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Abstract

Purpose – The purpose of this research is to investigate the relationship between journal self-citation and journal impact factor (JIF)/journal immediacy index (JII).

Design/methodology/approach – This research examined research papers in 20 key journals in environmental engineering with a publication year range of 1999 to 2008. The bibliographical information of cited references was obtained from the Science Citation Index Expanded of the Web of Science.

Findings – The findings indicated that JIF and JII values changed only slightly regardless of the inclusion or exclusion of self-citations, suggesting that the influence of self-citation on journals was insignificant. Consequently there is no need for evaluations to exclude journal self-citations in journal or researcher evaluations. In addition the findings indicated that JIF and five-year JIF were highly correlated, suggesting that it would not be necessary to extend the calculation of JIF to five years. Considering the cost in terms of time and effort, the two-year JIF is sufficient in the discipline of environmental engineering.

Originality/value – This research provides a better understanding of journal self-citations in journal or researcher evaluation with JIF and JII as indicators.

Keywords Journal self-citation, Journal impact factor, Journal immediacy index, Environmental engineering, Journals

Paper type Research paper

Introduction

Journal self-citations are citations of previous papers in the same journal. Since the cited object in journal self-citations is the paper, not the author, journal self-citations are different from other kinds of self-citations, which are related to the author's country, affiliation or research team. The characteristics and patterns of journal self-citation may completely differ from those of author self-citation. An author may never cite their own previously published papers, and yet still cite others' papers published in the same journal, creating an incidence of journal self-citing without author self-citation.

Researchers often hold different views on the role played by and meaning of journal self-citations in citation analysis studies. Some studies, journal evaluation systems, and policies directly exclude self-citations in evaluating the impact of a researcher,

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journal, or institution with little or no explanation. It seems logical to say that a journal with more self-citations would have a higher number of citations and higher journal impact factor (JIF). However was the rise of JIF related to the rise of self-citations? More self-citations indeed brought higher JIF, but did JIF increase with the rise of self-citations? Thus far some studies have shown that the two are actually not correlated (Brice and Bligh, 2004; Fan and McGhee, 2008; Frandsen, 2007; McVeigh, 2004; Motamed *et al.*, 2002), while some others felt journal self-citations did raise JIF (Fassoulaki *et al.*, 2002; Yu and Wang, 2007), or that a higher impact factor of a journal resulted in a higher self-citation rate (Herbertz, 1995). In contrast some believed that a journal with a higher JIF would have a lower self-citation rate (Fassoulaki *et al.*, 2002; Krauss, 2007). So what exactly could be the influence of self-citations on JIF? Did impact factors cause the increase in self-citations, or did the high rate of self-citations raise impact factors? These issues still needed to be clarified (Begley, 2006; Fassoulaki *et al.*, 2000, 2002; Frandsen, 2007; Maczelka and Zsindely, 1992; McVeigh, 2004; Motamed *et al.*, 2002).

This study discusses the relationship between journal self-citations, impact factor (measuring the frequency of a journal being cited in the past two years and five years), and journal immediacy index (JII) (reflecting the frequency of a journal being cited in the current year). It intends to provide a better understanding of journal self-citations in journal or researcher evaluation using JIF and JII as indicators. To that end 20 key journals in environmental engineering were selected to examine how JIF and JII could be affected by including and excluding journal self-citations.

Literature review

Journal self-citations and JIF

It has been over 50 years since Garfield (1955) first proposed the concept of impact factors. The impact factor has been officially adopted in the Journal Citation Reports (JCR) for over 30 years (Bensman, 2007). However the debate over the validity of JIF in journal evaluation has not been fully resolved (Bensman, 2007; Pendlebury, 2009; Schubert and Glänzel, 2007). How journal self-citations, often regarded as noise or interference in citation analysis studies, affect JIF remains unsettled, especially when diverse results have been obtained from different fields and areas. The study by Fassoulaki *et al.* (2000) of six anaesthesia journals showed that journal self-citations had huge influence on JIF with higher influence demonstrated by high self-citation rates. In the analysis of 13 research institutes in molecular biology Herbertz (1995) also indicated that journals with higher JIF usually had more self-citations.

However in an analysis of six otolaryngology journals from the USA, UK, and Europe, Motamed *et al.* (2002) claimed that journal self-citations and JIF were not significantly correlated. Similar results were found in another medical journal study conducted by Fan and McGhee (2008). These researchers focused on the most influential authors and ophthalmology journals in the field of cataract and corneal refractive surgery, and suggested that journal self-citations and JIF were not significantly correlated. Brice and Bligh (2004) examined two general medical journals and four specialist medical education journals from 1997 to 2001 and found high self-citation rates to have no influence on JIF. The study took a prominent medical journal (*Journal of the American Medical Association*) as an example and found its JIF rose from 9.522 in 1998 to 17.569 in 2001, while its self-citation rate remained below 12

per cent and showed a slightly declining tendency. This demonstrated that the rise of JIF did not result from the increase of self-citations.

Nonetheless the findings of Fassoulaki *et al.* (2002) showed a negative correlation between JIF and journal self-citing/cited rates. They examined the self-citing and self-cited rates in 36 journals from seven subfields of medicine, including anaesthesiology, dermatology, genetics and heredity, immunology, general and internal medicine, ophthalmology, and surgery. They suggested that self-citations may affect impact factor but had little influence on journals with high JIF. Following the finding of high JIF journals with lower self-citation rates by Fassoulaki *et al.* (2002), Krauss (2007) focused on ecological journals in ISI and found some journals with high JIF and high self-citation rates belonged to a specific subfield of ecology without competition from journals of similar scope. This finding confirmed Garfield's inference that journals with higher self-citation rates may belong to smaller or more independent fields.

Frandsen (2007) analysed 32 economics journals and could not directly verify a direct relationship between JIF and self-citations; rather the findings found that JIF was affected by document type, geographical location, language, and development over time. Yu and Wang (2007) divided journals into three groups according to high, medium, and low JIF values, and compared the influence of self-citations on impact factor. The journals with high JIF all had low self-citation rates, indicating that self-citations had little influence on JIF. Journals with medium JIF and low self-citation rates were not much affected, whereas those with medium JIF and high self-citation rates were indeed affected. Furthermore journals with low JIF and high self-citation rates were tremendously affected, suggesting that manipulation of JIF could be achieved by raising self-citation rates. Since the journals covered different scientific fields in their study, the basis for comparison was weak. However its methodology of journal classification by impact factor and the comparison of the influence of self-citations on each group should be further discussed in the interpretation of results.

The influence of journal self-citations on journal impact factor continues to stir up heated debates. However most prior research has been relatively small in scale and limited to several or several dozen journals. In 2004 Thomson Reuters published a larger scale report of a survey on journal self-citations in the 5,876 journals indexed in the 2002 JCR-Science Edition (JCR-SE). According to the survey results self-citations only comprised a very small number of total citations. There were 4,816 journals (82 per cent) with a self-citation rate below 20 per cent; the average self-citation rate was 12.41 per cent and the median was 9.04 per cent. Self-citations and impact factor were only slightly negatively correlated. The self-citation rates of journals with high JIF (greater than 5) were not high; high self-citation rates usually appeared in journals with low JIF (less than 5); the influence of self-citations on journals with JIF between 0.5 and 5 was weak (McVeigh, 2004).

Besides this general survey the report offered an analysis of the cell biology field and examined how the self-citation rates of the top ten journals in this field affected their JIF values. The results showed that exclusion of journal self-citations only resulted in a small change in the rankings by journal impact factor. Meanwhile the report pointed out that self-citations varied highly among journals. The evidence shown in the report rectified the distorted stereotypical image of JIF being affected by journal self-citations. However this evidence did not lead to a satisfactory conclusion

because the scope of the report was limited to natural science journals in 2002. As citations tend to change over time, it remains questionable whether similar results could be obtained in a longer research time span or if the field was changed to humanity or social science (McVeigh, 2004).

Garfield (1990) illustrated the difference between two-year and five-year JIF 20 years ago. However some studies have suggested that the calculation of JIF for two years was too short and unfair to many disciplines, and proposed a longer citation window or different citation windows for different fields (Harzing and van der Wal, 2009; Leydesdorff, 2008; Pendlebury, 2009). In 2009 JCR introduced a new impact factor, a five-year impact factor, which made use of the calculation for two-year JIF but extended the citation window to five years. Jacsó (2009) pointed out the five-year JIF complements the two-year JIF for indicating the prestige, reputation and influence of journals. It may be more valid to use five-year JIF for disciplines with longer citing half-lives. To fully reflect a journal's impact the selection of the appropriate JIF has become essential and deserves further study.

Thomson Reuters specifically pointed out that journal self-citations were taken into account when determining the journal selection process for the Science Citation Index Expanded (SCIE). Did the company's editorial team carefully evaluate whether the high self-citation rates of specific journals affect their JIF? Or was it common for certain fields to have higher journal self-citation rates? (Testa, 2004). It seemed that after the research Thomson Reuters decided that the influence of self-citations on impact factor was very small. Even so the team tried hard to avoid the effect of extremely high journal self-citations on JIF. In fact they decided to remove certain journals from Web of Science due to their extremely high rate of self-citation in recent years. For example *World Journal of Gastroenterology*, published in China, was removed from SCIE in 2005 as its self-citation rate was as high as 85 per cent (Begley, 2006). However this journal was re-indexed in the 2008 JCR, and its self-citation rate dropped to 8 per cent.

Published in 2008 the 2007 JCR deleted nine journals from the list because the abnormally high rate of self-citations in these journals affected their JIF and rendered them unable to fully reflect their actual performance (Journal Citation Reports, 2008a). The 2008 JCR, published in 2009, again deleted 20 journals for the same reason (Journal Citation Reports, 2009). In 2010 the number of journals removed from the 2009 JCR was 26 (Journal Citation Reports, 2010). Thomson Reuters announced that these journals would remain in Web of Science under the watch of the editorial team. Once the inflation of self-citations improved, these journals would be re-indexed in JCR. The examples of journals removed from JCR for abnormally high self-citations indicate that Thomson Reuters recognises the influence on JIF caused by such high self-citations. As for how the self-citation rate became high enough to cause a deviation in JIF, JCR did not offer an explanation. This suggests that this issue deserves further exploration.

Besides calculating the value change in JIF, ranking journals by JIF in specific fields could also determine whether self-citations affected their impact factors. Jones (2003) focused on ten journals in forensic science and toxicology, and found that after excluding journal self-citations, the JIF of each journal dropped. The journal with the highest self-citation rate (32 per cent) had its JIF decline from 1.05 to 0.74, yet the overall ranking of journals' JIF showed only slight changes. Fassoulaki *et al.* (2002) also indicated that self-citations showed some influence on the value of JIF, but the influence did not significantly change journal rankings. Therefore they proposed that

self-citations did not need to be excluded in the evaluation of JIF rankings. This claim was similar to what Cronin and Meho (2006) suggested in ranking scientists' research performance by their h-index. Starting from 2009 JCR began to provide the self-cited rate of each journal, and divided the self-citation rate into two types. The first type was calculated by dividing the self-citations by total citations, while the second was self-cites to years used in JIF calculation. Meanwhile there were two types of JIF: the original JIF and the JIF excluding self-cites. The latter was smaller or equal to the former, but further clarification was needed regarding to what extent the decreasing value would be reasonable without possible manipulation of JIF by self-citations.

Journal self-citations and JII

JII is regarded as a manifestation of the current impact. It can be used to retrieve popular papers published in the current year as well as cutting-edge papers. It is also a tool to release research results and an indicator of journal visibility. The higher JII is, the more likely these journals can be used by researchers in a short period of time (Kovačić *et al.*, 2008). It is reasonable for JII to be affected by journal self-citations, as the immediacy index calculates the average number of times a paper of a specific year in a specific journal is cited by other papers in that same year; when an author submits a paper to a specific journal, they usually have access to the prior issues of that journal, which naturally raises the possibility of journal self-citations. If excluding self-citations in the calculation of JII leads to a decline in JII value, it means that the journal's immediacy index is mostly contributed to by journal self-citations. Kovačić *et al.* (2008) indicated that once a journal's high JII came from its high self-cited rate, this JII failed to reflect the journal's actual visibility.

Investigating ecological journals indexed by ISI, Krauss (2007) pointed out that journal self-citations showed a positive correlation with JII. In that study self-citations took a high proportion of JII, as high as 34 per cent. Based on the results Krauss suggested a modification of self-citations, pointing out that otherwise self-citations could distort the supposed current impact of journals reflected by JII. He also considered the following reasons for the high self-citation rates papers received in the first year of publication: a journal could publish a special edition within which papers cited one another; to raise the visibility of papers, authors could submit their papers to the same journal, while editors ask authors to cite newly published papers from their journals. These inferences were no different from explanations put forward in other studies. However none were comprehensive enough to address the role of the time factor in the high self-citation rates papers show in the first year of publication.

The results of previous studies did not reveal many different opinions on the influence of journal self-citations on JII, yet the influence and difference of journal self-citing and self-cited rates on JII in specific disciplines still deserves further discussion.

Methods and data collection

The ratio of journal self-citing refers to the percentage, which is the number of papers that cite the references from the other papers published in the same journal, divided by the number of all the references in the journal. The ratio of journal self-cited refers to the percentage calculated by dividing the number of papers that are cited in the

citations by the other papers published in the same journal by the total citations in that journal.

This study examined research papers in 20 key environmental engineering journals (listed in Table I) selected by the Environmental Engineering Programme of Taiwan's National Science Council. The range of publication years was set between 1999 and 2008. The bibliographical information of cited references in this study was obtained from Web of Science's Science Citation Index Expanded. The dates of retrieval were in the last week of March 2009.

After establishing the journal list, titles and ISSN were obtained from the official websites of each journal. The journal titles were based on the full names listed on their official websites, and abbreviated through the "Journal Information" function provided by JCR-SE. All forms of name abbreviations were searched for in the official websites of journals, SCIE, and Scopus, and then saved as authority control records to ensure completeness and consistency in data collection.

Among the selected journals, *Journal of Toxicology and Environmental Health* was divided into *Journal of Toxicology and Environmental Health, Part A: Current Issues* and *Journal of Toxicology and Environmental Health, Part B: Critical Reviews* in 1998. Its original title was kept in the list of key journals and JCR-SE. Since this study excluded review papers, only the relevant data, author information, and references in *Journal of Toxicology and Environmental Health, Part A: Current Issues* were obtained and analysed.

Journal title	Start year[a]	Frequency	Research papers
Aerosol Science and Technology	1982	12	952
Applied Catalysis B: Environmental	1992	20	2,022
Atmospheric Environment	1958 (1994)	40	5,584
Environmental Health Perspectives	1972	12	2,549
Environmental Science & Technology	1967	24	9,642
Environmental Toxicology and Chemistry	1982	12	3,327
Journal American Water Works Association	1914	12	1,057
Journal of Aerosol Science	1970	12	972
Journal of Computing in Civil Engineering	1987	4	365
Journal of Contaminant Hydrology	1986	12	926
Journal of Environmental Engineering – ASCE	1873 (1982)	12	1,499
Journal of Environmental Quality	1972	6	2,216
Journal of the Air & Waste Management Association	1951 (1995)	12	1,290
Journal of Toxicology and Environmental Health. Part A	1974 (1998)	24	1,157
Journal of Water Resources Planning and Management – ASCE	1873 (1982)	6	467
Science of the Total Environment	1972	24	3,879
Soil Science Society of America Journal	1936	6	2,240
Water Environment Research	1929 (1992)	6	945
Water Research	1958 (1966)	20	4,893
Water Resources Research	1965	12	3,521

Note: [a]Data source is Ulrich's Periodicals Directory; a year in parentheses indicates the year that journal started using the title given in this study

Table I.
Publication information of key environmental engineering journals (1999-2008)

Based on the authority control records, the paper number, reference number, and self-citing occurrences of each journal during the ten-year-long timeframe were obtained from SCIE. The JIF and JII of each journal were calculated using statistics such as the number of cited references and number of self-cited references.

In JCR's calculation of JIF the document types are papers, review papers, and conference papers. Unlike research papers, review papers often contain a large number of references, which may easily affect JIF (Pendlebury, 2009). In order to eliminate the interference of review papers, the document type for this study was limited to research papers. All the journals' impact factors were obtained and calculated by this study, which were different from the values in JCR. Meanwhile some restrictions on the years of source data were imposed: the calculation of JIF was from 2001 to 2008, and the five-year impact factor from 2004 to 2008.

Results and discussion

Journal self-citation and two-year/five-year JIF

As seen in Table II, four out of 20 key environmental engineering journals had JIF values greater than 2, and *Applied Catalysis B: Environmental* had the highest impact factor of 3.3. The JIF values of 11 journals were between 1 and 2, and less than 1 for the rest of them. *Journal American Water Works Association* had the lowest impact factor of 0.418. After the exclusion of journals' self-citations their impact factor tended to decline. *Applied Catalysis B: Environmental* still ranked the highest, but its JIF value dropped from 3.3 to 2.637. Before the exclusion of self-citations four journals had impact factors greater than 2. After the exclusion only three journals had JIFs higher than 2. Among these, *Atmospheric Environment* showed the largest decline, from 2.397 to 1.646, with a decrease of 31.33 per cent. The 11 journals with JIFs between 1 and 2 showed little change. After the exclusion of self-citations their impact factors all remained between 1 and 2, with the range of change between 11.37 and 30.68 per cent.

With a longer period of time the accumulation of the self-citations increased, but when the number of papers in a certain period of time was taken into account, the five-year JIF value was not necessarily higher than value of two-year JIF. According to the data in Table II the five-year impact factor for all the selected journals remained higher than the standard impact factor whether before or after the exclusion of self-citations. The number of journals with five-year JIF higher than 2 increased to ten; journals with five-year JIF between 1 and 2 decreased to six; and journals with five-year JIF of less than 1 decreased from five to four. Before the exclusion of self-citations the mean of variation between two-year JIF and five-year JIF for the 20 selected journals was 35.1 per cent, with a median of 33.79 per cent. After the exclusion the mean was 39.92 per cent, and the median was 40.22 per cent.

From another angle four out of five journals with JIF below 1 had a value higher than the median of 33.79 per cent after extending the citation period; their values were apparently greater than those of other groups. Journals with JIF higher than 1 showed little change after extending the citation timeframe; the range of variation was from 22.94 to 28.25 per cent. There was no consistent change in journals with JIF between 1 and 2, with the highest rate of 50.26 per cent for *Water Research* and the lowest rate of 10.12 per cent for *Science and Technology*.

When including self-citations for the 20 journals, the one with the greatest change between standard JIF and five-year JIF was *Journal of Water Resources Planning and*

Table II.
Rankings for JIF and five-year JIF

Journal title	Impact factor				Five-year impact factor			
	Including SC	Rank	Excluding SC	Rank	Including SC	Rank	Excluding SC	Rank
Applied Catalysis B: Environmental	3.300	1	2.637	1	4.232	1	3.525	1
Environmental Science & Technology	3.045	2	2.212	3	3.824	2	2.957	3
Environmental Health Perspectives	2.934	3	2.482	2	3.666	3	3.215	2
Atmospheric Environment	2.397	4	1.646	5	2.946	4	2.147	6
Water Research	1.894	5	1.647	4	2.845	5	2.554	4
Environmental Toxicology and Chemistry	1.884	6	1.512	7	2.320	8	1.938	8
Science of the Total Environment	1.832	7	1.624	6	2.596	6	2.322	5
Journal of Aerosol Science	1.747	8	1.456	8	2.104	10	1.815	10
Journal of Environmental Quality	1.726	9	1.389	9	2.497	7	2.111	7
Aerosol Science and Technology	1.650	10	1.374	10	1.817	13	1.507	12
Water Resources Research	1.484	11	1.026	15	1.991	11	1.480	13
Soil Science Society of America Journal	1.482	12	1.238	11	2.200	9	1.902	9
Journal of Toxicology and Environmental Health. Part A	1.387	13	1.130	12	1.601	15	1.396	14
Journal of Contaminant Hydrology	1.352	14	1.084	14	1.918	12	1.579	11
Journal of the Air & Waste Management Association	1.285	15	1.095	13	1.610	14	1.385	15
Journal of Water Resources Planning and Management – ASCE	0.755	16	0.593	16	1.270	16	1.013	16
Water Environment Research	0.638	17	0.526	18	0.851	19	0.731	18
Journal of Environmental Engineering – ASCE	0.599	18	0.539	17	0.920	17	0.829	17
Journal of Computing in Civil Engineering	0.573	19	0.430	19	0.884	18	0.687	19
Journal American Water Works Association	0.418	20	0.331	20	0.566	20	0.469	20

Note: Ordered by value of impact factor from high to low; SC, self-cited

Management – ASCE: its value rose from 0.755 to 1.27, with an increase rate of 68.27 per cent.

When the self-cited figures were removed from the analysis, the values of JIF and five-year JIF became very close. After the exclusion the number of journals with five-year JIF values higher than 2 decreased from ten to seven. *Atmospheric Environment* still had the greatest decline: its value dropped from 2.946 to 2.147, showing a decrease of as much as 27.14 per cent. *Journal of Environmental Engineering – ASCE* again had the smallest decline: its value dropped from 0.92 to 0.829, a decrease of only 9.86 per cent. Compared to five-year JIF values each group was affected by the self-citations and showed large differences. In the 10 journals with five-year JIF values higher than 2, the highest decrease rate was 27.14 per cent and the lowest 10.24 per cent. In the four journals with five-year JIF less than 1, the highest decrease rate was 22.3 per cent and the lowest 9.86 per cent. There was no general pattern among the journals.

For the two kinds of JIF the results before and after the exclusion of self-citations were highly correlated with Pearson's $r = 0.986$ ($p = 0.000$). Meanwhile for five-year JIF the results before and after the exclusion of self-citations were also highly correlated with Pearson's $r = 0.990$ ($p = 0.000$). In the paired-samples *t*-test JIF and five-year JIF showed a significant difference before and after the exclusion of self-citations. By comparing the mean of JIF and five-year JIF, the values of five-year JIF were higher regardless of the presence or absence of self-citations.

The results of the two kinds of JIF before and after the exclusion of self-citations were highly correlated with Spearman's $\rho = 0.982$ ($p = 0.000$). For five-year JIF the results before and after the exclusion of self-citations were also highly correlated with Spearman's $\rho = 0.986$ ($p = 0.000$). Based on the results of two correlation coefficient tests, the values or ranks of JIF or five-year JIF were not affected whether journal self-citations were excluded or not.

In addition, when the self-citations were included, the average JIF and five-year JIF for 20 journals were highly correlated with Pearson's $r = 0.983$ ($p = 0.000$). Even when the self-citations were excluded the two were still highly correlated with Pearson's $r = 0.983$ ($p = 0.000$). Rank analysis also shows that the rankings of the average JIF were significantly correlated with the rankings of the average five-year JIF, and the correlation was high. Similarly, after the exclusion of self-citations the two were also highly correlated.

Some prior studies have claimed that it is not appropriate to use two years of citation data for all disciplines when calculating JIF (Harzing and van der Wal, 2009; Leydesdorff, 2008; McVeigh, 2004). JCR began providing five-year JIF in its database in 2009; however, due to the limitation of the number of publications and citations produced and received by journals, the values of five-year JIF were not always higher than the values of two-year JIF. According to the study results, for all journals the five-year JIF values were consistently higher than two-year JIF values. Among them four journals (*Journal of Water Resources Planning and Management – ASCE*, *Journal of Computing in Civil Engineering*, *Journal of Environmental Engineering*, and *Water Research*) showed 50 percent differences in the values of JIF and five-year JIF. This indicated that for these four journals, a longer time may be needed to fully present citations received by them. In order to further confirm the reasons for this, the journals' cited half-life in the past five years was searched for in JCR. The results showed that

the cited half-life of *Applied Catalysis B: Environmental* was 4.8 years, while the others were above five years. The cited half-life of three journals, *Journal American Water Works Association*, *Soil Science Society of America Journal*, and *Water Resources Research*, were above ten years. This suggested that the citation window for JIF was often affected by the length of the half-life.

Pearson correlation results indicated that the values and ranks between JIF and five-year JIF were both highly correlated, which was consistent with the study by Adler *et al.* (2008) of mathematical journals. They indicated that the values of five-year and ten-year JIF in mathematical journals would basically be consistent with two-year JIF values. Therefore it can be inferred that for the 20 key journals in environmental engineering, there would be no need to extend the calculation of JIF to a five-year citation window. Nonetheless a significant difference between values of JIF and five-year JIF still existed.

Journal self-citation and JII

As shown in Table III the JII values for nine out of 20 key journals in environmental engineering exceeded 0.3, and *Environmental Health Perspectives* had the highest JII of 0.415. *Journal of Computing in Civil Engineering* had the lowest JII value of 0.057. After the exclusion of journals' self-citations their JII tended to decline. None of them had an immediacy index above 0.35. Originally in third place, *Applied Catalysis B: Environmental* climbed to number one with a JII of 0.321. The threshold values for each group dropped: 0.177 for the high JII group, 0.094-0.175 for the medium JII group, and 0.065 for the low JII group. No definite trend was found in the values of immediacy index for each group after the exclusion of self-citations. In each group the decline for journals did not follow any pattern. Ten out of twenty journals had a decrease rate above 40 percent, whereas two showed a decrease rate below 20 percent.

In the above discussion on JII the decrease rate of half of the journals exceeded 40 percent after the exclusion of self-citations. Further investigation is necessary to clarify the relationship between JII and self-citing/cited rates. Based on the correlation results a high correlation existed in JII values of the 20 selected journals before and after the exclusion of self-citations (Pearson's $r = 0.944$, $p = 0.000$). However JII was not statistically correlated with the journal self-citing rate or the journal self-cited rate. After the exclusion of self-citations JII was again not statistically correlated with the journal self-citing rate or the journal self-cited rate. In the paired-samples *t*-test the values of JII before and after the exclusion of self-citations were significantly different.

In addition the average JII and journals' publication frequency were moderately correlated with Pearson's $r = 0.517$ ($p = 0.019$). After the exclusion of self-citations the two were also moderately correlated, with Pearson's r dropping slightly to 0.512 ($p = 0.021$). JII and journals' annual number of publications were moderately correlated with Pearson's $r = 0.545$ ($p = 0.013$). Yet after the exclusion of self-citations Pearson's r of the two dropped to 0.438 ($p = 0.053$), which did not reach a statistically significant correlation. According to the Help section of JCR the scale and publication frequency of journals were not taken into consideration in the JII. Infrequently issued journals and papers published late in the year had shorter time available to be cited, so their JII values were lower (Journal Citation Reports, 2008b). According to the findings of this paper the JII is moderately correlated with publication frequency. Therefore it is

Table III.
Ranks for JII

Journal title	Value of JII	JII rank	Excluding SC JII	Excluding SC JII rank	Decline percentage after exluding SC
Environmental Health Perspectives	0.415	1	0.262	2	36.87
Environmental Science & Technology	0.404	2	0.231	5	42.82
Applied Catalysis B: Environmental	0.402	3	0.321	1	20.15
Atmospheric Environment	0.384	4	0.237	4	38.28
Science of the Total Environment	0.354	5	0.175	10	50.56
Environmental Toxicology and Chemistry	0.344	6	0.215	6	37.50
Journal of Aerosol Science	0.344	6	0.237	3	31.10
Journal of Contaminant Hydrology	0.311	8	0.177	9	43.09
Aerosol Science and Technology	0.300	9	0.205	7	31.67
Journal of Environmental Quality	0.293	10	0.155	11	47.10
Water Research	0.224	11	0.181	8	19.20
Water Resources Research	0.220	12	0.108	14	50.91
Soil Science Society of America Journal	0.204	13	0.135	13	33.82
Journal of Toxicology and Environmental Health. Part A	0.180	14	0.142	12	21.11
Journal of the Air & Waste Management Association	0.166	15	0.094	15	43.37
Journal of Environmental Engineering – ASCE	0.120	16	0.056	16	53.33
Water Environment Research	0.120	16	0.065	17	45.83
Journal of Water Resources Planning and Management – ASCE	0.096	18	0.055	18	42.71
Journal American Water Works Association	0.057	19	0.034	20	40.35
Journal of Computing in Civil Engineering	0.057	20	0.051	19	10.53

Notes: Ordered by value of JII from high to low; SC, self-cited

suggested that, when using the JII as an indicator for the current impact of a journal, the differences caused by publication frequency should be taken into account.

In further analysis the values of JII before and after the exclusion of self-citations were ranked in order from high to low. The relationship among the rankings for JII, the self-citing/cited rate, and the number of publications were probed further here. The statistical results showed that the rankings for the average JII before and after the exclusion of self-citations were highly correlated with Spearman's $\rho = 0.941$ ($p = 0.000$). The rankings for the number of publications and the average JII were significantly correlated, a moderate correlation with Spearman's $rho = 0.605$ ($p = 0.005$); the degree of correlation was even higher than the correlation with direct values of JII. Even after the exclusion of self-citations the ranks for JII values and the number of publications were significantly correlated with Spearman's $\rho = 0.429$ ($p = 0.028$). As for the ranks of the self-citing and cited rates, none of their correlations with the JII before and after the exclusion of self-citations reached a statistically significant level.

These findings are not consistent with the study results of Krauss (2007) regarding ecological journals. Krauss's study suggested that the journal self-citing rate showed a positive correlation with JII, yet in this study neither the values nor the rankings of JII show a statistically significant correlation with the self-citing rate or the self-cited rate. Such differences could be a result of the discipline chosen as the study's focus. In Krauss's study 107 ecological journals indexed by JCR were analysed, which revealed a great difference from the discipline examined in this paper in regard to aspects such as discipline domain, journal scope, and journal features. Furthermore, Krauss pointed out that the editors of six journals had directly encouraged authors to cite previous publications in their journals. If journal self-citations were encouraged, the citation statistics may be manipulated and distorted.

In both cases of values and rankings of JII, the correlation coefficient values with and without self-citations were all highly correlated. This explained why despite the influence of self-citations on immediacy index, little difference existed in the immediacy index and the rankings of immediacy index for the 20 journals before and after the exclusion of self-citations.

Journal self-citation and JIF/JII

JIF and JII are widely used indicators of the influence and visibility of journals. Although the calculation formulas for the two indicators are different, they both evaluate a journal's impact through its papers' citation counts. Does this mean they are affected by journals' self-citations in the same way? From the values of correlation coefficients shown in Table IV, with the inclusion of self-citations, JIF and JII values reached a statistically significant level over eight years. A moderate correlation was detected in the earlier four years, while a high correlation was detected in the later years. The values of the two indicators were ranked and analysed for Spearman's rank correlations. As seen in Table IV JIF and JII values also reached a statistically significant level and had a high correlation in every year except 2003. After the exclusion of self-citations JIF and JII showed a moderate correlation with Pearson correlation coefficients in 2004. In the remaining years both the values and rankings of the two indicators reached a statistically significant level and showed a high correlation.

IF	II 2001-2008 including self-citations Pearson's r	Spearman's ρ	2001-2008 excluding self-citations Pearson's r	Spearman's ρ
2001	0.532**	0.741**	0.845**	0.822**
2002	0.693**	0.799**	0.805**	0.771**
2003	0.453*	0.626**	0.795**	0.779**
2004	0.625**	0.771**	0.630**	0.779**
2005	0.804**	0.827**	0.794**	0.817**
2006	0.790**	0.749**	0.711**	0.817**
2007	0.879**	0.851**	0.842**	0.853**
2008	0.839**	0.823**	0.936**	0.882**

Notes: *Significantly correlated when the significance level is set at 0.05 (two-tailed); **significantly correlated when the significance level is set at 0.01 (two-tailed)

Table IV. Correlation coefficients between JIF and JII with/without self-citations

Based on these findings the degree of correlation between JIF and JII is not high enough for either to replace each other in terms of the values. Yet if only the rankings of journals were taken into account, it may be possible for JIF and JII to replace each other. Although the replacement is possible, differences between specific journals or years may appear.

Conclusion

This study discovered that with and without self-citations JIF and five-year JIF were highly correlated in their values and rankings. Meanwhile the correlation between the self-citing/cited rates and two-year/five-year JIF with and without self-citations did not reach a statistically significant level. This indicates that the 20 journals' JIF and five-year JIF were not affected by journal self-citing or self-citations, but the rankings of JIF before and after the exclusion of self-citations were not statistically correlated with the self-citations. The rankings of five-year JIF and of journal self-citing rates reached a significant level and showed a moderate correlation. After the exclusion of journal self-citations the two did not reach a significant level, suggesting a greater influence of self-citations on JIF of longer citation timeframes. With respect to the calculation of JIF the values between two-year and five-year citation windows were highly correlated and significantly different. Therefore both two-year JIF and five-year JIF could be appropriate. With and without self-citations both two-year and five-year JIF had a moderate correlation with publication frequency and the number of publications. Therefore it is recommended to be aware of the effects of publication frequency and number of publications on two-year and five-year JIF.

For JII both the values and the rankings were highly correlated before and after the exclusion of self-citations. This indicates that it was meaningless to exclude journal self-citations when calculating JII or conducting a ranking of JII for the 20 environmental engineering key journals. JII showed some degree of correlation with the number of publications and publication frequency of journals. With and without self-citations JII was moderately correlated with the publication frequency. Before the exclusion of self-citations JII showed a moderate correlation with the number of publications, but after the exclusion of self-citations, the two did not reach a statistically significant level. From the perspective of ranks the correlation coefficient

results between the ranks of JII and the number of publications showed a moderate correlation. Even though the values of the correlation coefficient dropped after the exclusion of journal self-citations, the two still reached a significant level and showed a moderate correlation.

Since journal JIF and JII showed little difference before and after the exclusion of self-citations, the influence of journal self-citations was not statistically significant. Therefore excluding journal self-citations is not necessary in research assessment. However this study focused only on environmental engineering journals, and different disciplines may yield different results. However it may serve as a guideline for other engineering disciplines.

All the correlations between two-year and five-year JIF were high, indicating that there was no need to extend the calculation of JIF to five years. Especially when considering the cost of time and effort, citation windows of five years are not necessary in the field of environmental engineering.

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