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Journal topic citation potential and between-field comparisons: The topic normalized impact factor

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ABSTRACT

The journal impact factor is not comparable among fields of science and social science because of systematic differences in publication and citation behavior across disciplines. In this work, a source normalization of the journal impact factor is proposed. We use the aggregate impact factor of the citing journals as a measure of the citation potential in the journal topic, and we employ this citation potential in the normalization of the journal impact factor to make it comparable between scientific fields. An empirical application comparing some impact indicators with our topic normalized impact factor in a set of 224 journals from four different fields shows that our normalization, using the citation potential in the journal topic, reduces the between-group variance with respect to the within-group variance in a higher proportion than the rest of indicators analyzed. The effect of journal self-citations over the normalization process is also studied.

1. Introduction

This work is related to journal metrics and citation-based indicators for the assessment of scientific scholar journals from a general bibliometric perspective. For decades, the *journal impact factor* (JIF) has been an accepted indicator in ranking journals. However, there are increasing arguments against the fairness of using the JIF as the sole ranking criteria (Waltman & Van Eck, 2013).

The *2-year impact factor* published by Thomson Reuters in the *Journal Citation Reports* (JCR) is defined as the average number of citations to each journal in a current year with respect to 'citable items' published in that journal during the two preceding years (Garfield, 1972). Nevertheless, it has been criticized due to arbitrary decisions in its construction. The definition of 'citable items' including letters together with the peer reviewed papers (research articles, proceedings papers, and reviews), the focus on the two preceding years, the incomparability between fields, etc., have been discussed in the literature (Bensman, 2007; Moed et al., 2012) and have given many possible modifications and improvements (Althouse, West, Bergstrom, & Bergstrom, 2009; Bornmann & Daniel, 2008). In response, Thomson Reuters has incorporated the *5-year impact factor*, the *eigenfactor score*, and the *article influence score* (Bergstrom, 2007) to the JCR journals. All these indicators consider a 5-year citation window and are useful for comparing journals in the same subject category. However, subject

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categories may overlap and are sometimes problematic. Moreover, although in many cases the 5-year impact factor is greater than the 2-year impact factor, both indicators lead statistically to the same ranking (Leydesdorff, 2009; Rousseau, 2009). Alternative indicators, considering at the same time production and impact, are the *central area indices* (Dorta-González & Dorta-González, 2010, 2011; Egghe, 2013).

Nevertheless, all the previous impact indicators do not solve the problem when comparing journals from different fields of science. Different scientific fields have different citation practices and citation-based bibliometric indicators need to be normalized for such differences in order to allow for journal comparisons. This problem of field-specific differences in citation impact indicators comes from institutional research evaluation (Leydesdorff & Bornmann, 2011; Van Raan, Van Leeuwen, Visser, Van Eck, & Waltman, 2010). For example, research institutes often have among their missions the objective of integrating interdisciplinary bodies of knowledge which are generally populated by scholars with different disciplinary backgrounds (Leydesdorff & Rafols, 2011; Wagner et al., 2011).

There are statistical patterns which are field-specific and allow for the normalization of the JIF. Garfield (1979) proposes the term 'citation potential' for systematic differences among fields of science, based on the average number of references. For example, in the biomedical fields long reference lists with more than fifty items are common, but in mathematics short lists with less than twenty references are the standard (P. Dorta-González & M.I. Dorta-González, 2013a). These differences are a consequence of the citation cultures and can produce significant differences in the JIF, since the probability of being cited is affected. In this sense, the average number of references is the variable that has most frequently been used in the literature to justify the differences between fields of science, as well as the most employed in source-normalization (Leydesdorff & Bornmann, 2011; Moed, 2010; Zitt & Small, 2008). However, the variables that to a greater degree explain the variance in the impact factor do not include the average number of references (P. Dorta-González & M.I. Dorta-González, 2013a) and therefore it is necessary to consider other sources of variance in the normalization process, such as the ratio of references to journals included in the JCR, the field growth, the ratio of JCR references to the target window, and the proportion of cited to citing items. Given these large differences in citation practices, the development of bibliometric indicators that allow for between-field comparisons is clearly a critical issue (Waltman & Van Eck, 2013).

Traditionally, normalization for field differences has usually been done based on a field classification system. In said approach, each publication belongs to one or more fields and the citation impact of a publication is calculated relative to the other publications in the same field. Most efforts to classify journals in terms of fields of science have focused on correlations between citation patterns (Leydesdorff, 2006; Rosvall & Bergstrom, 2008). An example of a field classification system is the *JCR subject category list* (Pudovkin & Garfield, 2002; Rafols & Leydesdorff, 2009). For these subject categories, Egghe and Rousseau (2002) propose the *aggregate impact factor* in a similar way as the JIF, taking all journals in a category as one meta-journal. However, the position of individual journals of merging specialties remains difficult to determine with precision and some journals are assigned to more than one category. In this sense, P. Dorta-González and M.I. Dorta-González (2013a) propose the *categories normalized impact factor* considering all the indexing categories of each journal.

Nevertheless, the precise delineation between fields of science and the next-lower level specialties has until now remained an unsolved problem in bibliometrics because these delineations are fuzzy at any moment in time and develop dynamically over time. Therefore, classifying a dynamic system in terms of fixed categories can lead to error because the classification system is defined historically while the dynamics of science is evolutionary (Leydesdorff, 2012, p. 359).

Recently, the idea of source normalization was introduced, which offers an alternative approach to normalizing field differences. In this approach, normalization is achieved by looking at the referencing behavior of citing journals. Journal performance is a complex multi-dimensional concept difficult to be fully captured in one single metric (Moed et al., 2012, p. 368). In this sense many indices, such as the *fractionally counted impact factor* (Leydesdorff & Bornmann, 2011; Zitt & Small, 2008), dividing each citation by the number of references, and the *2-year maximum journal impact factor* (P. Dorta-González & M.I. Dorta-González, 2013b), considering the 2-year citation time window of maximum impact instead of the previous 2-year time window, have been proposed. Other indicators for the Scopus database, with a 3-year citation time window and a different definition of citable items, are the *source normalized impact per paper SNIP* (Moed, 2010), dividing each citation by the median number of references, and the *scimago journal ranking SJR* (González-Pereira, Guerrero-Bote, & Moya-Anegón, 2009), considering the prestige of the citing journals.

However, all these metrics do not include any great degree of normalization in relation to the specific topic of each journal. The topic normalization is necessary because different scientific topics have different citation practices. Therefore, citation-based bibliometric indicators need to be normalized for such differences between topics in order to allow for between-topic comparisons of the citation impact. In this sense, we use the aggregate impact factor of the citing journals as a measure of the citation potential in the journal topic, and we employ this citation potential in the normalization of the journal impact factor to make it comparable between scientific fields. In order to test this new impact indicator, an empirical application with more than two hundred journals belonging to four different fields is presented. As the main conclusion, we obtain that our *topic normalized impact factor* reduces the between-group variance in relation to the within-group variance in a higher proportion than the rest of indicators analyzed, as well as not being influenced by journal self-citations.

2. The normalization of the impact factor using the citation potential in the journal topic

The editorial policy of a journal determines its explicit topic. However, the implicit topic can be determined by its scientific impact. In this sense, we can define the topic of the citation impact of a journal, hereafter journal topic, through all the citing