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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

Table 1
Notation.

Notation	Explanation
J	Journals in the database
$j \in J$	Journal in evaluation
T_j	Topic of journal j (meta-journal of all citing journals to j, excluding j)
$i \in T_j$	Journals in the topic of journal j
y	Current year (census period)
$y-1, y-2$	Citation time window (target window)
$NPub_y^j$	Number of publications (citable items) in journal j in year y
$NPub_y^J = \sum_{j \in J} NPub_y^j$	Number of publications (citable items) in database J
$v_y^j = \frac{NPub_{y-1}^j + NPub_{y-2}^j}{NPub_{y-1}^J + NPub_{y-2}^J}$	Weight of journal j in database J in the target window of year y
$NCit_{y,y-t}^{ij}$	Number of times in year y that the year $y-t$ volumes of journal j are cited by the journal i, $t=1, 2$
$w_y^{ij} = \frac{NCit_{y,y-1}^{ij} + NCit_{y,y-2}^{ij}}{\sum_{k \in T_j}(NCit_{y,y-1}^{kj} + NCit_{y,y-2}^{kj})}$	Weight of journal i in the topic of j in year y
$NCit_{y,y-t}^j = \sum_{i \in J} NCit_{y,y-t}^{ij}$	Number of times in year y that the year $y-t$ volumes of journal j are cited by journals in the database, $t=1, 2$
$JIF_y^j = \frac{NCit_{y,y-1}^j + NCit_{y,y-2}^j}{NPub_{y-1}^j + NPub_{y-2}^j}$	Journal impact factor of j in year y
$CP_y^J = \sum_{j \in J}(v_y^j \times JIF_y^j)$	Citation potential of database J in year y (aggregate impact factor in J)
$CP_y^{T_j} = \sum_{i \in T_j}(w_y^{ij} \times JIF_y^i)$	Citation potential of topic j in year y (aggregate impact factor in topic j)
$TNIF_y^j = \frac{CP_y^J}{CP_y^{T_j}} \times JIF_y^j$	Topic normalized impact factor of journal j in year y

journals. For example, if a journal j is cited by journals in n different fields, then the journal topic can be characterized by all these n fields in a proportional form to the number of citations to journal j.

We define the citation potential in the topic of journal j in a year y as the weighted average of the impact factors of all citing journals to j in the year y with respect to the previous two years. This average is weighted by the number of citations to j, excluding self-citations of j to j.

However, why does this citation potential characterize the journal topic? Given two journals with the same impact factor, the journal of the topic with less citation potential is more influential. This is because the probability of being cited is affected by the systematic differences in the citation cultures among topics.

The idea of normalizing the impact factor of a journal through all citing journals does not intend to assess each citation by the influence or prestige of the citing journal, but characterizes the journal topic in terms of its citation potential and uses it in the normalization process.

In this section we formulate a source normalization, considering the citation potential in the journal topic. We divide the JIF by the citation potential in the journal topic. Thus, if the JIF is higher than the citation potential in its topic then this ratio will be higher than the JIF, whereas if the JIF is smaller than the citation potential in its topic then this ratio will be smaller than the JIF.

In order to facilitate the reading of the formulation in the rest of this section, Table 1 shows the notation with its explanation.

2.1. The journal impact factor

A journal impact indicator is a measure of the number of times that items published in a census period, cite items published during an earlier target window. The impact factor reported by Thomson Reuters has a one year census period and uses the two previous years as the target window.

As an average, the impact factor is based on two elements: the numerator, which is the number of citations in the current year to any items published in a journal in the previous two years, and the denominator, which is the number of 'citable items' (articles, proceedings papers, reviews, and letters) published in the same previous two years (Garfield, 1972). Journal items include 'citable items' but also editorials, news, corrections, retractions, and other items.

Let $NPub_y^j$ be the number of publications (citable items) in journal j in year y. Let $NCit_{y,y-t}^j$ be the number of times in year y that the year $y-t$ volumes of journal j are cited by journals in the database, $t=1, 2$. Then, the journal impact factor of j in year y is:

$$JIF_y^j = \frac{NCit_{y,y-1}^j + NCit_{y,y-2}^j}{NPub_{y-1}^j + NPub_{y-2}^j}. \tag{1}$$

2.2. The citation potential of a database

As a reference measure in the normalization process we propose the citation potential of the database. This measure will be later used in the normalization weighting factor.

Let J be the set of all journals in a specific database (e.g. Web of Science, Scopus, etc.). Denoting $NPub_y^J = \sum_{j \in J} NPub_y^j$ and $NCit_{y,y-t}^J = \sum_{j \in J} NCit_{y,y-t}^j$, the citation potential in J is the ratio between the citations in year y to any journal of database J in years $y-1$ and $y-2$, and the number of citable items published in years $y-1$ and $y-2$, that is,

$$CP_y^J = \frac{\sum_{j \in J}(NCit_{y,y-1}^j + NCit_{y,y-2}^j)}{\sum_{j \in J}(NPub_{y-1}^j + NPub_{y-2}^j)} = \frac{NCit_{y,y-1}^J + NCit_{y,y-2}^J}{NPub_{y-1}^J + NPub_{y-2}^J}. \tag{2}$$

This citation potential can also be expressed as a weighted average impact factor considering weights proportional to the number of citable items in the target years. Let

$$\nu_y^j = \frac{NPub_{y-1}^j + NPub_{y-2}^j}{NPub_{y-1}^J + NPub_{y-2}^J} \tag{3}$$

be the weight of journal j in the database J in the target window of year y. Note that $\sum_{j \in J} \nu_y^j = 1$.

Then, from Eqs. (1)–(3),

$$CP_y^J = \frac{\sum_{j \in J}(NCit_{y,y-1}^j + NCit_{y,y-2}^j)}{NPub_{y-1}^J + NPub_{y-2}^J} = \sum_{j \in J} \frac{NCit_{y,y-1}^j + NCit_{y,y-2}^j}{NPub_{y-1}^J + NPub_{y-2}^J} = \sum_{j \in J} \left(\frac{NPub_{y-1}^j + NPub_{y-2}^j}{NPub_{y-1}^J + NPub_{y-2}^J} \times JIF_y^j \right) = \sum_{j \in J} (\nu_y^j \times JIF_y^j). \tag{4}$$

This formulation allows us to easily obtain the citation potential of the JCR database, which is 2.822 in year 2011 (P. Dorta-González & M.I. Dorta-González, 2013a). It also allows us to calculate, in a similar way, the citation potential in any set of journals (as discussed below).

2.3. The citation potential in the journal topic

Later, a journal topic normalization of the impact factor will be proposed. This normalization is achieved considering the aggregate impact factor in the topic of each journal, which characterizes its citation potential. The citation potential in the topic of a journal j is proposed as a weighted average of the impact factors of all citing journals i, excluding self-citations of journal j, weighted by the number of citations from i to j.

In a more formal way, we define the *topic* of a journal $j \in J$ as the set of all journals $i \in J$ that in the current year y cite the previous 2-years issues $y-1$ and $y-2$ of journal j, excluding journal j self-citations. In this topic the weight of each journal i is proportional to the number of citations from i to j.

In this definition, in a similar way as in the impact factor, we exclusively consider citations in the census year y to the target window of years $y-1$ and $y-2$ as the representation of the topic at the research front. We have proposed a formulation excluding journal self-citation because in some cases the percentage of journal self-citation is so high that it could lead to a normalized impact factor close to the classical JIF. However, the effect of journal self-citation in the normalization process is also studied in the empirical application.

Let T_j be the topic of journal j, that is, the meta-journal of all citing journals to journal j excluding journal j. Let $NCit_{y,y-t}^{ij}$ be the number of times in year y that the year $y-t$ volumes of journal j are cited by journal i in the database J, $t = 1, 2$. Therefore, the weight of journal i in the topic of journal j in year y is:

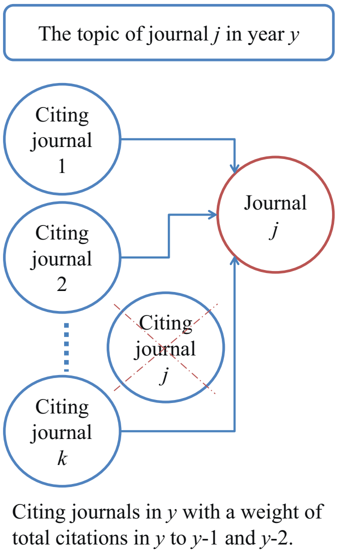
$$w_y^{ij} = \frac{NCit_{y,y-1}^{ij} + NCit_{y,y-2}^{ij}}{\sum_{k \in T_j}(NCit_{y,y-1}^{kj} + NCit_{y,y-2}^{kj})}. \tag{5}$$

Note that $\sum_{i \in T_j} w_y^{ij} = 1, \quad \forall j \in J$.

Therefore, in a similar way as in Eq. (4), the formulation of the citation potential in the topic of journal j (i.e. the aggregate impact factor of meta-journal T_j) as a weighted average impact factor is:

$$CP_y^{T_j} = \sum_{i \in T_j} (w_y^{ij} \times JIF_y^i). \tag{6}$$

This aggregate impact factor is a measure of the citation potential in the topic of journal j. Later, it will be used in the normalization of the indicator.



The citation potential of the journal topic

Let *j* be a journal with JIF = 2.000, and consider the following data about the citing journals (excluding *j*):

Citing journal	Total citations	Weight	JIF
1	100	100 / 200 = 0.5	1.000
2	60	60 / 200 = 0.3	2.500
3	30	30 / 200 = 0.15	0.800
4	10	10 / 200 = 0.05	1.400
Total	200	1	

Citation potential in the topic of journal *j*:
0.5×1+0.3×2.5+0.15×0.8+0.05×1.4 = 1.440.

Then, 2.000 / 1.440 = 1.39 and the JIF (2.000) is 39% greater than the citation potential in the journal topic (1.440).

Fig. 1. One example of journal topic and citation potential.

Consider the example in Fig. 1. Let *j* be a journal with JIF = 2.000 and the citing journals (excluding *j*) indicated in Fig. 1. The citation potential in the topic of journal *j* is 0.5 × 1.000 + 0.3 × 2.500 + 0.15 × 0.800 + 0.05 × 1.400 = 1.440. The journal impact factor (2.000) is 39% greater than the citation potential in the topic (2.000/1.440 = 1.39) and, therefore, in the comparison with other journals the JIF should be proportionally increased in a way that will be illustrated below.

2.4. The topic normalized impact factor

We propose a normalized citation indicator that compares 'actual' impact factor with 'expected' impact factor, based on the citation potential of its topic, i.e. the weighted average impact factor of all citing journals.

The ratio $CP_y^J/CP_y^{T_j}$ is the normalized score in the topic of journal *j*. If $CP_y^J = CP_y^{T_j}$ then this score is one. A score higher than one shows that the citation potential in the journal topic is below the citation potential in the database, while a score lower than one shows that the citation potential in the journal topic is above the citation potential in the database.

Therefore, we define the *Topic Normalized Impact Factor* of journal *j* in year *y* as:

$$TNIF_y^j = \frac{CP_y^J}{CP_y^{T_j}} \times JIF_y^j.$$

In the case where $CP_y^{T_j} = 0$ we consider that $TNIF_y^j = 0$. Notice that if $CP_y^{T_j} > CP_y^J$ then the score is lower than one and therefore it reduces the impact factor of journal *j*. Conversely, if $CP_y^{T_j} < CP_y^J$ then the score is higher than one and therefore it increases the impact factor of journal *j*.

In the example of Fig. 1, considering that $CP_y^J = 1.800$ then the normalized score of journal *j* is $CP_y^J/CP_y^{T_j} = 1.800/1.440 = 1.25$ and the $TNIF_y^j = 1.25 \times 2.000 = 2.500$. This amount is greater than the JIF because the citation potential of the database is greater than the citation potential in the topic of the journal.

3. Methods and materials

We used six impact indicators: 2-year journal impact factor (2-JIF), 5-year journal impact factor (5-JIF), eigenfactor score (ES), fractionally counted impact factor (FCIF), topic normalized impact factor (TNIF), and TNIF including self-citation (self-cite).

We designed a cluster sample. Cluster sampling is a two-stage sampling design in which, firstly, one single cluster is randomly selected from a set of clusters and, secondly, all observations in the selected cluster are included in the sample (Bornmann & Mutz, 2013). Four fields (journal categories), each one from a different cluster obtained by P. Dorta-González and M.I. Dorta-González (2013a), were considered. This was motivated in order to obtain journals with systematic differences in publication and citation behavior. A total of 224 journals were considered in this empirical application. The journal categories and the number of journals in each category are: Astronomy & Astrophysics (56); Biology (85); Engineering, Aerospace (27); and History & Philosophy of Science (56).

The bibliometric data was obtained from the online version of the 2011 *Journal Citation Reports* (JCR) during the first week of May 2013. The JCR database (reported by Thomson Reuters, USA) is available at the www.webofknowledge.com website.

The fractionally counted impact factor was obtained from Leydesdorff and Bornmann (2011) because this indicator is calculated on a different database than the JCR.

4. Results and discussion

In the empirical application we studied which impact indicator produces a closer data distribution among scientific fields in relation to its centrality and variability measures. We used six impact indicators: 2-year journal impact factor (2-JIF), 5-year journal impact factor (5-JIF), eigenfactor score (ES), fractionally counted impact factor (FCIF), topic normalized impact factor (TNIF), and TNIF with self-citation (self-cite).

Table 2 shows the impact indicators for a set of 224 journals from four fields. Two of the fields have higher impact factors (Astronomy & Astrophysics and Biology), while the other two have lower impact factors (Aerospace Engineering and History & Philosophy of Science). Notice the ampleness in the variation interval for each indicator. For example, the range is 26.452 for the 2-JIF and 29.657 for the 5-JIF. In the case of the TNIF, the range of variation is 31.237, while this range is 13.572 when considering journal self-citation. This means that removing the influence of journal self-citation produces an increase in the variability of the scores, and therefore, the discrimination ability of the indicator increases.

The general pattern in Table 2 is a 5-JIF higher than the 2-JIF. Moreover, in those fields with lower impact factors (Aerospace Engineering and History & Philosophy of Science) there is a higher increase in the TNIF in relation to the JIF. This effect reduces the differences between fields in the case of the TNIF.

Notice the ampleness in the variation interval for the citation potential in the journal topics. The score varies from 1.736 to 6.049 in Astronomy & Astrophysics, from 0.345 to 5.993 in Biology, from 0 to 2.952 in Aerospace Engineering, and from 0 to 6.777 in History & Philosophy of Science. Note the citation potentials in the journal topics are very different from one another even within the same field. This means that the journal topic is one possible explanatory factor in the variance of the impact indicators. This variance may also reflect differences in quality between the journals or the publication of certain document types (e.g. reviews) in some journals. Moreover, the difference in the score, with and without self-citation, is very relevant in many cases and above one in ten journals. Note the case of P NATL A SCI INDIA where this difference is 2.320, and J BIOL EDUC where this is 1.955, for example.

The citation potential of the journal topic has an inverse effect over the topic normalized impact factor. That is, the lower the citation potential of the journal topic, the greater the increment in the topic normalized impact factor and vice versa. With respect to the self-citation effect, in some cases the self-citation increases the citation potential of the journal topic, thereby reducing the TNIF, but in other cases it reduces the citation potential of the journal topic, thereby increasing the TNIF.

Tables 3 and 4 provide the Pearson correlations and the Spearman rank correlations for all pairs of indicators, both for journal categories and aggregate data. The fact that a perfect Spearman correlation results when the two indexes are related by any monotonic function, can be contrasted with the Pearson correlation, which only gives a perfect value when the two indexes are related by a linear function. In this sense, the Spearman correlation is less sensitive than the Pearson correlation to strong outliers that are in the tails of both distributions. This is because Spearman coefficient limits the outlier to the value of its rank.

We consider the three typical levels of confidence: 99%, 95%, and 90% (significance levels of 0.01, 0.05, and 0.10). In 55 out of 75 possible cases in Table 3 (Pearson correlations) the confidence level is above 99%, and in 4 cases it is above 90%. In the other 16 cases the confidence level is below 90%. However, in 66 out of 75 possible cases in Table 4 (Spearman correlations) the confidence level is above 99%, and in 6 cases it is above 90%. Only in 3 of the 75 possible cases the confidence level is below 90%.

The correlation coefficients are interpreted according to the guidelines of Cohen (1992). The square of the correlation coefficient (coefficient of determination) is the proportion of variance in either of the two variables which may be predicted by (or attributed to) the variance of the other, using a straight-line relationship. For example, when $r = 0.85$, $r^2 = 0.72$, the 72% of the variance in the dependent variable is attributable to the independent variable. Cohen (1988: 77–81) states as a guiding criterion in the behavioral sciences: small effect size $r = 0.10$, medium effect size $r = 0.30$, and large effect size $r = 0.50$. According to this criterion, in Table 3, there is large effect size in 43 out of 75 cases, medium effect size in 18 out of 75 cases, and small effect size in 14 out of 75 cases.

The general pattern that can be observed in the correlations reported in Table 3 is that 2-JIF and 5-JIF are very strongly correlated, with all of the Pearson correlations above 0.94. For the aggregate data this correlation is 0.99 and the 2-JIF can explain more than 98% of the variance in the 5-JIF ($0.99^2 = 0.98$). The two TNIFs, including and excluding self-citation, have in most cases correlations much larger than 0.85. In the aggregate data, each indicator explains more than 72% of the variance in the other ($0.85^2 = 0.72$).

The correlations between indicators are higher in those journal categories in which the impact factors are high (Astronomy & Astrophysics and Biology), with 15 out of 30 coefficients larger than 0.85, and lower in those in which the impact factors are low (Aerospace Engineering and History & Philosophy of Science), with 7 (Pearson) and 4 (Spearman) out of 30 coefficients larger than 0.85.

Table 2
Impact indicators for a set of 224 journals from four fields.

Abbreviated journal title	JCR category	2-JIF	5-JIF	ES	FCIF	Citation potential		Topic normalized	
						Self-cite	CP^{Tj}	Self-cite	$TNIF^{j}$
Acta Astronaut	EA	0.614	0.619	0.00541	0.05420	0.540	0.501	3.209	3.458
Acta Astronom	A&A	1.680	2.200	0.00227	0.22789	4.102	4.773	1.156	0.993
Acta Biol Hung	B	0.593	0.625	0.00071	0.12339	1.393	1.451	1.201	1.153
Adv Exp Med Biol	B	1.093	1.374	0.03161	–	0.965	0.964	3.196	3.200
Adv Space Res	A&A	1.178	1.066	0.01963	–	1.794	1.947	1.853	1.707
Aerobiologia	B	1.515	1.669	0.00110	–	2.101	2.308	2.035	1.852
Aeronaut J	EA	0.482	0.501	0.00158	0.06042	0.884	0.929	1.539	1.464
Aerosp Sci Technol	EA	0.983	0.934	0.00293	0.13795	0.734	0.706	3.779	3.929
Aerospace Am	EA	0.048	0.036	0.00026	0.00668	1.481	1.481	0.091	0.091
Agr Hist	H&PS	0.312	0.231	0.00017	–	0.176	0.137	5.003	6.427
Agr Hum Values	H&PS	1.540	1.717	0.00213	0.03927	1.095	1.057	3.969	4.112
AIAA J	EA	1.057	1.277	0.01749	0.18514	1.190	1.226	2.507	2.433
AIRCR Eng Aerosp Tec	EA	0.195	0.281	0.00053	0.00188	0.881	0.881	0.625	0.625
Am Biol Teach	B	0.133	0.199	0.00041	0.01314	0.345	0.345	1.088	1.088
Am J Bioethics	H&PS	4.083	3.581	0.00482	0.32004	1.331	1.079	8.657	10.679
Am J Hum Biol	B	2.267	2.211	0.00628	0.22760	1.444	1.342	4.430	4.767
Ambix	H&PS	0.444	–	0.00015	–	0.378	0.222	3.315	5.644
Ann Geophys-Germany	A&A	1.842	1.757	0.01989	0.36827	2.443	2.546	2.128	2.042
Ann Hum Biol	B	1.975	1.789	0.00280	0.12583	1.388	1.320	4.015	4.222
Ann Sci	H&PS	0.417	0.451	0.00051	0.08108	0.575	0.594	2.047	1.981
Annu Rev Astron Astr	A&A	26.452	29.657	0.02108	2.20106	5.500	4.944	13.572	15.099
Annu Rev Earth Pl Sc	A&A	7.227	8.850	0.01065	1.08572	3.138	3.038	6.499	6.713
Arch Biol Sci	B	0.360	–	0.00069	–	0.575	0.767	1.767	1.325
Arch Hist Exact Sci	H&PS	0.184	0.218	0.00019	0.06667	0.122	0.000	4.256	0.000
Asia Life Sci	B	0.239	0.215	0.00008	–	0.446	0.524	1.512	1.287
Astrobiology	A&A	2.150	2.806	0.00608	0.39406	2.331	2.392	2.603	2.536
Astrobiology	B	2.150	2.806	0.00608	0.39406	2.331	2.392	2.603	2.536
Astron Astrophys	A&A	4.587	3.979	0.25425	0.43125	4.723	4.789	2.741	2.703
Astron Astrophys Rev	A&A	11.526	14.108	0.00548	1.07239	5.614	5.586	5.794	5.823
Astron Geophys	A&A	0.607	0.403	0.00046	0.11694	3.114	3.197	0.550	0.536
Astron J	A&A	4.035	4.317	0.07981	0.46921	5.020	5.210	2.268	2.186
Astron Lett+	A&A	0.988	0.865	0.00258	0.19316	2.593	3.169	1.075	0.880
Astron Nachr	A&A	1.012	0.862	0.00675	0.13215	4.079	4.313	0.700	0.662
Astron Rep+	A&A	0.725	0.671	0.00187	0.17826	1.892	2.729	1.081	0.750
Astropart Phys	A&A	3.216	2.783	0.01063	0.54674	4.098	4.239	2.215	2.141
Astrophys Bull	A&A	0.843	–	0.00060	–	1.854	2.830	1.283	0.841
Astrophys J	A&A	6.024	5.102	0.42962	0.53774	5.217	4.769	3.259	3.565
Astrophys J Lett	A&A	5.526	–	0.15733	–	5.195	5.162	3.002	3.021
Astrophys J Suppl S	A&A	13.456	11.438	0.07640	1.34721	5.011	4.564	7.578	8.320
Astrophys Space Sci	A&A	1.686	1.344	0.01240	0.19411	2.393	2.737	1.988	1.738
Astrophysics+	A&A	0.467	0.409	0.00058	0.03317	2.465	4.079	0.535	0.323
B Astron Soc India	A&A	2.722	–	0.00069	–	4.169	4.307	1.843	1.783
B Hist Med	H&PS	0.514	0.913	0.00109	0.11131	0.188	0.155	7.715	9.358
B Math Biol	B	1.847	2.002	0.00812	0.27554	1.623	1.605	3.211	3.247
B Stor Sci Mat	H&PS	0.000	–	0.00001	–	0.000	0.000	0.000	0.000
Balt Astron	A&A	0.444	0.575	0.00100	0.06481	3.356	4.909	0.373	0.255
Ber Wissgesch	H&PS	0.289	–	0.00016	–	1.098	1.401	0.743	0.582
Biocell	B	0.630	0.710	0.00057	0.06176	2.097	2.097	0.848	0.848
Bioelectrochemistry	B	3.759	3.238	0.00644	0.21842	2.584	2.541	4.105	4.175
Bioelectromagnetics	B	1.842	2.165	0.00330	0.25775	1.422	1.251	3.656	4.155
Bioessays	B	4.954	4.754	0.02410	0.50921	1.658	1.606	8.432	8.705
Biol Bull+	B	0.200	0.247	0.00055	0.01550	0.470	0.680	1.201	0.830
Biol Bull-US	B	1.698	2.197	0.00414	0.32143	1.486	1.477	3.225	3.244
Biol Direct	B	4.017	3.860	0.00690	–	3.383	3.287	3.351	3.449
Biol Letters	B	3.762	4.049	0.02992	–	2.362	2.327	4.495	4.562
Biol Philos	H&PS	1.203	1.360	0.00184	0.17451	1.873	1.960	1.813	1.732
Biol Res	B	1.029	1.269	0.00173	0.16880	1.472	1.521	1.973	1.909
Biol Rev	B	9.067	11.790	0.01402	1.39561	2.033	1.962	12.586	13.041
Biol Rhythm Res	B	0.440	0.593	0.00062	0.09468	1.689	2.469	0.735	0.503
Biologia	B	0.557	0.630	0.00256	0.06022	0.641	0.659	2.452	2.385
Biometrics	B	1.827	2.249	0.02046	0.42128	0.982	1.037	5.250	4.972
Biometrika	B	1.912	2.575	0.01880	0.26280	1.055	0.997	5.114	5.412
Biosci J	B	0.215	–	0.00047	–	0.466	0.526	1.302	1.153
Biosci Trends	B	0.968	0.811	0.00070	–	5.508	5.508	0.496	0.496
Bioscience	B	4.621	6.223	0.01816	0.59420	1.829	1.684	7.130	7.744
Biosemiotics-Neth	H&PS	0.444	0.439	0.00006	–	1.761	2.838	0.712	0.441
Biosystems	B	1.784	1.497	0.00591	0.20750	1.635	1.611	3.079	3.125
BMC Biol	B	5.750	5.841	0.01672	–	2.769	2.725	5.860	5.955

Table 2 (*Continued*)

Abbreviated journal title	JCR category	2-JIF	5-JIF	ES	FCIF	Citation potential		Topic normalized	
						Self-cite	CP^{Tj}	Self-cite	$TNIF^{j}$
Braz Arch Biol Techn	B	0.551	0.638	0.00220	0.05967	0.446	0.406	3.486	3.830
Braz J Biol	B	0.688	–	0.00290	–	0.628	0.617	3.092	3.147
Braz J Med Biol Res	B	1.129	1.381	0.00620	0.12949	0.694	0.682	4.591	4.672
Brit J Philos Sci	H&PS	1.097	1.364	0.00180	0.32361	0.619	0.502	5.001	6.167
Celest Mech Dyn Astr	A&A	1.457	1.280	0.00290	0.20297	1.826	2.117	2.252	1.942
Cent Eur J Biol	B	1.000	1.020	0.00126	–	1.397	1.457	2.020	1.937
Chinese J Aeronaut	EA	0.406	–	0.00086	–	0.498	0.531	2.301	2.158
Chronobiol Int	B	4.028	3.233	0.00616	0.19980	2.314	1.041	4.912	10.919
Classical Quant Grav	A&A	3.320	2.706	0.04893	0.36447	3.846	3.960	2.436	2.366
Comput Biol Chem	B	1.551	1.525	0.00234	0.19171	2.118	2.150	2.067	2.036
Comput Biol Med	B	1.089	1.302	0.00430	0.15093	1.025	1.014	2.998	3.031
Configurations	H&PS	0.182	0.321	0.00026	–	0.000	0.000	0.000	0.000
Contrib Astron Obs S	A&A	0.152	–	0.00024	–	3.750	4.650	0.114	0.092
Cosmic Res+	A&A	0.387	0.367	0.00077	0.03642	1.471	1.920	0.742	0.569
Cosmic Res+	EA	0.387	0.367	0.00077	0.03642	1.471	1.920	0.742	0.569
Cr Biol	B	1.533	1.826	0.00516	0.14757	1.621	1.625	2.669	2.662
Cr Phys	A&A	1.360	1.401	0.00525	0.20083	1.867	1.867	2.056	2.056
Cryobiology	B	2.062	2.199	0.00441	0.27563	1.583	1.494	3.676	3.895
Cryoletters	B	1.245	1.326	0.00100	0.15272	1.434	1.526	2.450	2.302
Cryptologia	H&PS	0.109	0.126	0.00015	–	0.077	0.069	3.995	4.458
Dynamis	H&PS	0.143	0.265	0.00032	–	1.221	1.761	0.331	0.229
Earth Moon Planets	A&A	0.667	0.763	0.00204	0.14357	3.887	3.929	0.484	0.479
Earth Sci Hist	H&PS	0.167	–	0.00012	–	0.635	1.103	0.742	0.427
Electromagn Biol Med	B	1.148	1.109	0.00055	0.09607	1.631	1.743	1.986	1.859
Endeavour	H&PS	0.226	0.235	0.00030	0.04423	0.113	0.000	5.644	0.000
Eng Stud	H&PS	1.048	1.048	0.00011	–	0.458	0.183	6.457	16.161
Epistemologia	H&PS	0.077	–	0.00000	–	0.039	0.000	5.572	0.000
ESA Bull-Eur Space	EA	1.163	1.511	0.00167	–	1.724	1.724	1.904	1.904
Eur J Sci Theol	H&PS	0.600	–	0.00006	–	0.721	0.851	2.348	1.990
Eur Phys J H	H&PS	1.182	1.182	0.00014	–	5.486	6.777	0.608	0.492
Excli J	B	1.061	–	0.00023	–	3.620	3.739	0.827	0.801
Exp Astron	A&A	1.818	1.950	0.00155	–	2.432	2.584	2.110	1.985
Faseb J	B	5.712	6.340	0.08876	0.69213	1.213	1.122	13.289	14.367
Folia Biol-Krakow	B	0.657	0.673	0.00045	0.15163	1.104	1.282	1.679	1.446
Folia Biol-Prague	B	1.151	1.183	0.00090	0.13578	2.392	2.474	1.358	1.313
Found Sci	H&PS	0.810	–	0.00026	–	1.103	2.226	2.072	1.027
Gen Relat Gravit	A&A	2.069	2.061	0.01002	0.29447	3.163	3.245	1.846	1.799
Geobiology	B	4.111	3.669	0.00518	–	2.974	2.881	3.901	4.027
Geophys Astro Fluid	A&A	1.000	1.146	0.00212	0.41417	3.985	4.386	0.708	0.643
Gravit Cosmol-Russia	A&A	0.460	–	0.00076	–	2.777	3.340	0.467	0.389
Her Russ Acad Sci+	H&PS	0.252	0.338	0.00050	–	0.607	0.820	1.172	0.867
Hist Hum Sci	H&PS	0.621	0.563	0.00099	0.05227	0.851	0.862	2.059	2.033
Hist Math	H&PS	0.355	0.408	0.00044	0.04301	0.596	0.796	1.681	1.259
Hist Phil Life Sci	H&PS	0.324	0.553	0.00025	–	1.171	1.594	0.781	0.574
Hist Philos Logic	H&PS	0.235	0.230	0.00008	0.08250	0.258	0.266	2.570	2.493
Hist Rec Aust Sci	H&PS	0.400	–	0.00009	–	0.485	0.485	2.327	2.327
Hist Sci	H&PS	0.667	0.699	0.00077	0.15152	0.360	0.292	5.229	6.446
Hist Stud Nat Sci	H&PS	0.440	0.643	0.00024	–	3.328	3.328	0.373	0.373
Hum Biol	B	1.312	1.005	0.00145	0.20210	1.597	1.636	2.318	2.263
Hyle	H&PS	0.500	0.310	0.00009	–	0.776	0.776	1.818	1.818
Icarus	A&A	3.385	3.218	0.04792	0.63786	4.181	4.618	2.285	2.069
IEEE Aero El Sys Mag	EA	0.297	0.337	0.00115	0.04121	0.572	0.572	1.465	1.465
IEEE Ann Hist Comput	H&PS	0.378	0.522	0.00046	–	1.597	2.359	0.668	0.452
IEEE T Aero Elec Sys	EA	1.095	1.680	0.00751	0.20374	0.742	0.692	4.165	4.465
Indian J Exp Biol	B	1.295	1.099	0.00276	–	0.637	0.580	5.737	6.301
Int J Aeroacoust	EA	0.943	–	0.00102	–	1.350	1.420	1.971	1.874
Int J Astrobiol	A&A	1.723	–	0.00140	–	3.204	3.765	1.518	1.291
Int J Astrobiol	B	1.723	–	0.00140	–	3.204	3.765	1.518	1.291
Int J Mod Phys D	A&A	1.183	1.333	0.00920	0.32595	3.013	3.102	1.108	1.076
Int J Radiat Biol	B	2.275	2.139	0.00565	0.25964	1.453	1.353	4.418	4.745
Int J Satell Comm N	EA	1.645	0.924	0.00102	0.12637	2.462	2.952	1.886	1.573
Int J Turbo Jet Eng	EA	0.025	0.135	0.00008	0.01264	0.025	0.000	2.822	0.000
ISIS	H&PS	0.779	1.065	0.00204	0.20833	0.323	0.242	6.806	9.084
J Aeros Comp Inf Com	EA	0.281	–	0.00029	–	0.595	0.635	1.333	1.249
J Aerospace Eng	EA	0.697	0.924	0.00132	0.12851	1.223	1.309	1.608	1.503
J Agr Biol Envir St	B	1.210	1.208	0.00176	0.39844	1.569	1.626	2.176	2.100
J Agr Environ Ethic	H&PS	1.109	1.242	0.00099	0.04511	0.915	0.886	3.420	3.532
J Aircraft	EA	0.538	0.654	0.00649	0.13768	0.909	1.088	1.670	1.395
J Am Helicopter Soc	EA	0.549	0.663	0.00080	0.16508	0.717	0.886	2.161	1.749

Table 2 (*Continued*)

Abbreviated journal title	JCR category	2-JIF	5-JIF	ES	FCIF	Citation potential		Topic normalized	
						Self-cite	CP^{Tj}	Self-cite	$TNIF^{j}$
J Astronaut Sci	EA	0.286	0.546	0.00084	0.51923	0.681	0.681	1.185	1.185
J Astrophys Astron	A&A	0.400	0.477	0.00061	0.19086	2.524	2.524	0.447	0.447
J Biol Educ	B	0.391	0.600	0.00030	–	2.671	4.626	0.413	0.239
J Biol Res-Thessalon	B	0.619	0.573	0.00031	–	1.230	1.371	1.420	1.274
J Biol Rhythm	B	2.934	3.114	0.00497	0.43625	3.015	3.025	2.746	2.737
J Biol Syst	B	0.570	0.694	0.00069	0.08423	1.291	1.608	1.246	1.000
J Biosciences	B	1.648	2.218	0.00521	0.17278	0.988	0.942	4.707	4.937
J Cosmol Astropart P	A&A	5.723	5.107	0.05669	0.33380	4.512	4.102	3.579	3.937
J Ethnobiol	B	0.576	–	0.00035	–	2.996	2.996	0.543	0.543
J Exp Biol	B	2.996	3.301	0.04616	0.49252	1.611	1.371	5.248	6.167
J Guid Control Dynam	EA	0.941	1.159	0.00792	0.23918	0.665	0.504	3.993	5.269
J Hist Astron	H&PS	0.238	0.179	0.00026	0.04321	0.915	1.457	0.734	0.461
J Hist Biol	B	0.628	0.542	0.00080	0.12593	3.752	3.917	0.472	0.452
J Hist Biol	H&PS	0.628	0.542	0.00080	0.12593	3.752	3.917	0.472	0.452
J Hist Med All Sci	H&PS	0.714	0.781	0.00067	0.07292	0.375	0.307	5.373	6.563
J Hist Neurosci	H&PS	0.425	0.538	0.00032	–	2.441	3.113	0.491	0.385
J Korean Astron Soc	A&A	0.615	–	0.00028	–	3.216	4.354	0.540	0.399
J Math Biol	B	2.963	2.480	0.00784	0.29717	1.261	1.196	6.631	6.991
J Propul Power	EA	0.761	1.003	0.00624	0.23808	1.216	1.425	1.766	1.507
J Radiat Res	B	1.683	1.794	0.00362	0.22551	1.352	1.308	3.513	3.631
J Spacecr Technol	EA	0.000	–	0.00003	–	0.000	0.000	0.000	0.000
J Spacecraft Rockets	EA	0.557	0.685	0.00428	0.13376	0.816	0.879	1.926	1.788
J Theor Biol	B	2.208	2.415	0.03209	0.33615	1.389	1.269	4.486	4.910
J Therm Biol	B	1.373	1.320	0.00241	0.21808	1.501	1.540	2.581	2.516
Kinemat Phys Celest+	A&A	0.361	–	0.00031	–	1.942	2.779	0.525	0.367
Life Sci J	B	0.073	–	0.00015	–	0.845	0.845	0.244	0.244
Living Rev Sol Phys	A&A	12.500	–	0.00278	–	5.339	5.019	6.607	7.028
Math Biosci	B	1.540	1.683	0.00671	0.20534	0.933	0.854	4.658	5.089
Math Med Biol	B	1.818	1.604	0.00118	0.23683	1.970	1.974	2.604	2.599
Med Hist	H&PS	0.535	0.545	0.00055	0.07246	0.619	0.631	2.439	2.393
Microgravity Sci Tec	EA	0.591	0.526	0.00126	0.31337	1.022	1.259	1.632	1.325
Microsc Res Techniq	B	1.792	1.873	0.00662	0.27657	1.029	0.973	4.915	5.197
Mon Not R Astron Soc	A&A	4.900	4.585	0.24884	0.44058	5.030	5.118	2.749	2.702
New Astron	A&A	1.411	1.327	0.00396	0.31242	3.832	4.010	1.039	0.993
New Astron Rev	A&A	1.321	0.874	0.00406	0.07966	4.269	4.269	0.873	0.873
Nexus Netw J	H&PS	0.070	–	0.00006	–	0.053	0.000	3.727	0.000
Notes Rec Roy Soc	H&PS	0.163	0.234	0.00027	0.07600	0.258	0.306	1.783	1.503
Nuncius	H&PS	0.038	0.068	0.00020	–	0.513	0.513	0.209	0.209
Observatory	A&A	0.481	0.320	0.00013	0.23101	2.476	4.186	0.548	0.324
Origins Life Evol B	B	2.660	2.081	0.00222	0.20001	5.722	5.993	1.312	1.253
Osiris	H&PS	0.292	0.554	0.00033	0.13636	0.390	0.390	2.113	2.113
P Biol Soc Wash	B	0.292	0.402	0.00048	0.08753	0.533	0.593	1.546	1.390
P I Mech Eng G-J Aer	EA	0.488	0.579	0.00199	0.04850	0.665	0.752	2.071	1.831
P Natl A Sci India B	B	0.019	–	0.00005	–	2.339	4.659	0.023	0.012
P Roy Soc B-Biol Sci	B	5.415	5.670	0.09614	0.02516	2.297	2.129	6.653	7.178
Period Biol	B	0.192	0.346	0.00050	0.03002	0.303	0.469	1.788	1.155
Perspect Biol Med	H&PS	1.342	1.396	0.00217	0.19235	2.978	3.148	1.272	1.203
Philos Sci	H&PS	0.552	0.792	0.00219	–	0.428	0.380	3.640	4.099
Philos T R Soc B	B	6.401	7.154	0.07729	0.49996	2.169	2.103	8.328	8.589
Phys Life Rev	B	7.208	5.241	0.00215	–	2.381	1.816	8.543	11.201
Phys Perspect	H&PS	0.214	0.262	0.00013	–	0.302	0.319	2.000	1.893
Phys Rev D	A&A	4.558	4.027	0.30080	0.61496	4.068	3.760	3.162	3.421
Planet Space Sci	A&A	2.224	2.128	0.01863	0.48178	2.896	2.981	2.167	2.105
Plos Biol	B	11.452	13.630	0.14959	1.19212	3.263	3.159	9.904	10.230
PLos One	B	4.092	4.537	0.50162	–	1.308	0.980	8.828	11.783
Prog Aerosp Sci	EA	3.000	3.554	0.00226	0.32586	0.859	0.692	9.856	12.234
Publ Astron Soc Aust	A&A	2.259	2.370	0.00370	0.23862	5.819	6.049	1.096	1.054
Publ Astron Soc Jpn	A&A	2.438	3.108	0.01847	0.50170	3.962	4.406	1.737	1.562
Publ Astron Soc Pac	A&A	3.582	2.997	0.01871	0.35906	5.132	5.227	1.970	1.934
Q Rev Biol	B	7.727	6.538	0.00320	1.00320	2.944	2.944	7.407	7.407
Radiat Environ Bioph	B	1.696	1.755	0.00290	0.34765	1.755	1.764	2.727	2.713
Radiat Res	B	2.684	2.844	0.01397	0.43866	1.864	1.712	4.063	4.424
Radio Sci	A&A	1.075	1.124	0.00453	0.28768	1.561	1.736	1.943	1.747
Res Astron Astrophys	A&A	1.320	1.325	0.00228	–	3.880	4.643	0.960	0.802
Rev Biol Trop	B	0.459	0.544	0.00203	0.04986	0.646	0.732	2.005	1.770
Rev Mex Astron Astr	A&A	1.000	1.352	0.00158	0.16629	4.036	4.300	0.699	0.656
Rev Mex Fis E	H&PS	0.111	–	0.00011	–	0.900	1.295	0.348	0.242
Riv Biol-Biol Forum	B	0.613	0.455	0.00022	0.00432	2.643	2.643	0.655	0.655
Sci China Life Sci	B	2.024	2.030	0.00092	–	1.283	1.110	4.452	5.146

Table 2 (*Continued*)

Abbreviated journal title	JCR category	2-JIF	5-JIF	ES	FCIF	Citation potential		Topic normalized	
						Self-cite	CP^{Tj}	Self-cite	$TNIF^{j}$
Sci China Ser C	B	1.610	1.148	0.00239	0.11358	1.353	1.353	3.358	3.358
Sci Context	H&PS	0.395	0.382	0.00044	0.06799	0.297	0.271	3.753	4.113
Sci Educ-Netherlands	H&PS	0.702	–	0.00112	–	0.919	1.099	2.156	1.803
Sci Eng Ethics	H&PS	0.738	0.937	0.00112	0.13089	0.901	0.959	2.311	2.172
Soc Hist Med	H&PS	0.545	0.659	0.00090	0.16879	0.860	0.958	1.788	1.605
Soc Stud Sci	H&PS	1.500	2.286	0.00365	0.16842	0.449	0.290	9.428	14.597
Sol Phys	A&A	2.776	2.880	0.02149	0.62204	3.677	3.895	2.131	2.011
Solar Syst Res+	A&A	0.682	0.623	0.00106	0.08108	1.640	2.032	1.174	0.947
Space Sci Rev	A&A	3.611	3.914	0.02961	0.72941	4.024	4.042	2.532	2.521
Space Weather	A&A	1.329	1.505	0.00227	0.29996	2.789	3.439	1.345	1.091
Stud Hist Philos M P	H&PS	0.641	0.622	0.00132	0.19796	1.172	1.356	1.543	1.334
Stud Hist Philos Sci	H&PS	0.513	0.677	0.00115	0.10470	0.381	0.323	3.800	4.482
Synthese	H&PS	0.649	0.728	0.00309	0.09312	0.230	0.163	7.963	11.236
T Jpn Soc Aeronaut S	EA	0.338	0.269	0.00041	0.07089	1.939	2.046	0.492	0.466
Technol Cult	H&PS	0.321	0.422	0.00089	0.02158	0.131	0.029	6.915	31.237
Theor Biosci	B	0.979	1.000	0.00069	0.23667	1.831	2.279	1.509	1.212
Turk J Biol	B	0.876	–	0.00062	–	0.848	0.826	2.915	2.993
ZH Obshch Biol	B	0.254	0.386	0.00033	0.05962	0.592	0.930	1.211	0.771

Source: 2011 JCR, and Leydesdorff & Bornmann (2011).
ES, Eigenfactor score; FCIF, fractionally counted impact factor; CP, citation potential; TNIF, topic normalized impact factor; self-cite, including self-citation; A&A, Astronomy & Astrophysics; B, Biology; EA, Engineering, Aerospace; H&PS, History & Philosophy of Science.

Central-tendency and variability measures for the fields are showed in Table 5. All the indicators have skewed distributions, with many journals having low values and only a small number of journals with high values. This is the reason why in these skewed distributions the medians are well below means. Notice the high differences between categories in medians, means, and standard deviations.

The fields considered are very different in relation to the citation behavior and some of them are penalized by the JIF. Note that the central-tendency measures of the JIF in Astronomy & Astrophysics and Biology are very much higher than those in Aerospace Engineering and History & Philosophy of Science; in general, more than three times higher. However,

Table 3
Pearson correlation coefficients.

JCR category	# Journals		5-JIF	ES	FCIF	Self-cite	TNIF
Astronomy & Astrophysics	56	2-JIF	0.99[c]	0.22	0.94[c]	0.97[c]	0.98[c]
		5-JIF		0.15	0.94[c]	0.96[c]	0.97[c]
		ES			0.17	0.20	0.21
		FCIF				0.95[c]	0.95[c]
		Self-cite					1.00[c]
Biology	85	2-JIF	0.97[c]	0.36[c]	0.87[c]	0.85[c]	0.82[c]
		5-JIF		0.38[c]	0.89[c]	0.84[c]	0.80[c]
		ES			0.51[c]	0.45[c]	0.49[c]
		FCIF				0.79[c]	0.73[c]
		Self-cite					0.97[c]
Engineering, Aerospace	27	2-JIF	0.94[c]	0.27	0.41	0.84[c]	0.86[c]
		5-JIF		0.30	0.49[a]	0.88[c]	0.91[c]
		ES			0.20	0.26	0.27
		FCIF				0.37	0.41
		Self-cite					0.96[c]
History & Philosophy of Science	56	2-JIF	0.96[c]	0.79[c]	0.62[c]	0.44[c]	0.31
		5-JIF		0.85[c]	0.64[c]	0.51[c]	0.33[a]
		ES			0.62[c]	0.58[c]	0.42[b]
		FCIF				0.23	0.04
		Self-cite					0.73[c]
Total	224	2-JIF	0.99[c]	0.32[c]	0.91[c]	0.64[c]	0.48[c]
		5-JIF		0.28[c]	0.91[c]	0.65[c]	0.47[c]
		ES			0.31[c]	0.24[c]	0.19[b]
		FCIF				0.58[c]	0.40[c]
		Self-cite					0.85[c]

ES, eigenfactor score; FCIF, fractionally counted impact factor; TNIF, topic normalized impact factor; self-cite, TNIF including self-citation.
[a] 90% confidence level.
[b] 95% confidence level.
[c] 99% confidence level.

Table 4
Spearman rank correlation coefficients.

JCR category	# Journals		5-JIF	ES	FCIF	Self-cite	TNIF
Astronomy & Astrophysics	56	2-JIF	0.98[c]	0.82[c]	0.87[c]	0.93[c]	0.95[c]
		5-JIF		0.82[c]	0.88[c]	0.88[c]	0.91[c]
		ES			0.76[c]	0.80[c]	0.82[c]
		FCIF				0.82[c]	0.84[c]
		Self-cite					0.99[c]
Biology	85	2-JIF	0.97[c]	0.82[c]	0.81[c]	0.83[c]	0.84[c]
		5-JIF		0.85[c]	0.82[c]	0.85[c]	0.85[c]
		ES			0.71[c]	0.87[c]	0.86[c]
		FCIF				0.69[c]	0.68[c]
		Self-cite					0.99[c]
Engineering, Aerospace	27	2-JIF	0.87[c]	0.75[c]	0.54[b]	0.70[c]	0.84[c]
		5-JIF		0.77[c]	0.72[c]	0.69[c]	0.87[c]
		ES			0.54[b]	0.64[c]	0.77[c]
		FCIF				0.43	0.52[b]
		Self-cite					0.85[c]
History & Philosophy of Science	56	2-JIF	0.94[c]	0.66[c]	0.52[c]	0.35[a]	0.57[c]
		5-JIF		0.70[c]	0.57[c]	0.34[a]	0.48[c]
		ES			0.49[c]	0.33[a]	0.49[c]
		FCIF				0.03	0.22
		Self-cite					0.75[c]
Total	224	2-JIF	0.98[c]	0.84[c]	0.65[c]	0.57[c]	0.65[c]
		5-JIF		0.85[c]	0.65[c]	0.60[c]	0.65[c]
		ES			0.74[c]	0.54[c]	0.62[c]
		FCIF				0.39[c]	0.45[c]
		Self-cite					0.91[c]

ES, eigenfactor score; FCIF, fractionally counted impact factor; TNIF, topic normalized impact factor; self-cite, TNIF including self-citation.
[a] 90% confidence level.
[b] 95% confidence level.
[c] 99% confidence level.

the central-tendency measures of the TNIF are closer in all the fields considered. Furthermore, removing the influence of journal self-citation produces an increment in the variability of the scores.

Finally, we tested if the journal topic normalization reduces the between-group variance in relation to the within-group variance. Table 6 shows the central-tendency measures for the aggregate data and the between-group variances. The between-group or explained variance is the variability that is produced by the independent variable, i.e. the group differences. The within-group or error variance is the variability that is not produced by the independent variable. Note that the journal topic normalization produces the greatest percentage reduction of the variance (94.4%). Moreover, removing the influence of journal self-citation produces an increment in the within-group variance of the scores and therefore a better indicator discrimination ability.

Table 5
Central-tendency and variability measures.

JCR category	Measures	2-JIF	5-JIF	ES	FCIF	Self-cite	TNIF
Astronomy & Astrophysics	Median	1.683	1.757	0.00430	0.31919	1.844	1.723
	Mean	3.070	3.180	0.03561	0.41331	2.144	2.112
	Sd	4.292	4.548	0.08311	0.39276	2.209	2.457
Biology	Median	1.540	1.719	0.00256	0.20534	2.915	2.993
	Mean	2.096	2.374	0.01595	0.26865	3.473	3.671
	Sd	2.115	2.375	0.05812	0.26257	2.640	3.086
Engineering, Aerospace	Median	0.549	0.654	0.00126	0.13113	1.886	1.507
	Mean	0.680	0.833	0.00283	0.14485	2.174	2.130
	Sd	0.605	0.734	0.00377	0.12627	1.868	2.390
History & Philosophy of Science	Median	0.442	0.553	0.00033	0.09312	2.134	1.810
	Mean	0.580	0.725	0.00077	0.11780	2.931	3.523
	Sd	0.603	0.636	0.00097	0.07779	2.408	5.274

Sd, standard deviation; ES, eigenfactor score; FCIF, fractionally counted impact factor; TNIF, topic normalized impact factor; self-cite, TNIF including self-citation.

Table 6
Central-tendency and variability measures for the aggregate data.

Measures	2-JIF	5-JIF	ES	FCIF	Self-cite	TNIF
Median	1.000	1.159	0.00163	0.19203	2.111	1.922
Mean	1.790	1.998	0.01549	0.26395	2.849	3.059
Within-group variance (Sd^2)	7.325	8.124	0.00315	0.08509	5.995	13.128
Between-group variance (Sd^2)	1.432	1.441	0.00026	0.01826	0.412	0.730
Total reduction of the variance	5.893	6.683	0.00289	0.06683	5.583	12.398
Percentage reduction of the variance	80.5%	82.3%	91.9%	78.5%	93.1%	94.4%

Sd, standard deviation; ES, eigenfactor score; FCIF, fractionally counted impact factor; TNIF, topic normalized impact factor; self-cite, TNIF including self-citation; within-group, within the set of all journals (224); between-group, between the JCR categories.

5. Conclusions

Different scientific fields have different citation practices, and citation-based bibliometric indicators need to be normalized for such differences between fields in order to allow for between-field comparisons of citation indicators. In this paper, we provide a source normalization approach based on the journal topic and we compare it with some popular impact indicators.

An empirical application, with more than two hundred journals from four different fields, shows that our journal topic normalization reduces the between-group variance in relation to the within-group variance more than the rest of the indicators analyzed in this paper.

The fields considered are very different in relation to the citation behavior. For this reason, the JIF in Astronomy & Astrophysics and Biology are very much higher than the JIF in Aerospace Engineering and History & Philosophy of Science. However, the TNIFs are very close in all the fields considered. We propose removing the influence of journal self-citation because it produces an increment in the variability of the scores, whereby providing a better indicator discrimination ability.

Finally, it is necessary to be cautious when comparing journal impact indicators from different fields. In this sense, our index has behaved well in a great number of journals from very different fields.

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