A Case Study on the Relevance of the Journal Impact Factor

G. A. Fox, A. K. Fox, L. Guertault

Highlights
- Publication profiles of seven highly published authors were analyzed from Google Scholar profiles.
- Journal impact factor (JIF) not strongly correlated to citations in the first two years after publication.
- Significant correlation between the number of citations in the first two years and total citations to an article.
- More important to submit manuscripts to journals with appropriate readership than the highest JIF.

Abstract. In today’s world of research publishing, authors are typically encouraged to submit manuscripts to journals with the highest possible journal impact factor (JIF). This approach inherently assumes that the higher the JIF, the more likely the article will be cited. However, calls to move away from the JIF are becoming more common. This study analyzes the publication profiles of seven authors who are members of the Natural Resources and Environmental Systems (NRES) community of the American Society of Agricultural and Biological Engineers (ASABE) and who frequently publish in ASABE journals. This study hypothesized that statistically significant correlations existed between the JIF and the (1) total number of citations, (2) number of citations per year, and/or (3) number of citations in the first two years after publication. Based on 999 articles published by these seven authors from 1982 to 2018, statistically significant but fairly low to moderate correlations were observed between the JIF and the total citations, citations per year, and citations in the first two years after publication. The greatest correlation was observed between the number of citations that an article received in the first two years after publication and the number of citations per year (or the total number of citations). Therefore, ensuring an appropriate readership to generate short-term citations was more important than the JIF. When compared to high-JIF journals, there were statistically fewer citations per year and fewer citations in the first two years after publication for articles published in ASABE journals. While ASABE journal articles possess high citation longevity (i.e., cited half-life), efforts to immediately improve short-term metrics should focus on attracting high-quality research and improving article visibility. To extrapolate these findings to a wider community, future research should investigate these correlations for researchers in other ASABE technical communities and at various career stages.

Keywords. Citations, Journal citation factor, Journal impact factor, Peer review, Research impact.

The most common metric used for evaluating the prestige of a research journal and one of the primary considerations authors use when selecting a journal is the journal impact factor (JIF). Explicitly defined, a two-year JIF for a specific year is calculated according to the following equation, using 2018 as an example:

\[
JIF_{2018} = \frac{\text{Citations in 2018 to articles published in 2016 and 2017}}{\text{Number of citable articles published in 2016 and 2017}}
\]

In general, the JIF remains the most common method to assess journal quality (Callaway, 2016). Researchers commonly assume that publishing in a journal with a higher JIF is better for ensuring the potential impact of their research, where the impact is typically measured through citations. In fact, the JIF is frequently used by upper administration and review committees when evaluating the research impact of an author’s recent publications (Fox et al., 2019). As noted by Garfield (2006), “mere acceptance of the paper for publication by a high-impact journal is an implied indicator of prestige.”

While the JIF may be a useful metric for assessing the impact of a journal, several authors have recently pointed out that this metric is not appropriate for assessing the impact of an individual article. Brito and Rodríguez-Navarro (2019) specifically pointed out that the JIF assumes that all the articles

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in a journal have the same scientific merit, as measured by the journal’s JIF. Callaway (2016) specifically called to move away from the JIF because most published articles garner fewer citations than indicated by the journal’s JIF. More specifically, Callaway (2016) showed how a few highly cited articles can easily influence this metric, as demonstrated by the citation distributions for articles published in 2013 and 2014 in several journals including Science and Nature. Garfield (2006) noted the 80/20 rule: “20% of articles account for 80% of the citations.”

In fact, Garfield (2006), one of the creators of the JIF, also pointed out that citation analyses should be adjusted based on specific variables associated with the discipline, such as specialty, citation density, and half-life. He specifically noted that it may be more appropriate in some fields to consider the half-life (i.e., number of years required to accumulate 50% of the citations) or longer-period JIFs instead of the standard two-year JIF. For example, as of 2018, the two-year JIF for Transactions of the ASABE was 1.15, ranking in the middle of its disciplinary category, although the total citations of its published articles are almost twice the number for many of its comparable journals (Fox et al., 2019). Articles published in Transactions of the ASABE have a cited half-life of more than 14 years, which indicates that, on average, articles receive only half of their citations 14 years after publication. In addition, the JIF considers citations by other researchers in peer-reviewed journals as the only important type of citation, as opposed to practitioners, policy-makers, and management agencies that may use the research but not cite the work in journal articles.

Such calls for moving away from the JIF as the sole or most prominent journal quality metric have created an interesting set of questions. For example, is the JIF for the journal in which an article is published an accurate predictor of the citations that an article will receive? Is considering the readership (i.e., publishing in journals that are immediately read and used by peers in the same field) or citation longevity of a journal more or less important than the JIF?

Hansen and Henriksen (1997) analyzed citations to 217 articles in clinical physiology and nuclear medicine in the mid-1980s and early 1990s. They compared the JIF to a journal citation factor (JCF), calculated as the average number of times that articles in a journal were cited in the year of publication and in the subsequent year. They reported a direct relationship between the JIF and JCF, with a correlation coefficient (r) of 0.40 for all journals and r = 0.69 for journals with five or more articles in the dataset of their study. The JCF was significantly below the JIF. Do such relationships hold for recent articles in other disciplines, such as biological and agricultural engineering?

This study attempted to assess some of these questions using the publication profiles of seven “high-profile” authors who publish in ASABE journals and in other journals with a wide range of JIFs. For consistency, this study used publications from researchers in the Natural Resources and Environmental Systems (NRES) technical community of ASABE who are recent recipients of a major award through the NRES community. This study evaluated the following hypotheses: (1) there is a positive and statistically significant correlation between the JIF and the total number of citations an article receives and/or the number of citations per year; (2) there is a positive and statistically significant correlation between the JIF and the number of citations an article receives in the first two years after publication; (3) articles in journals with a much higher JIF than the ASABE journals receive significantly more citations, more citations per year, and more citations in the first two years after publication; and (4) a direct relationship exists between the JIF and JCF.

**METHODS**

We used the Google Scholar profiles (https://scholar.google.com) of seven authors who were recently recognized with the ASABE Hancor Soil and Water Engineering Award, which “honors and recognizes a member of ASABE who has performed noteworthy contributions to the advancement of soil and water engineering in teaching, research, planning, design, construction, management, or development of materials. These contributions shall have been either in the form of published literature, notable performance, or special actions which have served to advance the science of soil and water engineering” (ASABE, 2019). These seven recent awardees have actively published in ASABE journals along with several other journals in the same general fields of hydrology and water quality (table 1).

For each article published prior to 2019 according to the authors’ Google Scholar profiles, we extracted the journal name, year published, total number of citations, and number of citations in the first two years after publication as of 1 February 2020. More specifically for the last quantity, if the publication year of an article was 2012, as an example, we added the number of citations prior to and including 2014. This last quantity was specifically investigated because of its impact on the two-year JIF, as shown in equation 1. Note that we did not account for potential variations relative to article type (e.g., review articles are typically assumed to garner more citations). Note also that articles that were co-authored by two or more of these authors were assigned to a single author based on the first author listed; therefore, duplicate entries of the same article were removed from the dataset.

**Table 1. General statistics on publications for seven authors (A1 to A7) as extracted from Google Scholar.**

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>A6</th>
<th>A7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of articles analyzed</td>
<td>213</td>
<td>98</td>
<td>116</td>
<td>126</td>
<td>132</td>
<td>222</td>
<td>92</td>
</tr>
<tr>
<td>Google Scholar i10-index</td>
<td>52</td>
<td>38</td>
<td>38</td>
<td>45</td>
<td>43</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Average journal impact factor (JIF)</td>
<td>2.20</td>
<td>2.30</td>
<td>2.59</td>
<td>2.80</td>
<td>3.22</td>
<td>2.36</td>
<td>3.25</td>
</tr>
<tr>
<td>Highest JIF (two-year)</td>
<td>6.40</td>
<td>8.17</td>
<td>7.15</td>
<td>7.15</td>
<td>12.80</td>
<td>7.15</td>
<td>7.15</td>
</tr>
<tr>
<td>Articles in ASABE journals</td>
<td>29</td>
<td>19</td>
<td>25</td>
<td>20</td>
<td>9</td>
<td>48</td>
<td>12</td>
</tr>
</tbody>
</table>
To characterize the publication history of each author, we also extracted the h-index (i.e., the number of articles, h, published by an author with at least h citations) and i10-index (i.e., the number of articles published by an author with at least ten citations) as reported by Google Scholar (table 1). Google Scholar is a search engine that identifies scholarly citations from a diverse range of sources, including journals, conference proceedings, books, and reports. We preferred the use of Google Scholar because we were interested in quantifying research impact outside of just journal article citations. Practitioners, policy-makers, and management agencies may use the research but not cite the work in journal articles, and we desired to capture this impact as well. We used individual journal web pages to identify the reported 2018 two-year JIF and confirmed the JIF through the ISI Journal Citation Reports. We used the current JIF in 2018 instead of the JIF at the time of publication to reflect the current prestige of the journals.

Spearman rank-order correlation tests (nonparametric tests because of the non-normal distributions) were conducted in SigmaPlot (v13, Systat Software, San Jose, Cal.) to quantify the correlation (r) between the JIF and the total number of article citations, article citations per year, and article citations in the first two years after publication. The software reported p-values for the significance of the correlation, and p < 0.050 was assumed to represent a statistically significant correlation. Variables having relationships with the greatest r were also compared to assess the consistency.

Boxplots and Mann-Whitney rank-sum tests were also performed in SigmaPlot for the total number of article citations, article citations per year, and article citations in the first two years after publication between two groups: (1) ASABE journals, which included Transactions of the ASABE (JIF = 1.15) and Applied Engineering in Agriculture (JIF = 0.74), and (2) all other journals in the dataset. A similar analysis was performed in comparing the ASABE journals with journals that have JIF > 3.00, referred to here as high-JIF journals. All normality tests were conducted using Shapiro-Wilk tests in SigmaPlot with α = 0.050.

We also compiled the average number of article citations for journals with at least three articles in the dataset. Similar to Hansen and Henriksen (1997), we calculated a JCF as the average number of citations to articles in a particular journal in the first two years after publication. We used a two-year window to align the JCF with the JIF calculation. Note that Hansen and Henriksen (1997) calculated their JCF as the number of times that articles in a journal were cited in the subsequent year. SigmaPlot was used to derive a histogram of the differences between the JCF and the JIF. The correlation (r) and statistical significance between the JIF and JCF were quantified using Spearman rank-order correlation tests.

RESULTS AND DISCUSSION

In total, 999 articles were analyzed between the years 1982 and 2018 across a wide range of journals (fig. 1a, table 2). The journal with the highest number of articles was Transactions of the ASABE (n = 143). For the seven authors, the number of articles published in Transactions of the ASABE ranged between 9 and 48. Other journals with a high frequency of articles included the Journal of the American Water Resources Association (JAWRA), Journal of Hydrology, Journal of Environmental Quality, Hydrological Processes, Water Resources Research, and the Journal of Soil and Water Conservation, with each journal having at least 35 unique articles in the dataset. Articles were published in journals with JIFs that ranged between 0.00 and 12.80, and the JIF distributions for the journals in which these authors published were similar, with a median JIF typically between 2.00 and 4.00 (fig. 1b).

Surprisingly, the correlation between the JIF and the total number of citations to an article was only slightly positive (r = 0.155) but statistically significant (p < 0.001, fig. 2a). Note that two articles are not shown in figure 2a because they received 6,705 and 6,675 citations since their publication in 2007 in Transactions of the ASABE (JIF = 1.15) and in 1998 in JAWRA (JIF = 2.46), respectively, although they were both included in the statistical analysis. The total number of citations was influenced by the year of publication because newer articles have less opportunity to be cited. In normalizing the number of citations by the time since publication (i.e., number of citations per year), there was a slightly stronger correlation (r = 0.302) that was again statistically significant (p < 0.001, fig. 2b). The same two articles not
A significant but still relatively small correlation ($r = 0.317, p < 0.001$) was observed between the JIF and the number of citations in the first two years after publication. Much stronger correlations were observed between the number of citations in the first two years after publication and either the total number of citations to an article ($r = 0.660, p < 0.001$, fig. 2d) or the number of citations per year to an article ($r = 0.870, p < 0.001$, fig. 2e).

Note that the graphs in figure 2 were prepared using all articles published up to 2018. For articles published in 2017 and 2018, the total number of citations in the last two years would equal the total number of citations and therefore may influence the correlation. However, when excluding articles published in 2017 and 2018, the correlations were similar.

The relationship between the number of citations in the first two years after publication and the number of citations per year was consistent among the seven authors (fig. 3a). Focusing on submitting to journals where articles would be cited in the first two years after publication was a stronger predictor of overall citation performance as compared to the JIF. If an article was cited frequently in the first two years after publication, it appeared to be more likely cited over the long term, i.e., citations lead to more citations as articles become more visible, independent of the journal’s JIF. Many articles in the dataset were published in high-JIF journals but were not cited with any regularity. In our opinion, authors usually do not refuse to cite an article because it was published in a specific journal, and citable articles are typically identified using on-line searches across a wide range of journals, rather than by perusing hard-copy issues of selected journals.

Note that similar relationships were observed between the number of citations per year and the number of citations in the first two years after publication.

<table>
<thead>
<tr>
<th>Journal</th>
<th>JIF in 2018</th>
<th>No. of Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transactions of the ASABE</td>
<td>1.15</td>
<td>143</td>
</tr>
<tr>
<td>JAWRA</td>
<td>2.46</td>
<td>83</td>
</tr>
<tr>
<td>Journal of Hydrology</td>
<td>4.41</td>
<td>58</td>
</tr>
<tr>
<td>Journal of Environmental Quality</td>
<td>2.58</td>
<td>42</td>
</tr>
<tr>
<td>Hydrological Processes</td>
<td>3.19</td>
<td>41</td>
</tr>
<tr>
<td>Water Resources Research</td>
<td>4.14</td>
<td>36</td>
</tr>
<tr>
<td>Journal of Soil and Water Conservation</td>
<td>2.18</td>
<td>35</td>
</tr>
<tr>
<td>Water</td>
<td>2.52</td>
<td>34</td>
</tr>
<tr>
<td>Environmental Modelling and Software</td>
<td>4.55</td>
<td>26</td>
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<tr>
<td>Agricultural Water Management</td>
<td>3.54</td>
<td>21</td>
</tr>
<tr>
<td>Applied Engineering in Agriculture</td>
<td>0.74</td>
<td>19</td>
</tr>
<tr>
<td>Journal of Hydrologic Engineering</td>
<td>1.44</td>
<td>19</td>
</tr>
<tr>
<td>Science of the Total Environment</td>
<td>5.59</td>
<td>18</td>
</tr>
<tr>
<td>Journal of Environmental Management</td>
<td>4.87</td>
<td>12</td>
</tr>
<tr>
<td>Soil Science Society of America Journal</td>
<td>2.00</td>
<td>11</td>
</tr>
<tr>
<td>Advances in Water Resources</td>
<td>3.67</td>
<td>10</td>
</tr>
<tr>
<td>Earth Surface Processes and Landforms</td>
<td>3.60</td>
<td>10</td>
</tr>
<tr>
<td>Environmental Science and Technology</td>
<td>7.15</td>
<td>10</td>
</tr>
<tr>
<td>Vadose Zone Journal</td>
<td>3.63</td>
<td>10</td>
</tr>
<tr>
<td>Ecological Engineering</td>
<td>3.41</td>
<td>9</td>
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<tr>
<td>Ecological Modelling</td>
<td>2.63</td>
<td>9</td>
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<tr>
<td>Environmental Management</td>
<td>2.38</td>
<td>8</td>
</tr>
<tr>
<td>Agricultural Systems</td>
<td>4.13</td>
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</tr>
<tr>
<td>Hydrological Sciences Journal</td>
<td>2.18</td>
<td>8</td>
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<tr>
<td>Hydrology and Earth System Sciences</td>
<td>4.94</td>
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<tr>
<td>Agriculture, Ecosystems, and Environment</td>
<td>3.95</td>
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<td>BioEnergy Research</td>
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</tr>
<tr>
<td>Geoderma</td>
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<td>5</td>
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<td>Journal of Environmental Engineering</td>
<td>1.66</td>
<td>5</td>
</tr>
<tr>
<td>Journal of Irrigation and Drainage Engineering</td>
<td>1.34</td>
<td>5</td>
</tr>
<tr>
<td>Water Resources Management</td>
<td>2.99</td>
<td>5</td>
</tr>
<tr>
<td>Others</td>
<td>0.00-12.80</td>
<td>276</td>
</tr>
</tbody>
</table>

Table 2. Most common journals, their 2018 journal impact factor (JIF), and number of articles analyzed for each journal.

Figure 2. Relationships and statistical correlation ($r$) from Spearman rank-order correlation tests. Asterisks indicate statistically significant correlations ($p < 0.050$) between the journal impact factor (JIF), total number of citations to an article, number of citations per year to an article, and number of citations in first two years after publication.
the first two years after publication for articles in ASABE journals versus articles in all other journals (fig. 3b). However, it is readily apparent from this graph that most of the ASABE articles received fewer citations in the first two years after publication and therefore fewer citations per year. We hypothesize that this is somewhat due to authors preferring to publish in journals with a higher JIF for tenure and promotion notoriety. Thus, an author’s assumed high-impact research may not be preferably submitted to ASABE journals over journals with a higher JIF.

These observations were confirmed through additional statistical analyses. No significant differences were observed in the total number of citations to articles when grouped by journal type (i.e., ASABE journals versus all other journals, fig. 4a). The total number of citations to articles in ASABE journals was not statistically different from the total number for all other journals, which we hypothesize was due to the relatively large scatter in the dataset for the total number of citations. However, significant differences were observed in citations per year to an article and the number of citations in the first two years after publication (figs. 4b and 4c). These results were further supported when comparing ASABE journals to high-JIF journals (i.e., JIF > 3.00), as the differences between the groups in terms of citations per year and number of citations in the first two years after publication were greater (figs. 4d, 4e, and 4f). ASABE journals typically perform well regarding metrics related to the cited half-life or longevity of citations, which may help explain the lack of statistically significant differences in figures 4a and 4d, but the lower JIF for ASABE journals potentially drives fewer citations for their articles in the first two years after publication. ASABE currently charges subscription fees for access, and this may also be a factor behind the lower number of citations in the first two years after publication. To increase short-term and long-term journal metrics, ASABE journals should focus on attracting high-quality research and improving article visibility as soon as possible after publication.

With that said, the ASABE journals are not alone. When articles were combined relative to particular journals, 60 journals had at least three articles published in this dataset. For most journals, the two-year JCF was larger than the JIF, indicating that most articles published by these authors in these journals had received more citations than indicated by the JIF (fig. 5a). In fact, one journal (Agricultural Systems, JIF = 4.13, with eight articles) had a difference between the JCF and JIF greater than 35. Transactions of the ASABE and Applied Engineering in Agriculture had differences between the JCF and JIF of approximately 8.8 and 1.8, respectively. Five journals had a negative difference between the JCF and JIF. Similar to Hansen and Henriksen (1997), we noted a statistically significant relationship between the JIF and JCF when calculated over a two-year period (fig. 5b).

**CONCLUSIONS**

For seven authors with extensive publication records in the NRES community of ASABE and for journals with the range of JIFs investigated in this study, rapid readership exposure to ensure immediate citations appeared to be more important than the JIF for ensuring the highest possible number of citations to an article. Only a moderate correlation was observed between the JIF and the number of citations in the first two years after publication. The largest correlation was observed between the number of citations that an article received in the first two years after publication and the total number of citations or the number of citations per year. No statistically significant relationships were observed between the JIF and JCF, defined as the average number of citations to articles in a journal in the year of publication and in the two subsequent years. In fact, for this dataset, many JCFs were greater than the JIF.

Thus, based on the presented results, efforts to improve ASABE journals should ensure rapid access to articles for actively publishing researchers. Efforts should also focus on attracting high-quality research by ensuring high-quality reviews in a reasonable time, inviting submission of high-pro-
file review articles, encouraging the development of special collections, and improving the visibility of its publications. ASABE journals possess strong longevity metrics, but their articles garner fewer citations per year and fewer citations in the first two years after publication as compared to journals with similar and higher JIFs.

Overall, the JIF was not a predictor of the future impact of a research article as measured based on citations. We postulate that the differences in the prestige of the journals, within the range of JIFs investigated in this study, were not significant enough to impact article citations. The JIF remains an important consideration because of its widespread use, even though it was shown here to be a less relevant predictor of article citations. Future research should evaluate these correlations and relationships for authors in other technical communities who publish in ASABE journals but with different sets of competitor journals.

Figure 4. Boxplots of the (a and d) total number of citations to an article, (b and e) number of citations per year to an article, and (c and f) number of citations in the first two years after publication for (a, b, c) ASABE journals versus all other journals in the dataset and (d, e, f) ASABE journals versus high-JIF (JIF > 3.0) journals. Asterisks indicate statistically significant differences (p < 0.050) based on Mann-Whitney rank-sum tests.
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REFERENCES


