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Citation success index – An intuitive pair-wise journal comparison metric

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ABSTRACT

In this paper we present "citation success index", a metric for comparing the citation capacity of pairs of journals. Citation success index is the probability that a random paper in one journal has more citations than a random paper in another journal (50% means the two journals do equally well). Unlike the journal impact factor (IF), the citation success index depends on the broadness and the shape of citation distributions. Furthermore, it is insensitive to sporadic highly-cited papers that affect the IF. Nevertheless, we show, based on 16,000 journals containing ~2.4 million articles, that the citation success index is a relatively tight function of the ratio of IFs of journals being compared. This is due to the fact that journals with the same IF have quite similar citation distributions. The citation success index grows slowly as a function of IF ratio. It is substantial (>90%) only when the ratio of IFs exceeds ~6, whereas a factor of two difference in IF values translates into a modest advantage for the journal with higher IF (index of ~70%). We facilitate the wider adoption of this metric by providing an online calculator that takes as input parameters only the IFs of the pair of journals.

1. Introduction

Most authors of research articles, whether in teams or as individuals, ultimately aim to maximize the impact of their publications, even when this goal is expressed as a desire to reach the widest possible audience (Gordon, 1984; Luukkonen, 1992). The simplest and most direct indication of an impact of a publication is the number of citations it has received over some period of time. Despite warnings from the scientometrics community against the inappropriate interpretation of the research metrics (e.g., Hicks, Wouters, Waltman, de Rijcke, & Rafols, 2015), the author's citation count and the related h-index (Hirsch, 2005) can still be critical factors for funding, hiring, tenure and promotion decisions (Wouters, 2014).

To increase the visibility of their work within the scientific community, and eventually help increase their citation counts, authors often engage in various activities, such as presenting their work at conferences, giving colloquia, etc. Many authors believe that having a publication in a higher-impact venue is yet another avenue for increasing the visibility of their work, which may lead to receiving more citations and consequently more rewards (Calcagno et al., 2012). In particular, the authors often aspire to publish in high-impact, general-science journals, rather than the less prestigious specialized venues (Verma, 2015). Even when choosing among alternative specialized venues, authors tend to give preference to higher ranked ones (Garfield, 2006; Rousseau & Rousseau, 2012). A recent ethnographic study that examined the role of the performance metrics

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in knowledge production has found that some researchers think "that articles appearing in high impact journals generally attract larger citation numbers *precisely because they are published in high impact journals*" (Rushforth & De Rijcke, 2015; p. 133). Consequently, some authors adopt a practice of targeting the highest-impact venue first, "cascading" to journals with lower impact until acceptance (Gordon, 1984), even though this process can exert significant publication delays and place a burden on editors and reviewers, as well as the authors. It is outside of the scope of this paper to try to establish to what extent are such attitudes correct. There is some empirical evidence that very similar articles published in journals with higher impact factors do end up receiving more citations than their "twins" published in lower impact factor journals (Larivière & Gingras, 2010; Perneger, 2010; Shanahan, 2016). The prestige of a journal is often used, implicitly if not explicitly, as an assessment of the quality of research (De Rijcke, Wouters, Rushforth, Franssen, & Hammarfelt, 2016; Ravetz, 1971), so it is not surprising that the papers published in more prestigious journals will reach a wider audience, especially considering that many researchers do not have the time to learn about all the research being published in their research areas, instead giving priority to higher-ranked journals in their field and to prestigious general-science journals. (De Rijcke et al., 2016; Rushforth & De Rijcke, 2015).

Journal impact factor (IF), often considered "a direct reflection of a journal's prestige or quality" (Moed, 2010; p. 91), is the most widely used journal impact measure (Glänzel & Moed, 2002). The IF is a metric introduced by Eugene Garfield in 1972 (Garfield, 1972), and its definition is rather simple. The IF of a venue in year y equals the number of citations received in y to all documents published in that venue in the preceding two years ($y-2$ and $y-1$), divided by the number of "citable documents" (defined as research articles and reviews) covered by the citation database (Moed & van Leeuwen, 1996). Official IF values are released annually by the Thomson Reuters Journal Citation Reports.

Despite the prevalence of an IF as a measure of journal impact, there is a large body of research arguing that evaluating the impact of journals is not a straightforward task (Bar-Ilan, 2012; Bornmann, Werner, Gasparyan, & Kitas, 2012; Haustein, 2012; Rousseau, 2002; Thelwall, 2012; Waltman, 2016). For example, the database coverage has a strong effect on the IF, thus disadvantaging fields with strong non-English literature (e.g., social sciences and humanities) (Leydesdorff & Milojević, 2015) or the ones that publish heavily in non JCR-indexed literature (e.g., computer science and humanities) (Althouse, West, Bergstrom, & Bergstrom, 2009). Nevertheless, IF has been used by journal editors and publishers to attract submissions and readership, and by researchers as an indicator of prestige and as a tool for screening an ever-growing body of literature for reading and, eventually, citing (De Rijcke et al., 2016; Rushforth & De Rijcke, 2015).

The most contested and criticized usage of IFs has been to assess, at least in the short-term, the quality of individual scientific publications on the basis of the IF of the venue (e.g., Archambault & Larivière, 2009; DORA, 2012). At the heart of this criticism lies the fact that the IF is a very poor predictor of the number of citations that a given paper will receive (Seglen, 1992, 1997). The reasons for this are essentially two-fold: (1) the citation distributions for individual journals are broad and therefore overlap even if their IFs are quite different (Larivière et al., 2016). (2) Furthermore, these wide citation distributions are skewed, so that the IF, being based on an arithmetic mean, may be affected by the tail of a small number of highly-cited articles. These limitations of the IF have led to a recent proposal that journals should advertise full citation distributions (the number (or fraction) of papers that have received 0, 1, 2,. . . citations) rather than just the IFs (Larivière et al., 2016).

In this paper, we present a new metric that is specifically designed to compare pairs of journals and addresses the aforementioned limitations of the IF. The metric, which we call *citation success index*, depends on the shape (e.g., the broadness) of the citation distributions. Also, unlike the IF it is not skewed by sporadic highly-cited papers. We define the citation success index as the probability that a random paper in journal A has more citations than a random paper in journal B. This metric not only acknowledges the fact that some articles from a low-IF journal may receive more citations than some articles from a higher-IF journal, a point that was made in Larivière et al. (2016), but actually quantifies the likelihood of such outcome in a simple and intuitive way.

2. Materials and methods

For this study we use *Thomson Reuters* Web of Science (WoS) database of bibliographic records of journal articles. Specifically, we use all records that WoS classifies as the following document types: article, review and proceedings paper. These are the types of documents that are commonly cited, and feature in the calculation of the official IF in Journal Citation Reports (JCR). For simplicity, we will refer to these "citable" documents as "articles." We performed all of the analysis for citations received in 2010. Our results do not depend on the choice of year. For the analysis we selected 15,906 journals that have published 25 or more articles during the publication window (years 2008 and 2009). The cut was chosen to ensure well-sampled citation distributions, but the results are insensitive to the exact choice of the threshold. The total number of articles published in selected journals from 2008/09 is 2,352,554. The IF values computed from our data are smaller than those officially published by JCR by about 4%, because the latter includes citations to document types other than the articles (e.g., to editorials), as well as unmatched citations (citations for which the cited item is not identified other than that it belongs to that journal). See (Bar-Ilan, 2010; Larivière et al., 2016; McVeigh and Mann, 2009) for details. In our analysis, we have adjusted the computed IF values by multiplying by a factor of 1.04. Accurate reproduction of the official IFs is not essential for our analysis because the missing citations are not expected to change the citation distribution (Larivière et al., 2016).