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## Short Communications

# INCREASING THE BETWEEN-YEAR STABILITY OF THE IMPACT FACTOR IN THE SCIENCE CITATION INDEX

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The critical evaluation of scientific productivity during last years has been done with the help of the Journal Citation Reports ranks of journals. The relative performance of each journal was derived from a simple calculation called Impact Factor. Such measure has been widely criticized by scientometricians, but alternative proposals were never adopted due perhaps to their complexity, but also to economic limitations. For the informetric purposes this situation has led to a worrying lack of standardization and, worst of all, makes useless many studies for comparative purposes. In order to enhance the comparative value of the impact factor we develop a new easy method that increases the time period used for its calculation. Such new index has advantages over the old one.

Lately more attention has been paid to research evaluation to optimize the funds allocated to science policy. Bibliometrics applied to serials is the main tool to record such evaluation, since most of the scientific output is published as articles in scientific journals. Probably the most successful method to achieve certain objectivity in such a task is the citation analysis, although several bibliometric indicators, different from those derived from citation analysis, are also common in the metrics of science.

The measure of the impact of scientific works and the influence of source journals, core of the citation analysis, has several shortcomings as evaluation tool. Such opinion is recognized by scientometricians who advise a cautionary use, but the scores are frequently misused by policy makers.

The most used and misunderstood indicators are those derived from the Science Citation Index (SCI) database, a compilation of the core journals of almost all scientific fields. Several citation indicators are supplied by the *Journal Citation Report*, calculated from data in SCI, but the most widely known is the impact factor (IF), a solution to generate journal rankings with several conspicuous shortcomings:

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- Only a few number of journals (about 4000) received an IF value. Those not listed in the JCR are generally believed by policy makers to have a zero value, which is by no means the case.
- The journal coverage of the JCR has many biases, favouring English-language journals, those devoted to basic research or review and finally, the specialized journals in the scientific fields with shorter half-life periods of citation.
- There are great differences among IF of the journals sampled in the JCR, almost four orders between the first and the last one.
- During several consecutive years the same journal often shows a great disparity of IF values, with more than 100% differences between years.
- The data presented by SCI have several technical limitations, and in fact they are not free of errors; the largest of all is the poor coverage of the current calendar year. Only the lost, misspelled or incorrect citations accounts for 3.6% of its literature coverage.

Several authors have developed complex indicators, probably best suited to evaluate research performance, but none of them are easy to apply due to the need of building very large databases. Other proposals for new indexes obtained from citation data would require deep changes in the SCI scheme.

In order to give more value to the IF, a modification in its calculation is proposed. Although not suited to solve all of its weaknesses, at least more stability could be achieved and no special change is required in the JCR.

The impact factor of a journal in the current year is the ratio obtained by dividing the citations found in the citing year to papers in the previous two years and the number of source articles in the same two years. Due to the fact that many of the journals received more than 50% of the citations out of the two-year period, an extended impact factor has been introduced:

$$IF_y(N) = \frac{\sum_{i=y-1}^{y=n} C_i}{\sum_{i=y-1}^{y=n} S_i} ,$$

where $y$ is the current year, $n$ is the degree of the IF and shows the number of back years (2 for the SCI IF), $C$ is the number of citations received and $S$ the number of articles published.

Original data ware gathered from the printed edition of the SCI and *Journal Citation Report* from years 1988, 1987 and 1986. A reduced sample was compiled selecting one journal out of ten in the 1988 alphabetical list. After excluding some titles due to the lack of data during those years, a sample of 306 journals was used.

Data were compiled for each journal including the number of source articles, citations of up to four years and the impact factors ($n=2$). With these data the impact factors for $n=3$ and $n=4$ were obtained. For $n>4$ the impact-factor values of several journals could become unavailable.

As shown in Table 1, there are small differences between the mean values.

Table 1
The average values and the corresponding standard error for the three-years sampled (n=306)

| Year | 1986 | 1987 | 1988 |
|---|---|---|---|
| Source articles | 164 ± 16 | 159 ± 16 | 166 ± 17 |
| Citations received | 3880 ± 805 | 3952 ± 830 | 4147 ± 879 |
| Impact Factor | 1.688 ± 0.171 | 1.590 ± 0.152 | 1.602 ± 0.160 |

The annual evolution pattern of the IF changes from one journal to another, but frequently a journal IF jumps to higher or lower values without a known reason. So, a general trend of low stability appears after only a preliminary look at the lists.

A measure of instability was developed for the values of IF over the three-year period

$$ST = \frac{1}{N \cdot \overline{IF}} \sum \left| IF_i - \overline{IF} \right| ,$$

where $i$ refers to each year value and n is the total number of years.

The results could be summarized as follows.

- The values of FI(3) and FI(4) are very similar, but they are greater than those of FI(2).

Table 2
The average values and the corresponding standard error calculated for the three-years (n=306)

| Year | FI(2) | FI(3) | FI(4) |
|---|---|---|---|
| 1986 | 1.688 ±0.171 | 1.738 ± 0.173 | 1.731 ± 0.167 |
| 1987 | 1.590 ±0.152 | 1.760 ± 0.170 | 1.746 ± 0.168 |
| 1988 | 1.602 ±0.160 | 1.799 ± 0.174 | 1.801 ± 0.177 |

- The mean values obtained for the instability of the index of grade two are higher than those calculated for the indexes of grade three and four, as shown in Table 3.

Table 3
The mean values (± standard error) of the instability index

| |
|---|
| ST(2) = 0.1402 ± 0.0069 |
| ST(3) = 0.1168 ± 0.0060 |
| ST(4) = 0.0967 ± 0.0055 |

- The use of IF(4) gives the lowest instability values, i.e. the impact factor extended to four years is better suited to avoid the year-to-year variations of the index.

Therefore, according to the results, the described proposal is an easy method to enhance the value of bibliometric indexes based on citation analysis. Nevertheless, it is not a formal endorsement of its use for ranking journals or evaluating performance of researchers without taking into account additional indicators.

Finally, it is suggested that the *Journal Citation Report* should adopt the four-year scheme to optimize the stability of impact factors of the journals it covers.