the Scopus citation index. The shortest overall delays occur in science technology and medical (STM) fields and the longest in social science, arts/humanities and business/economics. Business/economics with a delay of 18 months took twice as long as chemistry with a 9 month average delay. Analysis of the variance indicated that by far the largest amount of variance in the time between submission and acceptance was among articles within a journal as compared with journals, disciplines or the size of the journal. For the time between acceptance and publication most of the variation in delay can be accounted for by differences between specific journals.

Keywords: Scholarly Publishing; Review Time; Processing Time

1 Introduction

Scholarly journal publishing has a long history going back to Henry Oldenburg's *Philosophical Transaction of the Royal Societ*y founded in 1665. For the past two centuries the volume of peer reviewed articles published per year has increased by a relative steady 3,5 % per year, with a current number of articles of around 1,8 – 1,9 million, published in an estimated 28'000 journals (Ware and Mabe 2012). Over the years the scientific journal as an institution has evolved in many ways and after the second world war and the ensuing rapid growth in science commercial publishers have increasingly entered this market, which earlier was dominated by scientific societies.

The dissemination medium has very rapidly changed from printed issues to predominantly digitally distributed publishing (Van Orsdel and Born, 2002). At the same time this has triggered the emergence of new business models for digital publishing, including bundled e-licenses, pay-per-view and open access publishing. Scholarly journal publishing in its current form has been the object of increased critique since the advent of the World Wide Web and the opportunities it offers for process innovation, The debate has in particular concerned three aspects. Firstly that the reach of the dissemination that the traditional subscription model achieves is suboptimal. Secondly that the peer review process is flawed and frequently leads to arbitrary decisions. Thirdly that there are significant delays in publishing articles. Traditional paper publishing in particular creates significant delays both due to the need to bundle articles into issues and backlogs created by page limits resulting from the high per page cost of this type of publishing.

The solution proposed to the limited dissemination is Open Access (OA), which can be achieved either through publishing in open access journals ("gold OA") or through author's uploading manuscript versions of their articles ("green OA") to subject or institutional repositories (Suber 2012). OA journals have increased their output by 20-30% per year for over a decade and now publish around 12 % of all peer reviewed articles (Laakso and Björk 2012). The open accessibility can be achieved via a number of business models of which the publishing fee variant is rapidly increasing its market share.

The critique of the peer review process has led to a number of experiments with alternative models. The web medium lends itself to different forms of open review, where manuscripts can be "published" prior to review or with minimal review and subsequently evaluated by reader comments and elevated to full article status via post publication feedback. (Björk 2011). Open review was tried and deemed a failure in a well-known experiment by Nature (2006). More successful than open review experiments is an alternative peer review model practiced by an increasing number of OA "megajournals" in the wake of PLoS ONE, which currently publishes around 20,000 articles per year. In this form of peer review only the scientific validity of the results is checked, the decision concerning the potential contribution is left for the readers to decide.

An important reason for the success of PLoS ONE is also that is offers a very attractive alternative to authors who are tired of the long delays involved in publishing in traditional journals and rejection on what are felt to be arbitrary and or biased opinions of reviewers and/or editor. The delay was a necessary facet of the publishing process prior to the turn of the millennium, when journals were almost exclusively published in paper form, and where journal page limits were an economic necessity. Since then electronic only journals have shown that the delay can be considerably shortened. Also the traditional journals have acknowledged the existence of the problem by starting to post "in press" or completely copy edited and formatted "ahead of print" versions of accepted manuscripts even before they become part of an issue and receive page numbers. A recent survey with authors showed that the speed of publication was the third most important factor affecting authors' choice of journal, after topical fit and the quality of the journal (Solomon and Björk 2012).

In some fields of science authors have tried to partly bypass the system by publishing their manuscripts in open web repositories prior to submission as working papers (economics) or preprints (physics), in order to speed up the dissemination of the results. In other cases experiments have been made with new types of peer review journals, in which only lightly screened manuscripts have been openly published on the journal web sites, and the better ones have later been elevated to full journal article status (Björk 2011), proving the seal of quality.

It is our belief that the length of the delay is not constant across different fields of science, but depends on the review and publishing cultures that have evolved in different sciences. For example a delay of two years, common in economics and management, would be difficult to accept for academics in the biomedical sciences.

1.1 The Life-cycle stages of a peer-reviewed article

During its life-cycle a scholarly article undergoes a number of stages, some of which are in focus in this study. During the writing and finalizing of a manuscript most authors tend to show it to a few trusted colleagues, from whom they receive feedback and suggestions for improvement. In many disciplines it's also common to publish versions as conference papers and in a few disciplines, in particular physics and economics, a tradition of publishing working papers has evolved. At some stage the author (or authors) formally submits the manuscript to a particular journal. Most journals require that a manuscript hasn't been published elsewhere and that is not under consideration for publishing by another journal. In medicine this rule can be even stricter in that authors are also restricted from discussing the results with the popular media, the so-called Inglefinger rule. From the viewpoint of the whole scholarly community the rule excluding parallel submission is understandable in terms of avoiding unnecessary replication of the unpaid referee work done by the editor and other

scholars. On the other hand this causes publishing delays for authors whose work is rejected in the first and even second journal to which they submit.

The quality and extent of the peer review that a manuscript undergoes varies considerably across journals and disciplines. The editors of many journals screen submissions and quickly reject manuscripts that are clearly unsuitable without sending them out for external peer review. The review process can also involve several cycles of review and revision, a practice common in more selective journals particularly in specific disciplines such as business and management.

Manuscripts at some point are accepted, rejected or in some cases withdrawn by the author who may find the requested revisions or the revision process unacceptable. If accepted manuscripts are generally copy edited and typeset by the publisher or contractor, after which the author is usually asked to check the final version. In traditional print publishing the finalized manuscript is then put in the queue for publishing, awaiting its turn, usually though not always according to its position in the queue. Articles submitted to a special issue are treated a bit differently. The queuing can take as long as a year or more if the journal has a significant back-log. If the journal also publishes an electronic version manuscripts are often published earlier on the journal website under headings like "in-press" usually without exact page numbers and assignment of issue. Most electronic open access journals publish articles directly when they are ready rather than in issues, thus speeding up the process.

If we would take a manuscript and not journal-centric view the total delay would often be even longer since many manuscripts are rejected, and in some cases several times before publication. This time from submission to rejection, in some cases from multiple journals, needs to be added to the delay of the journal that finally publishes the article. Azar (2004) discusses this for the case of economics journals and points out the importance of first-response delays, since it is often at this stage that authors need to find alternative journals for submitting their manuscripts.

In this study we take the journal-centric view looking in particular at the delay from submission to acceptance and the delay from acceptance to final publication, as well as the total delay time. Although it might be possible to get data for other stages in the overall process for some journals these three points in time are common for all peer reviewed journals.

1.2 Previous Research

There are a number of possible sources of information about publication delays. Ideally publishers would track and make this data available. This is however rare, perhaps because publishers and editors may be hesitant to disclose long delays. Sometimes the information can be found in editorials in journals, which often also provide information about the acceptance rates of journals. Another option is to gather article data about submission and acceptance dates which is often published individually in each article or on the articles' face page on the

publisher's web site. This is a very labor-intensive process but provides precise statistics for the articles sampled. A final option is to gather the data from authors which would be difficult and likely to be fairly inaccurate.

Earlier studies have mostly collected the data included in published articles. One of the few studies using statistics solicited from publishers was the early study of economics journal by Yohe (1980) , who obtained statistics from the editors of 20 journals and extracted article level data for 5 more.

Trivedi (1993) found that the average total publication delay for econometrics articles in seven studied journals was 22.8 months, consisting of 13.4 months from submission to acceptance and 9.4 months from acceptance to publication.

Ellison (2002) concentrated his study on the review times only (submission to acceptance) and found an average of 16.5 months in 1999 for a selection of 25 journals in economics and related fields. He was also able to do a longitudinal analysis for a subset of the journals using data both from Yohe (1980) and Coe and Weinstock (1967) and found that the review times had more than doubled in three decades (1970-1999), for five leading economics journals from 8.7 to 20.7 months. The main reason for this seems to be the increasing number of iterative rounds in the review process. He also found that the average review times vary between different sub-specialties of economics, even for articles published in the same journals with broader scopes, and suggest that the expectations for the type and length of the reviews have been socially shaped within narrow scholarly communities.

Also Hartmann (1997) reports on a dramatic increase in submission to publication delays. For articles in the Journal of Atmospheric Sciences the total time increased from 5.9 to 15.2 months between 1970 and 1997 and while the acceptance to publication lag increased somewhat (4.4 to 6.6 months) the increase was mainly attributable to the increase in the time required by the review process (1.5 to 8.5 months).

Kling and Swygart-Hobaugh (2002) compared the evolution of publication delays for three natural science and three social science journals between 1970/1980 and 2000, in an attempt to see if the email communication widely in use in 2000 had reduced average delays. They found that the delays in chemistry and physics journals had decreased from 6.5 months to 5.8 (and even more so for a minority of articles published electronically before paper publication) but that the delays in the economics, management and psychology journals had increased from 9.0 to 23.8 months.

Diospatonyi et al (2001) studied the evolution of publication delays in ten chemistry journals in the period 1985-1999, and could not find any clear development to shorter or longer periods, with the yearly averages ranging between 6.7 and 7.5 months. The paper contains detailed breakdowns of the spread of delay within journals as well as an analysis of the breakdown between submission to acceptance vs acceptance to publication.

Carroll (2001) compared publication delays for six statistics journals and found a slight decrease from 25.2 months in 1994 to 22.3 in 1999. He suggest that the decline might be due to electronic publishing becoming more common in the five year interval. Amat (2008) studied 14 journals in food science and found an average publication delay of 11.8 months (for a range of 6.2 - 17.2 months). The delays of three civil engineering journals reported by Björk and Turk (2006) varied between 6.7 months (for an OA journal) compared to 18.0 and 18.9 for two conventional journals.

The study by Luwel and Moed (1998) differed from the above because it included journals from different subject areas. The study was triggered by claims of Dutch researchers that articles in technical sciences and mathematics have much longer delays than articles in physics and chemistry, and that researchers in the former fields are disadvantaged in short term bibliometric comparisons, often used when comparing candidates for promotion etc. In a selection of 15 leading international journals in the above fields, the range of delays was between 2.5 and 17.5 months with mathematics and engineering journals tending to be towards the higher end.

Another study with journals from different disciplines was the study of 26 Iranian journals publishing in the Persian language (Khosrowjerdi et al 2011). The delay range for these predominantly social science and humanities journals was very wide (5.8 to 34.6 months) with an average of 17.3 months.

The study by Dong et al (2006) is the only study that tried to analyse if the delay times for OA journals differ from subscription journals in biomedicine. They compared six OA journals from the leading OA publisher BioMedCentral (BMC) with six journals on corresponding topics from Nature Publishing Group (NPG) as well as six other BMC journals with eleven society journals. The results demonstrated that the NPG journals were equal to the BMC journals in overall publication delay (4.5 months) but marginally faster if the electronic publication dates were compared. The BMC journals clearly outperformed the society journals (4.8 vs 8.9 months). It is noteworthy that the in the subscription journals the print versions trailed the electronic versions by only short periods of between 0.5 to 1.5 months.

Yu et al (2004), as part of the building of a mathematical model of the delay process, collected delay data for seven journals. Scientometrics, an information science journal had a delay of 5.5 months and the Journal of Mathematical physics a delay of 9.0 but the five other journals, four of which were in different engineering fields and one in the social sciences, had delays in the range 16.4 – 20.0 months.

Tort et al (2011) studied the delays between electronic and print publishing in neuroscience journal, and found a significant increase between 2003 and 2011. They were also able to demonstrate that increasing the delay increases a particular journal's impact factor, due to the time windows used by the ISI in calculating the impact factor!

Table 1 about Here

Previous studies point to two things. Firstly that there are substantial differences in publication delays with leading biomedical and chemistry journals achieving delays of roughly half a year and at the other end of the spectrum economics and statistics journals typically having average delays of close to two years. Secondly that the delays have increased substantially in some disciplines over the past decades, partly due to an increase in the length of the review process.

Two factors which have not been explicitly studied are the effects of journal size and scientific quality level on the delays. Most of the previous studies have been benchmarking studies within narrow disciplines of relatively homogeneous, highly cited journals. Size could in particular effect the delay after acceptance since smaller journals may appear only four times a year or even twice a year, which means that articles might have to wait in a queue for quite some time before publication. Quality might lengthen the submission to acceptance times since articles might go through several iterations in the review process. On the other hand the most highly cited journals in their fields might find it easier to recruit reviewers and are more likely to have a larger editorial staff and process submissions more quickly.

1.3 Aims

Based on the previously published data, a lot of anecdotal evidence and personal experiences as authors the aims of this study were defined as follows.

To study publication delays in scholarly peer-reviewed journals across disciplines, journal size and journal quality.

We explicitly ruled out doing a longitudinal analysis, due to the very time-consuming work of data collection.

2. Method

2.1 Pilot study

Before starting data collection we did a "feasibility study" that addressed two issues. Firstly we checked our ability to obtain copies of articles from journals indexed in Scopus or at least the abstracts if they happen to contain the necessary information. Secondly we checked whether the journals or their freely available abstracts included sufficient information on the publication timeframe. It was necessary to check access to electronic copies of the journals through our libraries' electronic holdings as we felt it would not be feasible to gather the data from paper copies of a given journal or get the necessary copies via interlibrary loan. Access to the journals was checked via the libraries of Hanken School of

Economics and Michigan State University. For this pilot study we randomly selected 100 journals indexed in Scopus.

A total of 66% of these journals were available through either the electronic holdings of our libraries or they were freely available on line and were deemed to be appropriate for analysis. The majority of journals we could not find or gain access were smaller journals published in other countries than the US, UK, Netherlands and Germany.

Sixty-four percent of the available journals contained at least the submission and acceptance dates and it was possible to determine the date of publication either as listed or by the date of the issue in which an article was published. We also found that journals typically published the dates of up to five different key points in the publication process. These included, submission, revision based on feedback, acceptance, publication ahead of print in an electronic format, and final publication as part of an issue. The first four were usually included as dates, whereas the last item could often only be determined by the month of the issue which contained the article. The results of the pilot study confirmed that there is enough data available to make the study feasible.

2.2 Main study

The main source database for the study was the Scopus citation index, which contains information about some 19,500 scholarly journals, including the yearly article and citation counts. The SCImago Journal & Country Rank web site (SCImago, 2013) provides freely accessible Scopus data at the journal level which was the data source for this study.

Elsevier, the publisher of Scopus provides a freely downloadable spreadsheet on their web site (Scopus, 2013) that among other information provides a hierarchical classification of each journal's discipline. The highest classification included only 4 categories and was felt to be too broad. The second level includes 27 categories and was felt to be too specific. We decided to merge some of these latter groups based on our subjective assumption of similarity in reviewing culture and publication speed resulting in nine groups. These include arts/humanities, biomedicine, business/economics, chemistry, earth science, engineering, mathematics, physics, and social sciences.

We hypothesized that there were differences in the publication time associated with journal size. We stratified by size in such a way to ensure each article within a discipline category had an equal chance of inclusion in the study. The journals were ordered by size based on Scopus article counts in 2010. The journals containing the first third of the articles in a discipline made up the smallest journal strata, the journals containing the middle third made up the middle journal strata and the last third of the articles the large journal strata. This resulted in a much smaller number of journals in the largest journal strata though an equal number of articles per strata.

We randomly ordered the journals in each discipline/size strata and went through the journals in order checking to see if they were available from either of our two libraries, Hanken School of Economics and Michigan State University or at least the abstract or journal was freely available and contained the necessary dates. For those journals we were able to access, we checked first whether they appeared to be peer-reviewed scholarly journals and contained at least the dates of submission and acceptance. When an appropriate journal was found we selected 20 articles working backward from the last article published in 2012. Special issues, invited articles and editorials where skipped. For each article we recorded the ISSN, DOI, or if not easily obtained, title, submission and acceptance dates. If available we also recorded the date a revision request was made and the date the article was published electronically ahead of print. Publication date unless stated specifically was based on the midpoint of the publication period. So if a journal was published monthly, it was the 15th of the month the issue was published. If it was quarterly, the date was the middle of the quarter, for example February 15th for the first quarter. A handful OA journals contained exact date of final publication, which was used in place of an estimated date. When our method of determining the publication date resulted in a negative number of day between acceptance and publication, we set the number of days from acceptance to publication to zero. While we originally calculated the time between submission and acceptance and the time between acceptance and publication in days, for the purposes of analyzing and presenting the data, we converted days into months by dividing by 30.44.

Five journals were included for each size group for each of the 9 discipline categories resulting in data for 135 journals and 2,700 articles. For the purposes of this study, the time from submission to acceptance and acceptance to publication measured in months was used as the main outcome variables. Source Normalized Impact per Paper (SNIP) version 2 citation measures were obtained from the JournalM3trics web site (2013). We also obtained information on whether a journal was in the Directory of Open Access Journals (DOAJ).

Data management and most of the analyses were conducted using the Statistical Package for the Social Sciences (SPSS). Most analyses were conducted at the level of individual articles. Since SNIP values are assigned to journals, we averaged the time from submission to acceptance and from acceptance to publication for assessing the relationship between these times and each journal's SNIP.

The data collected formed a balanced design and hence it was possible using analysis of variance (ANOVA) to partition the variance associated with each factor in the design. Discipline was crossed with size group. Journals were nested in both discipline and size group and articles were nested in a journal. Discipline and size group were considered to be fixed effects while journals and articles within a journal were considered to be random effects that were sampled. Based on this design we estimated the variance components for the time between submission and acceptance as well as acceptance and publication using GENOVA (Brennan, 2001). This analysis was used to assess the percentage of the variance in the times from submission to acceptance and from acceptance to publication

that could be attributed to each source, discipline, size, their interaction, journals and articles within journals.

3. Results

Although more detailed data were available for some journals, we focused the reporting on the time from original submission to acceptance and from acceptance to final publication as we felt these were the key time points and we were able to obtain complete data across all disciplines and size groups. The first time period reflects the delay due to the peer review and revision process used by a journal and the second the length of the publishing process, backlog due to publication page limits and potentially other factors.

Table 2 presents summary statistics for submission to acceptance, acceptance to publication and total time submission to publication. Figures 1 and 2 present this information in graphic form for the 9 disciplines (Figure 1) and 3 journal size groupings (Figure 2). Detailed summary statistics for the breakdown by disciplines and size groups are contained in the Appendix. As can be seen in Figure 1, total time from submission to publication varies significantly by discipline with business at just under 18 months having publication times nearly twice that of chemistry at about 9 months. Larger journals appear to have the shortest publication times with mid-sized journals the longest.

Based on inclusion in the DOAJ there were 19 Open Access (OA) journals or approximately 14% of the sample. Of these, 7 were determined to be OA from their inception and 12 were determined to have been converted to OA at some point. The latter usually means that the journal may still publish a parallel paper version and also it typically bundles the articles in issues. The methodology for determining born versus converted are described elsewhere (Solomon, Laakso & Björk, 2013). Table 3 presents the average time in months submission to acceptance and acceptance to publication for journals created as OA and those that converted to OA. Submission to publication times appear to be considerably shorter for OA journals, particularly those that were created as OA journals. The differences were reflected in both received to accepted and accepted to published but the greatest differences, particularly for the journals created OA were in accepted to published times. These differences should be considered with caution as the sample sizes are fairly small and the percentages of journals within each discipline are not balanced.

We felt there may be a correlation between publication times and the citation rate of the journal. Since citation rate is at the level of the journal rather than the article, we aggregated to the level of a journal using averages for the times from submission to acceptance and from acceptance to publication. We used SNIP as the citation measure because these statistics are normalized to account for differences in citation rates across disciplines. The Pearson product moment correlation between SNIP and submission to acceptance and acceptance to publication were 0.20 and -0.09 respectively. The correlation for the time from

submission to acceptance with SNIP was significantly different from zero p< 0.02.

Table 4 contains the estimated variance components[1] for discipline, size group, journals within discipline/size group and articles within journals. For submission to acceptance, the variation among journals and articles accounted for the bulk of the variation, mostly in terms of articles within journals. For acceptance to publication, again the variation was almost entirely among journals and articles nested in journals. For this component however the variation among journals accounted for the bulk of the variation.

4. Discussion

The results of this study have to be interpreted with some caution. The main caveat is that we were only able to include data from journals that published the submission and acceptance dates while in most cases the publication date was inferred from the issue and estimated as the mid-point of the publication period for the issue. Since the decision to publish this information was generally consistent across all the journals of a particular publisher, only those publishers that choose to publish submission and acceptance date are included in the study. This resulted in 54% of the sample being published by the two biggest publishers Elsevier and Springer/Kluwer. This was not our intention but was the result of the limitation noted above. A list of the publishers included in the study the number of journals from each publisher included is contained in the Appendix.

There were striking differences between disciplines with business/economics having around twice the total delay submission to publication compared to chemistry. Differences were also found in terms of the size of the journal though they were fairly modest with the larger journals appearing to be the most efficient both in terms of the time from submission to acceptance and in publishing articles once accepted.

Open access journals, particularly those which were created as OA journals rather than were converted from subscription appear to be able to publish articles considerably more quickly than subscription journals. This in part may reflect the fact they are electronic only and tend to publish articles as they are ready rather than bundling them into issues. Given the small numbers and the fact the OA journals are not evenly distributed across disciplines these finding should be interpreted with a great deal of caution.

The analysis of variance indicates most of the variation in publication times is at the level of individual journals and articles. For the time from submission to

[1] The components for the fixed factors, discipline, journal size level and their interaction are not true variance components. Since they are fixed effects they are not statistical expectations but quadratic forms that are averages similar in nature to a variance component. (Brennan, 2001) Since the distinction is irrelevant for the purposes of this study, we will refer to these quadratic forms as variance components in the discussion of the results.

acceptance, the bulk is among articles. This is not surprising. There are many idiosyncratic factors that influence the length of individual article reviews. Editors more often than not accept manuscripts pending revisions and authors vary greatly in how quickly they complete the revisions. Hence the length of the review process for a particular article may reflect the actions of the author rather than the editor or reviewers. All these and other factors result in significant differences in review times among submissions for a specific journal.

There was also considerably more variation among journals within a discipline and size group than among disciplines and size groups. This indicates there are real differences in this important aspect of publishing that are not explained by either the anomalies of individual reviews or the culture of review of different fields. Some journals just appear to be faster in conducting the review process. This likely in part reflects the level and number of cycles of revisions typically required by the editor. It also may reflect how quickly manuscripts go out for review and what expectation the editor or editorial team has for how long a reviewer should take in reviewing a manuscript.

For the time from acceptance to publication the vast majority of the variation is among journals. Again, this does not seem surprising. The backlogs in processing manuscripts through typesetting and copyediting, frequency of publication and the backlog due to page limits if they exist would all largely impact on publication times at the journal level.

5. Conclusions

We believe this to be the first broad study of publishing delays, covering all fields of science. Our study also differs from all earlier studies by our use of a random sample covering journals of all quality levels. Previous studies, have usually used small convenience samples of typically top journals in their fields, which introduces a strong bias towards journals that may include long review processes. Our results are, nevertheless, not in conflict with the earlier studies, but instead, add to them. The methodology was very labor intensive and it would be very useful for future studies if publishers included the date of submission and acceptance as a standard part of their article information. This would provide a level of transparency for potential authors as to the delays they could expect in review and publication processes when considering where to submit their manuscripts. It would also provide a strong incentive for journals to speed up these processes.

The aim of our study was to provide overall data on review and publishing times across various fields of science. We did not attempt to determine how delays have evolved over time. Some of the earlier studies have done this, but we made a conscious choice to concentrate on the differences between disciplines, due to the resource intensiveness of our method. A longitudinal study would be a good topic for a follow-up study, and should ideally go back around 25 years, to the time before email, web submission systems and electronic publishing. That

would on the other hand also imply challenges in finding the data with the articles.

It would be very useful to make a more detailed study of why delays differ so much between disciplines, Our impression is that the clear differences among fields have evolved over decades through the development of intra-disciplinary social norms for what is expected from a scholarly journal in the field. This includes what is an acceptable delay for informing authors of review results and acceptance or rejection decisions as well as the processing and queuing time once a manuscript is accepted. This is in line with the conclusions of for instance Ellison (2000). These differences in review and publication times may also reflect the nature of the disciplines. For example in rapidly developing fields where separate groups of researchers may be racing to achieve a particular breakthrough, the speed of the publication process can determine which group gains credit for the breakthrough as publication has become the de facto determiner of who gets the credit for a major finding.

Other interesting topics for further studies would be the differences between journals within a discipline and articles within journals. For some individual articles the delay times can be excessively long. The delays can be due to the authors taking excessively long times making revisions after the original review cycle. They can also be due to excessively long review periods or delays in the publication process. As found in this study, most of the variation in submission to acceptance times is among individual manuscripts within a journal while most of the variation in acceptance to publication time is among journals within a discipline/size group. Since publication delays are both detrimental to the careers of individual scholars and retard the rate at which scientific fields advance, understanding and attempting to minimize unnecessary delays in the peer-review and publication process is in everyone's best interest.

One of the reasons for the popularity of OA journals, in addition to the wider dissemination, is the belief that they have much faster submission to publication times. This perception is often highlighted in the promotional material for fully electronic OA journals. It appears from our very limited sample of OA journals that journals which are only disseminated in digital form and publish articles individually as they are ready tend to have considerably shorter submission to publication periods with most of the difference due to shorter acceptance to publication times. A follow-up study comparing subscription journals with OA-journals would need to further split up OA-journals into a number of subgroups, such as megajournals (PloS ONE and closes), journals from so-called predatory journals with spam academics with emails promising very rapid publication and high quality OA journals.

Some critics of the current system have discussed the almost de facto standard journal policy of not allowing authors the possibility of submitting their manuscripts to other journals in parallel (Torgerson et al 2005), as long as the article has not been definitely rejected (Piron 2001). This policy can result in long delays in the publication process of articles rejected in the first-choice journal potentially rendering the results of the research outdated and of little use

by the time it is finally published. The policy is often justified by saying that it would be very inefficient and unfair to editors and referees if the same articles would be refereed in several journals at the same time. On the other hand exactly the same thing happens when articles after rejection or author withdrawal are resubmitted to other journals and new reviewers get involved. Interestingly there is one journal category where this rule is not enforced, law journals published by leading US universities, which allow authors to submit to competing journals simultaneously. Although no empirical studies could be found of the publishing delay in these law journals, several authors for example (Posner, 2008) have pointed out that the delays are much shorter than in other fields. If publishers are going to stick to the demand that authors refrain from multiple simultaneous submissions of a manuscript then it seems to us, that they have an obligation to make the publication process as fast and efficient as possible.

Electronic publication offers a real potential for speeding up the scholarly journal publishing process, but in order to achieve this journals have to stop publishing a parallel paper version and need to convert to publishing articles in an issue-less mode as they become available. This is exactly what most born electronic journals do, and as their share of publishing increases, average publishing delays will tend to decrease.

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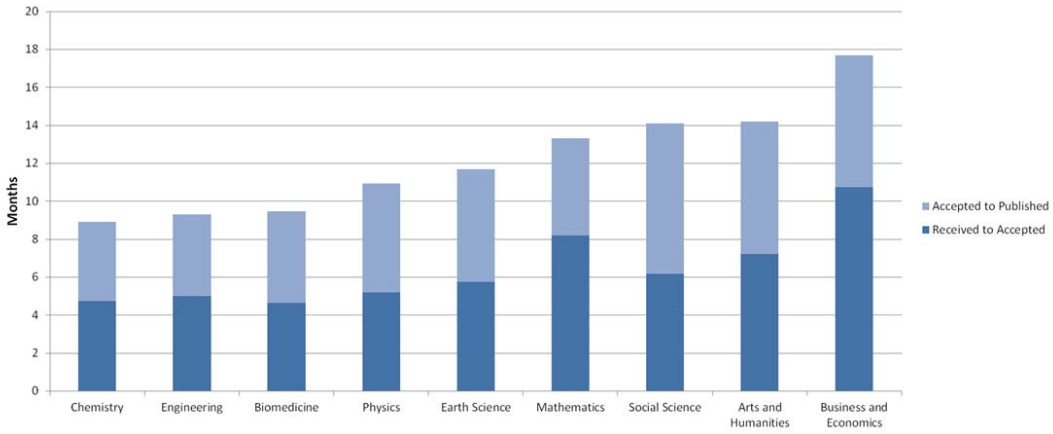

Figure 1: Average Publication Times in Months by Discipline

Figure is based on 15 journals per discipline, 5 for each size group, 20 articles per journal resulting in a total of 300 articles per discipline.

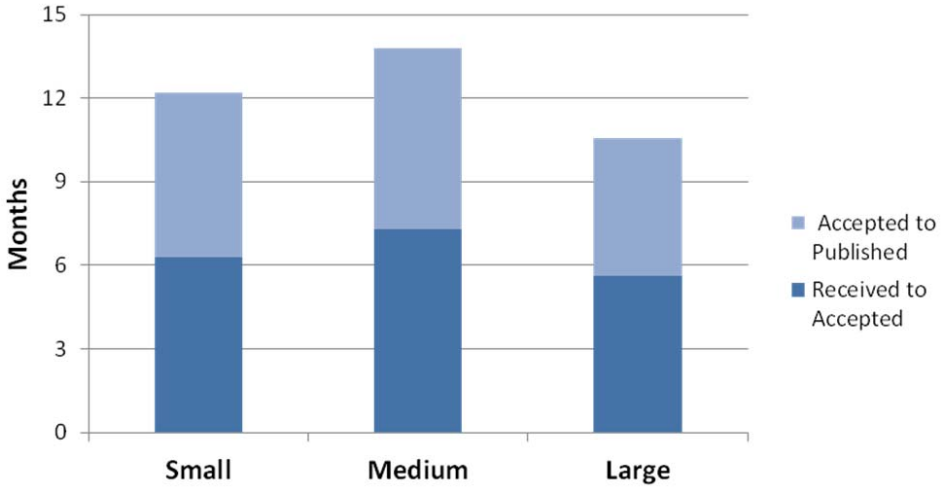

Figure 2: Average Publication Times in Months by Journal Size Group

Figure is based on 45 journals per size group, 15 for each discipline, 20 articles per journal resulting in a total of 900 articles per size group.

Table 1. Previous studies concerning publication delays in scholarly journals.

Study	Included journals	Period studied	Discipline	Delay (months)	
				Average	Range
Yohe 1980	25 journals	1980	Economics	18.9	4.9 – 28.7
Trivedi 1993	7 journals	1986-1990	Econometrics	22.8	19.7 –31.4
Carroll 2001	6 journals	1994, 1999	Statistics	22.3	15.0 - 26.0
Kling and Swygart-Hobaugh 2002	3 social science journals	1970/1980, 2000	Econ., management	23.8	17.0 –29.4
Kling and Swygart-Hobaugh 2002	3 natural science journals	1970/1980, 2000	Physics, Chemistry	5.8	4.0 – 7.4
Hartmann 1997	One journal	1970, 1997	Atmospheric Sciences	15.4	
Luwel and Moed 1998	15 journals	1992	Physical sciences, Eng.	9.4	2.5-17.0
Diospatonyi et al 2001	10 journals	1985-1999	Analytical chemistry	7.1	3.5 – 12.5
Raney 1998	One journal	1997	Geoscience	21.8	11.5 - 36.5
Yu et al 2004	7 journals	2002	Mainly engineering	15.1	5.5 – 20.0
Amat 2008	14 journals	2004	Agriculture	11.8	6.2 – 17.2
Dong et al 2006	28 commercial, Society and OA	2004	Biomedicine	6.3	3.0 -11.0
Björk and Turk 2006	One OA and two conventional	2005	Civil Engineering	14.5	6.7 – 18.9
Khosrowjerdi et al 2011	26 Iranian journals	2009	Cross-disciplinary	17.3	5.8 – 34.6

Table 2 Time Submission to Publication Totals

	Months Submitted to Accepted	Months Accepted to Published	Months Submitted to Published
Mean	6.41	5.78	12.18
Std. Deviation	5.35	4.21	7.17
Std. Error of Mean*	0.10	0.08	0.14

Statistics based on 135 Journals / 2,700 Articles
*The Standard errors of the means are approximate due to the lack of independence between articles in the same journal.

Table 3 Time Submission to Publication for OA Journals

Created Open Access		Months Submitted to Accepted	Months Accepted to Published	Months Submitted to Published
Yes	Mean	4.17	1.80	5.97
	Std. Deviation	3.08	1.56	3.77
	Std. Error of Mean	0.26	0.13	0.32
	Number	7 Journals / 140 Articles		
No	Mean	5.12	4.76	9.88
	Std. Deviation	4.37	5.17	7.90
	Std. Error of Mean	0.28	0.33	0.51
	Number	12 Journals / 240 Articles		

The standard errors of the mean are approximate due to lack of independence among articles in the same journal.

Table 4 Estimated Variance Components

Submit to Accept			Accept to Publish		
	Variance	**Percent**		**Variance**	**Percent**
Discipline	3.44	12%	**Discipline**	0.83	5%
Journal Size	0.52	2%	**Journal Size**	0.31	2%
Journal	8.49	29%	**Journal**	12.88	71%
Article	16.46	56%	**Article**	4.20	23%
Size x Discipline	0.49	2%	**Size x Discipline**	0.00	0%
Total	29.41		**Total**	18.23	

Publication Time in Months by Discipline

Discipline		Months Submitted to Accepted	Months Accepted to Published	Months Received to Published
Chemistry	Mean	4.73	4.18	8.91
	Std. Deviation	5.46	3.60	7.30
	Std. Error of Mean	0.32	0.21	0.42
Engineering	Mean	5.00	4.30	9.30
	Std. Deviation	3.68	3.06	5.29
	Std. Error of Mean	0.21	0.18	0.31
Biomedicine	Mean	4.65	4.82	9.47
	Std. Deviation	3.47	4.11	5.18
	Std. Error of Mean	0.20	0.24	0.30
Physics	Mean	5.21	5.72	10.93
	Std. Deviation	3.26	2.66	4.41
	Std. Error of Mean	0.19	0.15	0.25
Earth Science	Mean	5.74	5.96	11.70
	Std. Deviation	4.80	4.66	7.24
	Std. Error of Mean	0.28	0.27	0.42
Mathematics	Mean	8.20	5.11	13.30
	Std. Deviation	6.21	2.45	6.87
	Std. Error of Mean	0.36	0.14	0.40
Social Science	Mean	6.17	7.93	14.10
	Std. Deviation	4.36	5.73	7.32
	Std. Error of Mean	0.25	0.33	0.42
Arts and Letters	Mean	7.21	7.00	14.21
	Std. Deviation	5.26	5.38	7.71
	Std. Error of Mean	0.30	0.31	0.44
Business/Economics	Mean	10.75	6.96	17.70
	Std. Deviation	7.15	3.19	7.52
	Std. Error of Mean	0.41	0.18	0.43
All Journals	Mean	6.41	5.78	12.18
	Std. Deviation	5.35	4.21	7.17
	Std. Error of Mean	0.10	0.08	0.14

There are 15 journals, 5 per each size group and 20 articles per journal

Standard error of the mean is approximate due to lack of independence among articles in a journal.

Number of Journals from Each Publisher Included in the Study

Publisher	Number	Percent
American Chemical Society	1	0.8%
American Dairy Science Association	1	0.8%
American Physiological Society	1	0.8%
American Psychiatric Publishing, Inc.	1	0.8%
American Psychological Association	1	0.8%
American Society of Civil Engineers	1	0.8%
American Vacuum Society	1	0.8%
Arizona State University	1	0.8%
Australasian Association of Psychology and Philosophy	1	0.8%
Bentham Science Publishers	1	0.8%
BioMed Central	1	0.8%
Blackwell Publishing Inc.	3	2.3%
Butterworth Scientific Ltd.	1	0.8%
Cell Press	1	0.8%
Central Fisheries Research Institute	1	0.8%
Cognizant Communication Corp.	1	0.8%
Consejo Superior De Investigaciones Cientificas	2	1.5%
Copernicus Gesellschaften	1	0.8%
Electrochemical Society, Inc.	1	0.8%
Elsevier	61	46.6%
European Respiratory Society	1	0.8%
Geophysical Society of Finland	1	0.8%
Hindawi Publishing Corporation	1	0.8%
Institute for Ionics	1	0.8%
Institute of Physics Publishing	1	0.8%
Istituti Editoriali e Poligrafici Internazionali	1	0.8%
JAI Press	1	0.8%
Maik Nauka/Interperiodica Publishing	1	0.8%
Marcel Dekker Inc.	3	2.3%
Molecular Diversity Preservation International	1	0.8%
Oldenbourg Wissenschaftsverlag GmbH	1	0.8%
Opragen Publications	1	0.8%
Oxford University Press	1	0.8%
Pan American Health Organization/Organizacion Panamericana de la Salud	1	0.8%
Prolegomena: Journal of Philosophy	1	0.8%
Public Library of Science	1	0.8%
Raptor Research Foundation, Inc.	1	0.8%
Royal Society of Chemistry	2	1.5%
Royal Society of London	1	0.8%
SAGE Publications	1	0.8%
Springer Pub. Co.,	14	10.7%
Taylor & Francis	1	0.8%

Universidad de los Andes	1	0.8%
Universidad de Murcia	1	0.8%
Universidad Nacional de Colombia	1	0.8%
Universidade Estadual Paulista	1	0.8%
Universidade Federal do Rio de Janeiro	1	0.8%
University of the Aegean	1	0.8%
Versita (Central European Science Publishers)	1	0.8%
Wayne State University Press	1	0.8%
Wiley-Blackwell	2	1.5%

Publisher names retrieved from SCImago Journal & Country Rank website. http://www.scimagojr.com/