Misuse and abuse of journal impact factors

Ricardo Guerrero
International Microbiology; Apartado 16009, ES-08080 Barcelona, Spain; guerrero@bcn.servicom.es

Impact factor and citation impact

The scientific journal "impact factor" is the technical indicator most widely used for evaluating scientific journals. The impact factor was set up by the Institute of Scientific Information (ISI) in the 1960s, and it measures the frequency with which individual articles — the "average article" — in a journal are cited over a period, usually a year. It is calculated by dividing the number of all citations of articles published in a particular journal during the current year by the articles published in that same journal during the previous two years. Since 1975, ISI has published Journal Citation Reports annually as part of the Science Citation Index. At first, ISI used the impact factor to collect statistical data to evaluate and compare the journals indexed, so that librarians had a useful tool for the management of library journal collections (ISI 1999). The use of the impact factor, however, has gone far beyond that aim. Besides playing a major role in market research for both publishers and advertisers, the impact factor has been more and more used by science managers and decision-makers as an indicator of the individual scientific value of researchers in science policy. Research funding is frequently influenced by the impact factors of the journals in which applicants for grants have published their articles.

Another publishing-based way to accredit knowledge is by measuring the frequency with which articles are cited. The number of citations of a scientist's work has even been recommended as the best single indicator of scholarly recognition (Christenson & Sigelman 1985). A reference cited in a paper makes an explicit linkage between the research described in the paper and previous work that is a source of information for the author (Garfield 1994). The citation impact of a given paper implies that the authors citing it have found the paper useful for their work. These conceptual associations have been called "intellectual transactions", and they are indexed in ISI's databases. The impact factor and citation impact are closely related. In fact, a paper's citation impact may depend on the impact factor of the journal where it has been published (Christenson & Sigelman 1985).

Scientific journals and science policy

Government policy makers, corporate research managers and university administrators need valid and reliable science and technology indicators to set priorities for strategic planning, to target emerging specialties and new technologies, to identify areas of strength and excellence, and to assess research work (Garfield & Welljams-Dorof 1992). Primary research articles have traditionally been used as such indicators. For many years, the evaluation of the significance of research publications was based on qualitative analyses by experts in the field.

Over the last decades of the 20th century several institutions were set up which developed quantitative citation databases. ISI was developed primarily as an information-retrieval tool. Nevertheless, the fact that its databases were multidisciplinary and comprehensive, and that all items were fully indexed, seemed to make the databases well-suited as science and technology indicators. The danger of the impact factor and citation impact becoming the only indicators used to assess science and technology performance is often discussed, even in scientific journals with the highest impact factors such as *Science* and *Nature*. In 1989 *Nature* editor John Maddox wondered whether science journals influenced the way science is conducted, and, if not, whether they should (Maddox 1989). He wondered also whether the publication policies of journals also influenced the planning of experiments. In 1995 Maddox complained about the increasing bad manners that coexisted with the traditional good manners of research. He mentioned bad-manner practices such as self-advertisement, which has become more and more common; the lack of recognition of one's competitors' work; the tendency to overlook publications in other languages — surely he was referring to languages other than English — or by colleagues from other countries (Maddox 1995). In Maddox's opinion, academic institutions and grant-making agencies had the chief responsibility for this loss of good manners.

Impact factor and research assessment

Using the impact factors of scientific journals to assess research can lead to wrong assumptions because the total number of annual publications in each category is not taken into account. Scale effects in space — the extent of the literature in a field — and time — the length of time needed to conduct subsequent research after a seminal article is published — must influence impact factors. In fact, the probability of an article published in a top journal in a given category being cited increases with the total number of publications in its category. Journals devoted to a discipline such as ecology have low impact factors (top journals have impact factors of ~2–4) and their articles tend to be based on several years of field research. Obviously, articles describing methodological approaches that are automated and laboratory-based, such as many published in biochemistry journals (top journals have impact factors of about 30), should not

be compared with those describing time-consuming and field-based research work, as is often the case in ecological research (Statzner et al. 1995).

The official forms for personal curriculae vitae in some Spanish central agencies for research have a section devoted to publications. At the top of a subsection where scientists must list their outstanding publications there is a note reading "Include only articles published in journals that are indexed in SCI [Science Citation Index]." No comment.

Impact of the impact factors

The EASE 7th General Assembly and Conference (Tours, France, 21–24 May 2000) held three workshops, summarized in a final plenary session, to discuss the "impact" of impact factors in the medical, biological and physical sciences. Elisabeth Kessler, who chaired the session dealing with impact factors in the biological sciences, commented on drawbacks associated with the use of impact factors as indicators of scientific excellence. She showed a list compiled by Professor Per O. Seglen (Norway) of many such drawbacks:

- Journal impact factors are not statistically representative of individual journal articles.
- Journal impact factors correlate poorly with actual citations of individual articles.
- Authors use many criteria other than the impact factor to choose the journals to which they submit their manuscripts.
- Databases erroneously include citations to non-citable items.
- Authors tend to over-self-citation.
- Review articles are heavily cited and inflate the impact factor of journals.
- Long articles collect many citations and give high journal impact factors.
- Short publication lag allows many short-term journal self citations and gives high journal impact factors.
- The authors prefer citations in the national language of the journal.
- There are selective journal self-citations; articles tend to preferentially cite other articles published in the same journal.
- Coverage of databases is not complete.
- Books are not included in the databases as a source for citations.
- Databases have an English language bias.
- American publications tend to dominate databases.
- Journals included in databases may change from year to year.
- The impact factor is a function of the number of references per article in the research field considered.
- Research fields with literature that rapidly becomes obsolete are favoured.
- The impact factor of a given field depends on the dynamics (expansion or contraction) of the field.
- Small research fields tend to lack journals with high impact factors.
- The relationships between fields (clinical or basic research, for example) strongly determine journal impact factors.
- The citation rate of articles determines the impact factors of the journals in which they are published, whereas the contrary does not happen.

Conclusions

Basing research evaluation on the significance of research publications is subjective, because the evaluation of a publication depends on qualitative analyses by experts in the field. When bibliometrics developed it was mainly applied to assemble and interpret statistics relating to books and periodicals, to demonstrate historical movements, to determine the national or universal research use of books and journals, and to ascertain in many local situations the general use of books and journals. It also helped to interpret the process of development of a discipline by counting and analysing different aspects of the way it was communicated to the scientific community (Borgman 2000). Using these data for individual assessment is not only subjective but can also be time-consuming and expensive. Policy-makers should not use the same grounds for the assessment of research carried out in different scientific and technological fields. Researchers, for their part, should resist the temptation — exerted by the pressure to win promotion and research funds — to magnify their own bibliographies and increase the citation impact of their own articles by self-citing. The correct assessment of the individual quality of a researcher's scientific production can only be accomplished by reading and evaluating the individual value of each article produced, and this is a system which requires both specific expertise and enough time, two things which evaluation panels frequently lack.

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