Scientometrics (2010) 85:861–866
DOI 10.1007/s11192-010-0159-y

Indicators are the essence of scientometrics and bibliometrics

Comments to the book entitled "Bibliometrics and Citation Analysis, From the Science Citation Index to Cybermetrics" from Nicola De Bellis

P. Vinkler

Received: 2 January 2010 / Published online: 23 January 2010

The declared aim of the book of De Bellis (2009) is: "to provide readers from a wide range of cultural background with a simple and accessible survey of the main concepts, techniques, theoretical premises, and historical developments in the subfield of information science that deals with the quantitative analysis of scientific and technological literature." This aim has been fulfilled only partly by the author. In my view, scientometrics and bibliometrics are overlapping categories. We may differentiate between the two fields only by the *aim* and possible *consequences* of the study. The title of the book and its chapters suggest that both bibliometrics *and* scientometrics would be covered because "citation analysis" (see the title) is one of the most frequently used methods in scientometrics.

In my opinion, *scientometrics* is a scientific field dealing with all quantitative aspects of people or group of people, matters and phenomena in science, and their relationships, but which do not primarily belong within the scope of a particular scientific discipline. I would not restrict scientometrics to information aspects, only and, I would stress here the term: "*quantitative aspects*". Therefore, I find it rather strange that although the author writes on "biblio*metrics*", we can find only 16 equations and 3 functions throughout the book, which contains 417 pages. It should be noted that in the book ("Introduction to Informetrics", Elsevier, 1990) from Egghe and Rousseau (449 pages) a single chapter (pp. 254–259) ("Citation analysis of scientific journals") contains 25 equations.

According to the author: "even though mathematical reasoning is an essential part of current bibliometric research, a book pretending to reproduce even the smallest part of it would inevitably run the risk of losing itself in the details of the formalism." I cannot agree with the above statement, because, referring to J. Kepler: "The mind comprehends a thing the more correctly the closer the thing approaches toward pure quantity of its origin."

The main chapters of the book are the following:

Biblio/Sciento/Informetrics: Terminological Issues and Early Historical Developments

The Empirical Foundations of Bibliometrics:

The *Science Citation Index*

The Philosophical Foundations of Bibliometrics:

P. Vinkler (✉)
Chemical Research Center of the Hungarian Academy of Sciences, Budapest, Hungary
e-mail: pvinkler@chemres.hu

Bernal, Merton, Price, Garfield, and Small

The Mathematical Foundations of Bibliometrics

Maps and Paradigms: Bibliographic Citations at the Service of the History and Sociology of Science

Impact Factor and the Evaluation of Scientists: Bibliographic Citations at the Service of Science Policy and Management

On the Shoulders of Dwarfs: Citation as Rhetorical

Device and the Criticisms to the Normative Model

Measuring Scientific Communication in the Twentieth Century: From Bibliometrics to Cybermetrics

As far as the distinction between scientometrics and bibliometrics is concerned, we may readily accept that the *Lotka law* referring to the *publication productivity* of authors would be a bibliometric law. However, the study of the publication production of individuals seems to be a game only without evaluating their activity and without drawing the necessary consequences (as far as, e.g., grants or nominations, etc. are concerned). The distribution of publications among the authors is influenced by several factors, which are partly outside the scope of the scientific publication mechanism. I think, the Lotka-distribution of productivity of the authors of a university would be similar to the distribution of the number of full professors, associated professors, PhD students and undergraduates within that population. It is obvious that the Lotka law includes also *age* (or more precisely "publication age") and *position* distribution. Accordingly, the skewness of scientometric distributions is influenced by many factors, and it is very difficult (or even impossible) to separate the effects of the individual factors. Therefore, "laws" in bibliometrics or scientometrics can be regarded only as general tendencies. Each scientometric system is unique, sometimes with more individual than general features. Small systems are more uncertain than systems with great population. It is easier to obtain reliable indicators for characterizing the publication activity of countries than assessing the publications of individuals.

In my view: *The essence of scientometrics is the indicator*. To describe bibliometric or scientometric indicators without demonstrating the corresponding formulas, as the author tries to do, is hardly possible. For persons trained in any branch of natural sciences or in some "hard" social sciences (like: psychology or sociology or economics) the corresponding mathematical formulas can be easily understood.

One of the main drawbacks of the book that it gives only very limited number of *examples*. Without demonstrating the indicators, e.g., the mean impact factors of journals by subject field, or the trend of impact factors with time, or differences between the citedness indicators by countries, the reader will have no idea about the potential and value of the indices. Even the essence of scientometrics fails without offering relevant data, indicators, maps, and functions. Nevertheless, the author is not alone, who presents a scientometric publication similarly to an essay. The other danger for scientometricians is to present calculations with sophisticated mathematical formulas but, without the description of the corresponding physical (sociological) background. Some scientometricians prefer the beauty of complicated mathematical equations and theoretical models to the lean truth of reality. It is not easy to sail between Scylla and Charybdis.

Nevertheless, the book gives a well understandable introduction also into the mathematical foundation of bibliometrics and scientometrics. We can learn, e.g., about: Pareto's law, Poisson models, cumulative advantage distribution, Lotka's law, Bradford's law, Zipf's law, Garfield's law of concentration, Mandelbrot's approach, Leimkuhler's law, and Power laws in the information production suggested by Egghe and Rousseau (2000).

The name of the author is not familiar to the members of the scientometrician community. Therefore, he has the advantage not to be subjective towards any special topic in the field. The book is written from the viewpoints of a science historian, consequently the parts dealing with the history of bibliometrics and scientometrics seem to be very useful for any reader. The role of J.D. Bernal, R.K. Merton, D. de Solla Price and E. Garfield in bibliometrics is treated in detail. Even the early linguistic and philosophical contexts are reviewed.

According to the author (p. 15) one of the most significant steps towards the institutionalization of scientometrics was made by the establishment of the journal, Scientometrics in 1978 by Tibor Braun. The journal became soon the leading information channel of the field. It is to be noted that in 2008 the median impact factor of 61 journals in information science and library science was 0.781, whereas the impact factor of Scientometrics was as high as 2.328 (JCR, Social Science Edition, ISI Web of Knowledge).

The gate-keepers of Scientometrics play an essential role in converting scientometric information to scientometric knowledge. It is the obligation of the members of the Editorial and Advisory Board to award the D. J. de Solla Price Memorial Medal periodically to scientists with outstanding contributions to the fields of quantitative studies of science. The Price Medal was conceived and launched by T. Braun. The first medalist was E. Garfield in 1984. The speech of the medalists at the awarding ceremony, which became an essential part of the programme of the ISSI Conferences since the foundation of the Society in 1993, gives always an exclusive possibility to learn the main research trends in scientometrics and research concept of the awardees.

The citation may be regarded as the *unit of impact* in evaluative scientometrics. Consequently, it is essential to prove that the references in scientific publications are made for professional reasons primarily. In Chapter 7.1.4. we can read about "Counting the Uncountable: "Bibliometric Models of Citation Practices". As far as I know, there are in the literature only a few quantitative models, which are based on the *frequency* and/or *strength* of motives toward referencing. A mere list of the referencing motives cannot be regarded as a "model". De Bellis refers to some important publications on the topic but, several others fail, e.g., Spiegel-Rösing (1977), Meho and Sonnenwald (2000), Hanney et al. (2005), Brooks (1986), Vinkler (1998). De Bellis refers to the model of Glänzel and Schubert (1995) and Glänzel (2007) as a citation model. The study of the mentioned authors refers however to a model based on a stochastic birth process describing the dynamics of the possible future *citations*. Whereas the model of Brooks and Vinkler, etc. refers to the frequency of motives of the referencing authors.

Scientometrics can yield essential data and indicators for science policy on each hierarchical level (e.g. monitoring performance, selecting research priorities, study of relations between science and society or science and economy). Therefore, scientometrics without applying relevant mathematical (statistical) methods *and* without exploring the relevant science sociological background, resembles a sailboat without sail, whereas scientometrics without practical applications seems to be similar to a sailboat without wind.

The most problematical chapter of the book is: "Impact Factor and the Evaluation of Scientists: Bibliographic Citations at the Service of Science Policy and Management." This part seems to be incomplete. No or very little information is given on indicators (e.g., Publication Strategy), relative indicators (e.g., Relative Publication Strategy, Relative Subfield Citedness), or on composite scientometric indices, important methods, such as the characteristic scores and scales method (Glänzel and Schubert 2003), or on scientometric (or bibliometric) standards. The *comparative potential* of the different indicators, their validity, reliability, and applicability remain mostly uncleared. The reader gets only little

support for selecting appropriate methods and indicators. The pros and cons of the indices are not given unequivocally.

Concerning the Hirsch-index (h-index) the author asserts: "the conceptual weaknesses of this umpteenth one-dimensional ranking tool have been easily identified". Basically, I agree. But, the h-index is a two (or three)-dimensional index. It is influenced by the number of citations, by the number publications, and by the distribution of citations over the papers. Consequently, the h-index may be regarded as a special composite index (i.e., consisting of several "simple" or growth indices). According to Schubert and Glänzel (2007): $h = P^{1/3}\ GF^{2/3}$, where P is the number of papers and GF is the Garfield (Impact) Factor of the journal (or, in general: citedness of papers). Nevertheless, as far as the methodological weaknesses are concerned, I fully agree with the author. My main concern is that with the increase of the number of citations to the most influential (highly cited) papers (i.e., Hirsch-core papers) the h-index *does not increase*. The h-index can increase only with increasing number of citations to the paper(s) *outside the Hirsch-core*. It may happen that even a single citation to a paper (ranked as $h + 1$) may increase the h-index by unity (see Vinkler 2009, 2010).

In my view, too great stress is laid in the book to the novel "h-type scientometrics", to the "letter-indexes" and methods (e.g., h, b, h_m, h_p, AR, Z, IQP, DCT, 'generalized' and 'rational' h-index, etc.) without substantial criticism.

It should be noted that the impact factor (IF) is used by the author in the meaning of "citedness" (i.e. citations per paper) similar to the general use in the literature. But, the *impact factor* of journals (i.e., Garfield Factor) cannot be changed for the *citedness* of a set of papers of a person or institute or country. The characteristics (i.e., mean number of references, ageing rate of information, time setting, etc.) of the sets mentioned can be different.

There is a misunderstanding among scientists and even scientometricians regarding the use of the journal impact factor for evaluating individual journal articles or sets of papers of persons or teams. The author explains correctly that the GF of journals refers to eminence of *the journal as a whole* and does not characterize the eminence of the individual papers published in it. Accordingly, the mean GF of the journals used for publication by an author or group of authors can be regarded as the *Publication Strategy* (PS), which characterizes the potential of the corresponding author(s) in selecting appropriate publication channels (Vinkler 1997).

We learn from the book that the Garfield (impact) factor (GF) and total citations: "both measures are surprisingly stable over time". In spite of this, the author has severe concerns regarding the use of the GF as a reliable indicator for characterizing journals. According to the author, the skewed distribution of the frequency of citations among journal publications would cause one of the main difficulties in using the impact factors for evaluation purposes. According to my experiences, however, the value of the GF of established journals (i.e., not changing in their scope, form, size, etc.) is stable in short time periods, whereas it is increasing during longer periods. Further, several studies prove that the ratios between outstandingly, remarkably, fairly, poorly and non-cited papers are rather stable in time referring to papers in the same journal (e.g., Glänzel 2007). And, it has been proved that the values (i.e., the share in citations of a journal to the total citations of the field related to the share in journal papers within a subject field, and the ratio of the corresponding GF-s of two journals) are identical measures. Consequently, despite of the skewness of the citation distribution, the GF (citations per paper of a journal) may be regarded as a reliable characteristic measure of the contribution of journals to the whole impact of journals dedicated to the corresponding field (see Vinkler 2004).

According to the author (p. 214): "The world average defines, exactly as the expected citation rate did in the Hungarian methodology, a worldwide reference level…" De Bellis does not realize the essential difference between the subjective standard (i.e., Publication Strategy) of the Relative Citation Rate indicator vs. the objective standard (i.e., mean citedness of the journal papers devoted to the field where the authors studied are active) used for calculating the Relative Subfield Citedness (i.e., RW or "crown" indicator).

The author of the book does not highlight that the indicators of the Leiden school and Budapest school correspond to each other i.e., the (CPP/JCSm) index corresponds to the Relative Citation Rate (RCR) indicator. Further, the (CPP/FCSm), i.e., the "crown" index corresponds to the Relative Subfield Citedness (RW) index, and the (JCSm/FCSm) index is equal to the Relative Publication Strategy indicator (Vinkler 1997). It should be mentioned here that the RCR indicator, which is the first relative impact index in scientometrics was developed by Schubert and Braun (1986).

Prediction is the essence of science. The author reports about the co-word and co-citation analysis and scientific mapping methods, but he does not lay stress on: how to use these techniques to detect not only past and present but to predict future research trends.

There are several sophisticated methods in the literature successfully applied for distributing credit of publications according to the number and rank of authors (e.g., Lukovits and Vinkler 1995; Trueba and Guerrero, 2004). These are neglected in the book.

The book can be recommended primarily to researches in science history and to librarians and social scientists, who are interested in bibliometrics and scientometrics. Also experienced scientometricians may find interesting details regarding the history and philosophical aspects of their field. Newcomers in the field may obtain important information on special topics in bibliometrics and scientometrics. One of the greatest benefits of the book is the list of relevant references. The interested reader has the opportunity to obtain information about even the most recent scientometric and bibliometric results.

References

Brooks, T. A. (1986). Evidence of complex citer motivations. *Journal of the American Society for Information Science, 37*, 34–36.

De Bellis, N. (2009). *Bibliometrics and citation analysis: from the science citation index to cybermetrics.* Lanham, Maryland: The Scarecrow Press, Inc.

Egghe, L., & Rousseau, R. (2000). Aging, obsolescence, impact, growth, and utilization: Definitions and relations. *Journal of the American Society for Information Science, 51*, 1004–1017.

Glänzel, W. (2007). Characteristic sores and scales. A bibliometric analysis of subject characteristics based on long-term citation observation. *Journal of Informetrics, 1*, 92–102.

Glänzel, W., & Schubert, A. (1995). Predictive aspects of a stochastic-model for processes. *Information Processing and Management, 31*, 69–80.

Glänzel, W., & Schubert, A. (2003). A new classification scheme of science fields and subfields designed for scientometric evaluation purposes. *Scientometrics, 56*, 357–367.

Hanney, S., Frame, I., Grant, J., Buxton, M., Young, T., & Lewison, G. (2005). Using categorizations of citations when assessing the outcomes from health research. *Scientometrics, 65*, 357–379.

Lukovits, I., & Vinkler, P. (1995). Correct credit distribution: A model for sharing credit among coauthors. *Social Indicators Research, 36*, 91–98.

Meho, L. I., & Sonnenwald, D. H. (2000). Citation ranking versus peer evaluation of senior faculty research performance: A case study of Kurdish scholarship. *Journal of the American Society for Information Science, 51*, 123–138.

Schubert, A., & Braun, T. (1986). Relative indicators and relational charts for comparative assessment of publication output and citation impact. *Scientometrics, 9*, 281–291.

Schubert, A., & Glänzel, W. (2007). A systematic analysis of Hirsch-type indices for journals. *Journal of Informetrics, 1*(3), 179–184.

Spiegel-Rösing, I. (1977). Science studies: Bibliometric and content analysis. *Social Studies of Science, 7*, 97–113.

Trueba, F. J., & Guerrero, H. (2004). A robust formula to credit authors for their publications. *Scientometrics, 60*, 181–204.

Vinkler, P. (1997). Relations of relative scientometric impact indicators. The relative publication strategy index. *Scientometrics, 40*, 163–169.

Vinkler, P. (1998). General performance indexes calculated for research institutes of the Hungarian Academy of Sciences based on scientometric indicators. *Scientometrics, 41*, 185–200.

Vinkler, P. (2004). Characterization of the impact of sets of scientific papers: The Garfield (Impact) factor. *Journal of the American Society for Information Science and Technology, 55*, 431–435.

Vinkler, P. (2009). The π-index. A new indicator for assessing scientific impact. *Journal of Information Science, 35*, 602–612.

Vinkler, P. (2010). The π_v-index. A new indicator to characterize the impact of journals. *Scientometrics* (in press).