On the relation between the WoS impact factor, the Eigenfactor, the SCImago Journal Rank, the Article Influence Score and the journal h-index

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Abstract

Four alternatives to the journal Impact Factor (IF) indicator are compared to find out their similarities. Together with the IF, the SCImago Journal Rank indicator (SJR), the Eigenfactor™ score, the Article Influence™ score and the journal h-index of 77 journals from more than ten fields were collected. Results show that although those indicators are calculated with different methods and even use different databases, they are strongly correlated with the WoS IF and among each other. These findings corroborate results published by several colleagues and show the feasibility of using free alternatives to the Web of Science for evaluating scientific journals.

Keywords: WoS impact factor, Eigenfactor, SCImago Journal Rank (SJR), Article Influence Score, journal h-index, correlations

Introduction

STIMULATE stands for *Scientific and Technological Information Management in Universities and Libraries: an Active Training Environment*. It is an international training programme in information management, supported by the Flemish Interuniversity Council (VLIR), aiming at young scientists and professionals from

developing countries. The programme has a dual purpose: on the one hand it intends to develop the personal professional skills of all participants, on the other hand participants are actively encouraged to transfer their newly acquired knowledge and skills to their colleagues and other stakeholders in their home country (Nieuwenhuysen & Vanouplines, 1997; Nieuwenhuysen, 2003; Stimulate 8 Group, 2009).

One of the higher level STIMULATE courses introduces students to the use of the World Wide Web and to bibliographic databases such as Thomson/Reuters's Web of Knowledge as tools for library management and research evaluation (Stimulate 6 Group, 2007). This article is the result of the 'active training part' of this particular course. We show that freely available journal indicators are of comparable quality and yield similar information than the journal impact factor provided by Thomson/Reuters' Journal Citation Reports. Moreover, some of these, namely the Eigenfactor™ score and the Article Influence™ score are since February 2009 incorporated in the JCR.

Research question

Do the journal impact factor as calculated by the Web of Science, the SCImago Journal Rank, the Eigenfactor™ score and the Article Influence™ measure similar aspects of a journal's characteristics or are they totally different indicators? How are these indicators related to the journal h-index? If these indicators measure similar properties of journals there must be a persistent (over several years) large correlation between them. For the two years, 2004 and 2006, we compare each indicator with each other one, leading to six cases. For the year 2006 we also compare with the latest available journal h-index as provided by SCImago (February 2009).

Definitions

In this section we recall the definitions of the journal indicators we will compare.

Journal Js impact factor for the year Y (denoted as IF_J) as provided by the Web of Science's Journal Citation Reports is defined as:

$$IF_J(Y) = \frac{CIT(Y,Y-1) + CIT(Y,Y-2)}{PUB_J(Y-1) + PUB_J(Y-2)}$$

In this formula the number of citations received (by journal J, from all journals and proceedings included in the WoS) in the year Y, by articles published in the year X is denoted by $CIT_J(Y,X)$. Similarly, $PUB_J(Z)$ denotes the number of articles published by this same journal in the year Z. We usually omit the index J. The WoS IF is a synchronous impact factor (Ingwersen et al., 2001).

The SCImago Journal Rank indicator (denoted as $SJR_J(Y)$) of journal J in year Y is a variation on the Google PageRank algorithm (Brin & Page, 1998), which is actually a variation on the Pinski-Narin (1976) weighted impact factor. For details of the mathematical calculations of these and similar indicators we refer the reader to (Langville & Meyer, 2006). According to the authors (SCImago, 2007) the SJR can be described as a journal prestige indicator. It is defined as a weighted sum of four terms. The first one is a kind of minimum prestige (the same for all journals, but depending on the total database); the second one depends on the number of published articles (a three year window is used); the third term is a term that depends on the prestige of the citing journals; finally the fourth term is a rest term in which a contribution of journals that are not connected to the citation network is taken into account. This last term depends on the number of published articles. The SCImago Journal Rank indicator is calculated using Elsevier's SCOPUS database.

The Eigenfactor™ score is another variation on the same idea. The authors, however, use Thomson/Reuters' JCR data. Details of their method can be found at http://www.eigenfactor.org/methods.htm., see also (Bergstrom, 2007; Bergstrom et al., 2008). The Eigenfactor™ algorithm is related to the eigenvector centrality network measure and is essentially the weighted PageRank as introduced in (Bollen et al., 2006). Eigenfactor™ scores are scaled so that their sum over all journals listed in the Journal Citation Reports (JCR) is 100.

The Article Influence™ score (AI score) is a measure of a journal's prestige based on per article citations. It is a measure of the average influence of each of its articles over the first five years after publication. The Article Influence™ score measures the average influence, per article, of the papers in a journal. As such, it is somewhat similar to Thomson/Reuters' Impact Factor. Article Influence™ scores are normalized so that the mean article in the entire JCR database has an article influence of 1.00.

Finally, the h-index as provided by SCImago is a 'life-time', i.e. since 1996, h-index. It refers to journals included in the SCOPUS database.

Previous work

Bollen et al. (2006) introduce the weighted PageRank, leading to a score which is essentially the Eigenfactor™ score. They compare this journal status indicator (their terminology) with the IF and with a product of both, denoted as Y. For the set of all 2003 ISI JCR journals they obtain a Spearman rank correlation of 0.61 between the IF and the weighted PageRank. Their basic conclusion is that the IF is a popularity factor of status, while the weighted PageRank gives more weight to real prestige.

Saad (2007) compares, using Pearson correlations, the Eigenfactor™ score, the Article Influence™ score and the journal h-index for the period 1989-2004, for different samples of journals, based on WoS data. He finds for the most representative sample correlations above 0.90.

Davis (2008) investigated the Eigenfactor™ score in an article with the title "*Eigenfactor: does the principle of repeated improvement result(s) in better estimates than raw citation counts?* ". One wonders; better than what? It turns out that the article investigates if the Eigenfactor™ leads to a different ranking than simple unweighted citation counts (based on WoS data), or than the classical impact factor. He finds that for journals from the category Medicine (General and Internal), year 2006, rankings are not significantly different.

Leydesdorff (2009) studied the relation between the traditional WoS journal indicators, namely impact factor, immediacy index, cited half-life, SJR, SCImago's h-index and PageRank. The SCImago Journal Rank turns out to be an equivalent of the Impact Factor for the Scopus domain. This is rather surprising as it is a derivative of the Pinski-Narin influence weight (Pinski & Narin, 1976), and as such closely related to PageRank. Leydesdorff does not include the Eigenfactor, but PageRank can be considered a close relative. He also does not include the Article Influence Score.

Finally, when this article was nearly finished, Bollen et al. (2009) published an impressive study on 39 scientific impact measures in the arXiv. In this paper they confirm the non-central position of the classical IF and the fact that scientific impact is a multi-faceted notion (Rousseau, 2002). They conclude that usage-based measures are stronger indicators of scientific prestige than the presently available citation measures (the ones studied in our article). The IF and the SCImago's SJR do not reflect prestige but rather popularity. They make the strong claim that IF and SJR are rather particular measures and are not at all core notions of scientific impact.

Method and results

Members of the team chose a JCR category and (about) five journals in this subfield. In total 77 journals were considered. These are journals in allergy, analytical chemistry, artificial intelligence, automation, business administration, cell biology, civil engineering, ecology, environmental science, immunology, information systems, medicine (general & internal), neuroscience, ophthalmology and physics. They then collected for the years 2004 and 2006 the WoS Impact factor (IF), SCImago's SJR value and h-index (only for 2006) and the Eigenfactor™ score together with the Article Influence™ score. Data were collected in November 2008, except for the h-index which was collected in February 2009. Next, for each year, all scores were brought together. As this type of data is heavily skewed logarithms (to the base 10) were taken. Finally, for

each year, Pearson correlation coefficients were calculated between each two sets of indicators, see Tables 1 and 2. Results are illustrated graphically in Figs 1 to 10.

Table 1. Pearson correlations between each pair of journal indicators (2004)

Indicators	IF	SJR	Eigenfactor	AI score
IF	1.00	0.873	0.806	0.895
SJR	--	1.00	0.673	0.760
Eigenfactor	--	--	1.00	0.785
AI score	--	--	--	1.00

Table 2. Pearson correlations between each pair of journal indicators (2006)

Indicators	IF	SJR	Eigenfactor	AI score	h
IF	1.00	0.915	0.827	0.918	0.869
SJR	--	1.00	0.731	0.813	0.760
Eigenfactor	--	--	1.00	0.827	0.951
AI score	--	--	--	1.00	0.855
h	--	--	--	--	1.00

Correlations are at least 0.673 and hence are all statistically significant. Comparing with the results obtained by Davis (2008) we see that our correlation (2006) between log(IF) and log(Eigenfactor) is 0.827, while for the category medicine (General and Internal) Davis found a Pearson correlation of 0.86. These correlations are of the same magnitude. Compared to Saad (2007) our correlations are somewhat lower.

Generally speaking the WoS IF correlates best with the other indicators. The Eigenfactor^{TM} has the smallest correlations (but still very high!). Moreover, the Eigenfactor^{TM} score correlates best with the h-index.

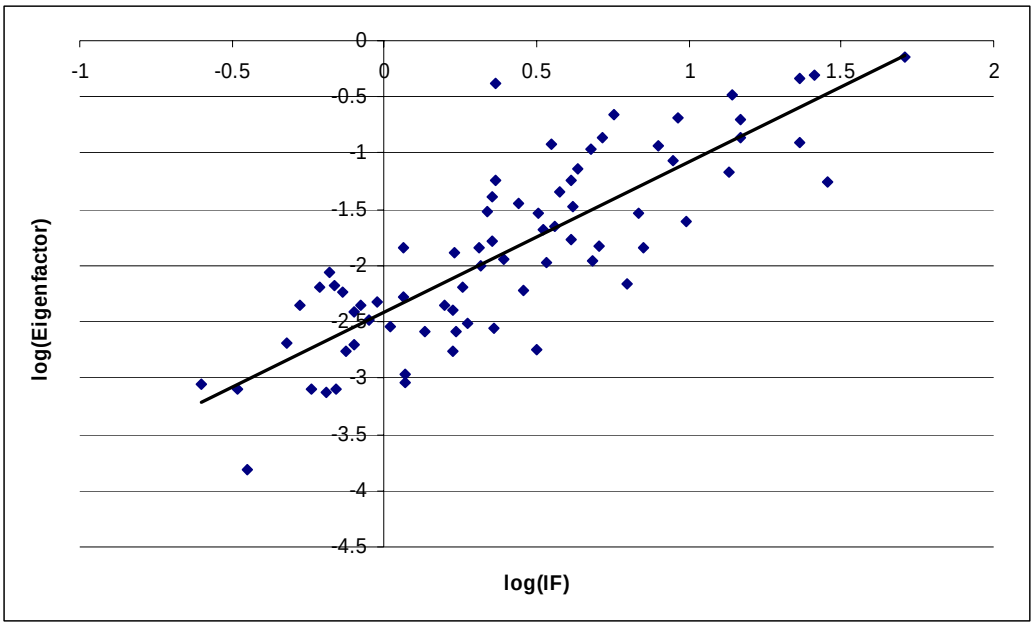

Fig.1. The Eigenfactor versus the WoS IF (2006)

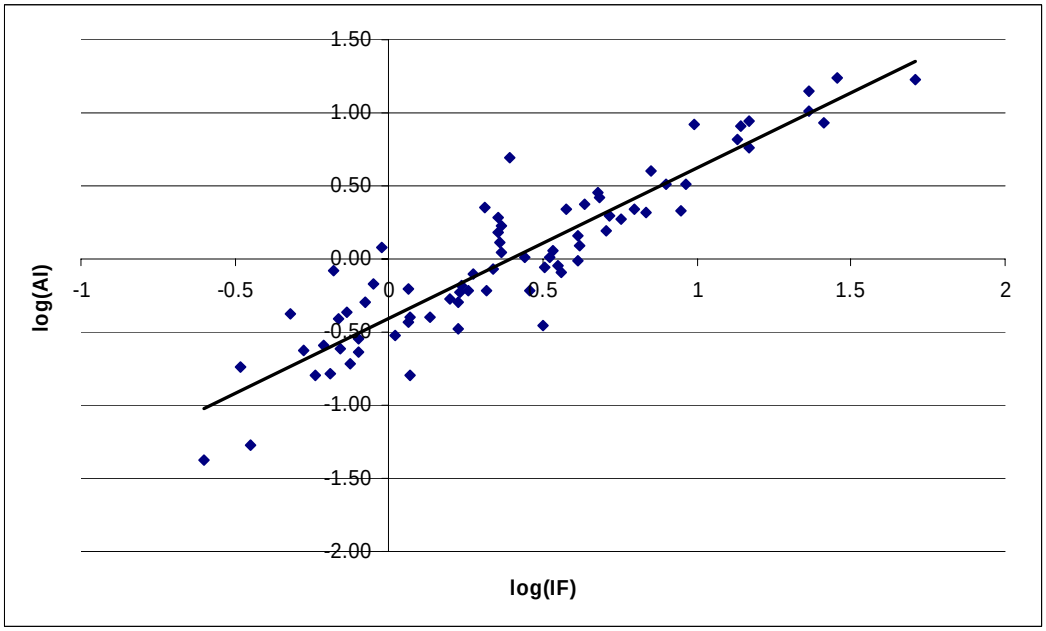

Fig. 2 The AI score versus the WoS IF (2006)

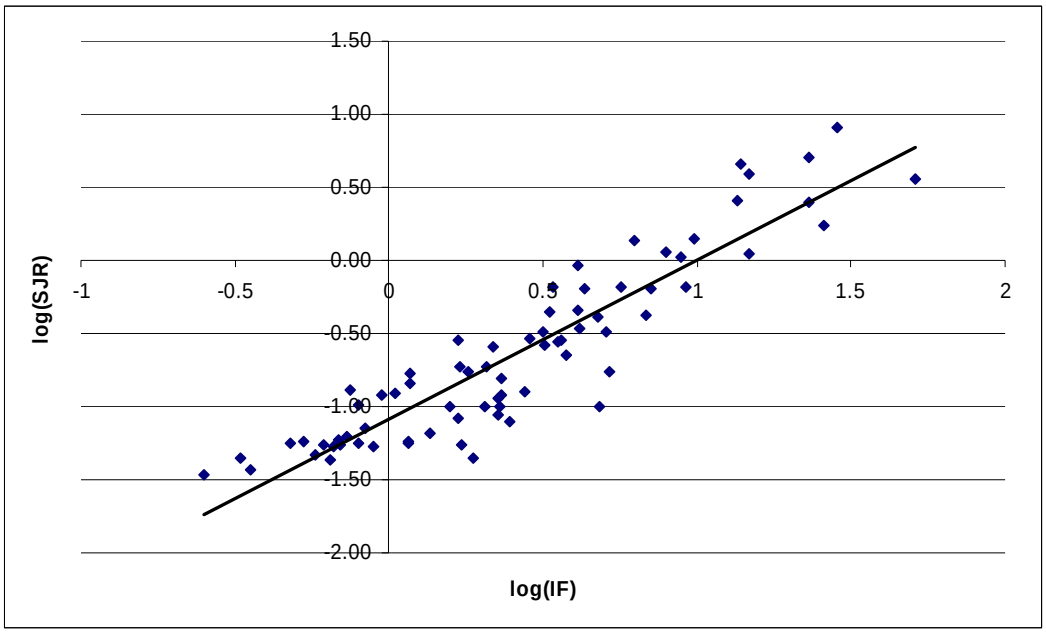

Fig. 3. SJR versus WoS IF (2006)

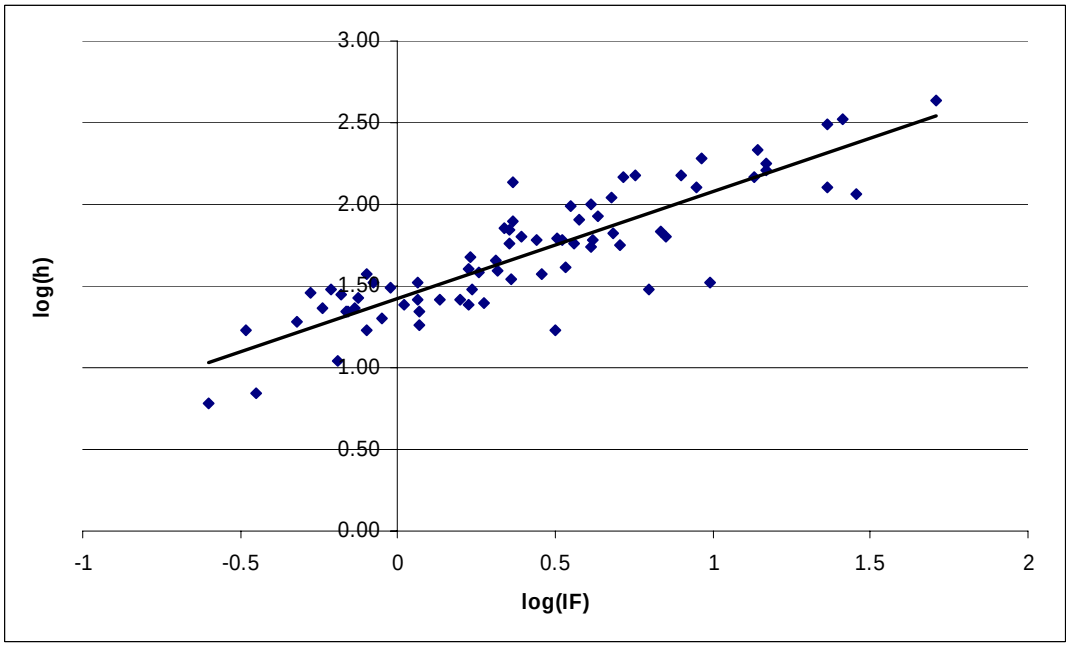

Fig.4 h-index versus WoS IF (2006)

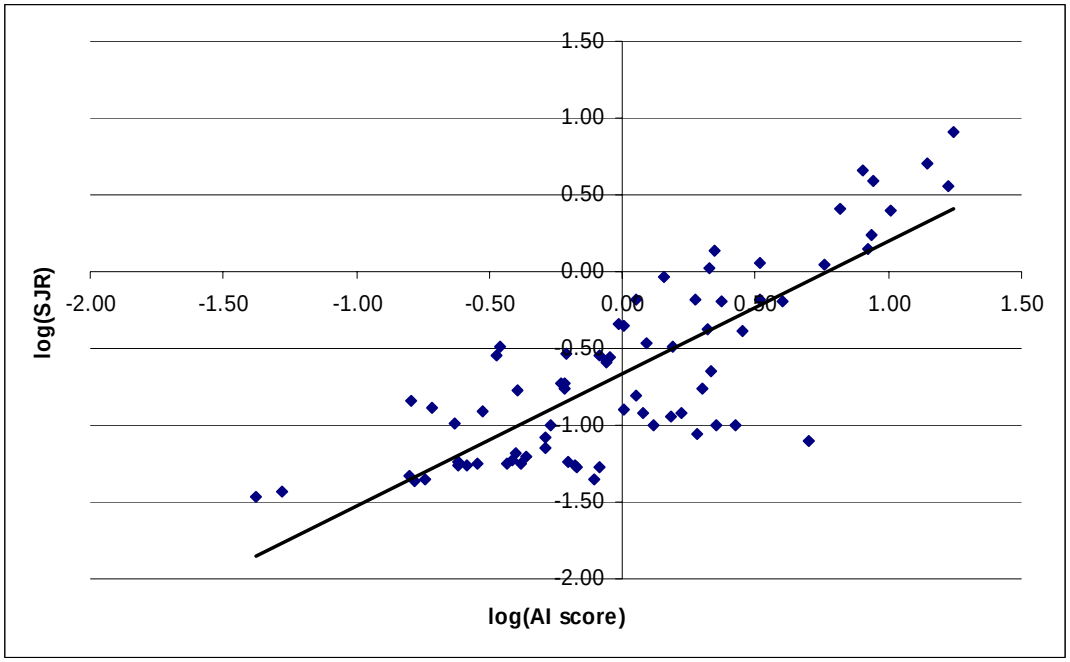

Fig.5 SJR versus AI score

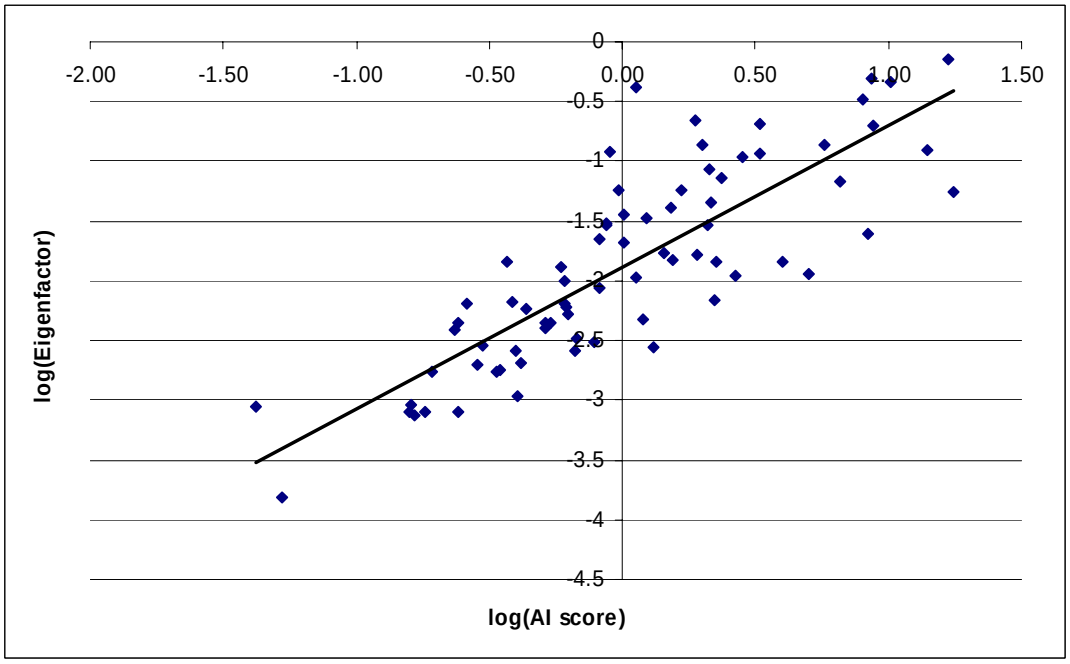

Fig.6 Eigenfactor versus AI score (2006)

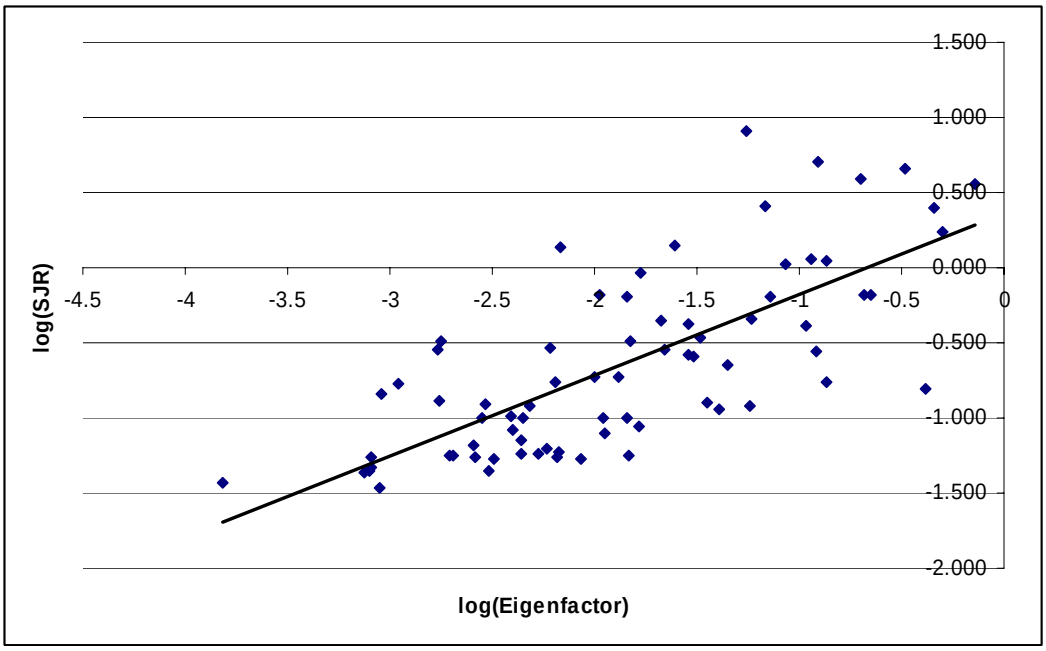

Fig. 7 SJR versus Eigenfactor (2006)

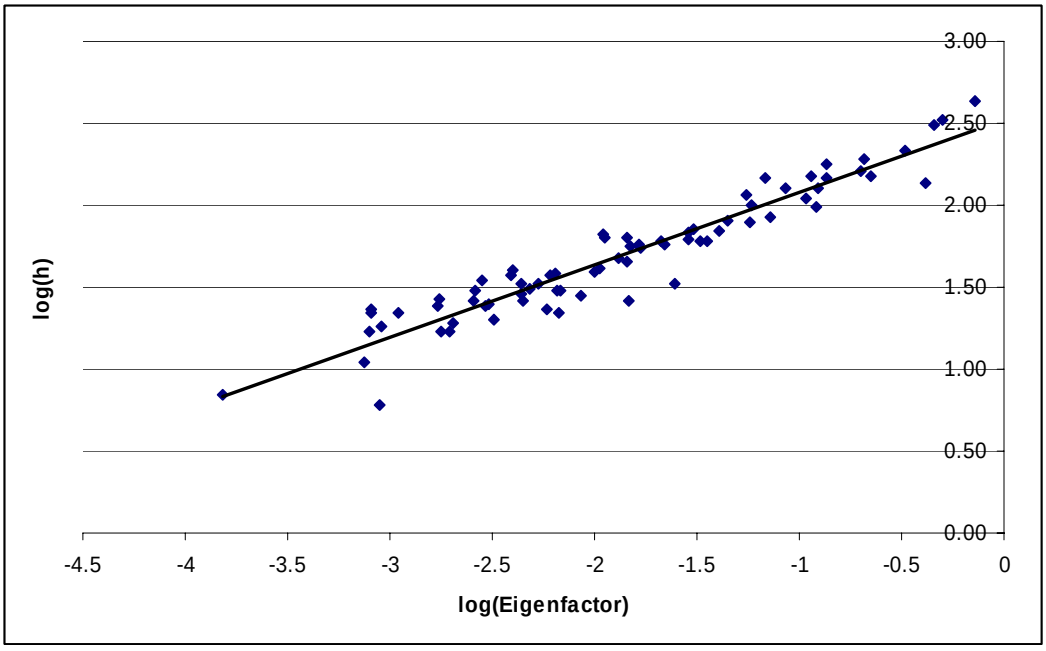

Fig. 8 h-index versus Eigenfactor (2006)

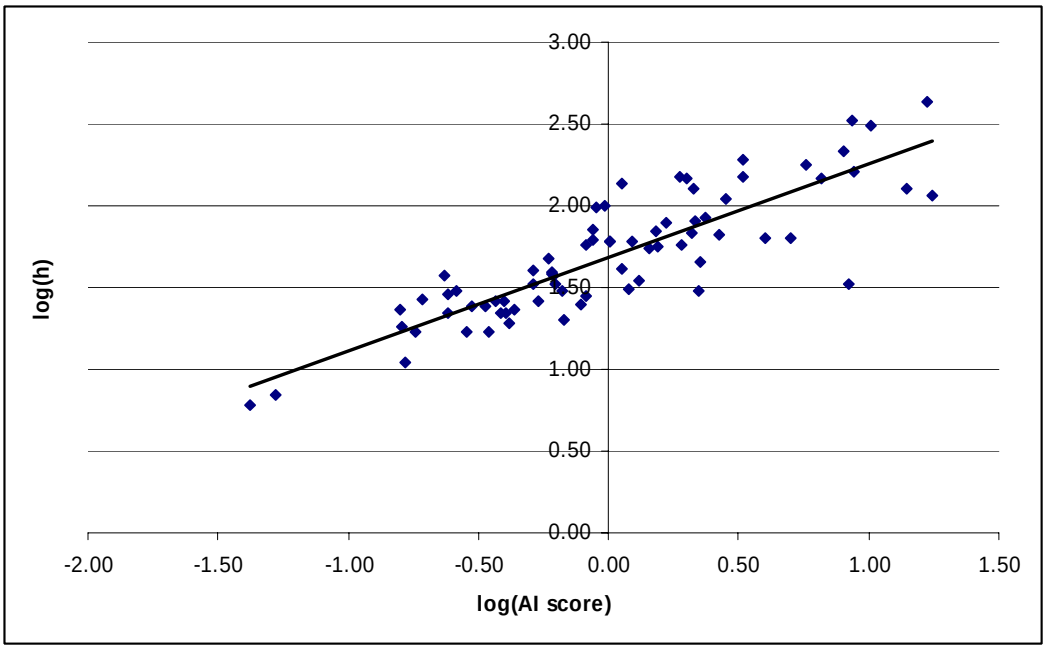

Fig .9 h-index versus AI score (2006)

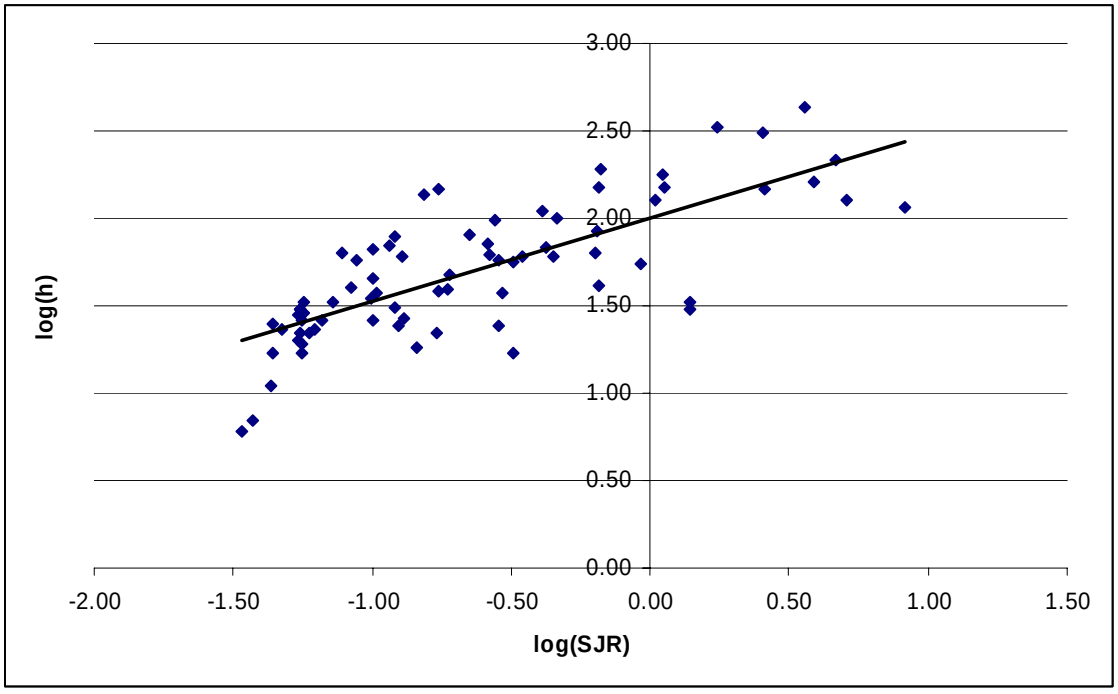

Fig. 10 h-index versus SJR (2006)

Discussion and conclusions

As the Web of Science and Scopus are different databases, it cannot be assumed that measurements of the same journal in the two databases automatically lead to the same (or at least very similar) results. Archambault et al. (2008) performed a comparison between these two databases on the country level and found that results were very highly correlated (always more than 0.99). They concluded that their *data provided strong evidence that scientometrics based on bibliometric methods is a sound undertaking on country level*. Although this conclusion may be somewhat too strong, as it is based on the comparison of just two databases, it does show that to some extent results obtained from the Web of Science can be compared to those obtained based on Scopus. Earlier Klavans and Boyack (2007) had pointed out how the two databases lead to fundamentally convergent maps of science, but that there were also noticeable differences. Some of these differences were due to the inclusion of conference proceedings in Scopus (situation at the time of writing of their article). However, nowadays WoS also includes conference proceedings so that differences due to conference proceedings are now surely reduced. On the individual level Meho and Yang pointed out that adding Scopus citations to WoS citations may alter considerably the ranking of individual scientists (Meho & Yang, 2008). An in-depth description of the SCOPUS database and a comparison with Ulrich's has been provided by Moya-Anegón et al. (2007). Meho and Rogers (2008) compare WoS and Scopus regarding citations in the field of Human-Computer Interaction. Also individual scientists' h-indices are compared. They conclude that WoS should include (more) conference proceedings, which has happened meanwhile.

We conclude that, although the new indicators are certainly not the same as the traditional and well-known impact factor, and as such do not yield the same information as JCR's journal impact factor they correlate very much with the WoS IF and among each other. This is an interesting finding for universities and institutes in developing countries who might not have the resources to procure access to the Web of Science and the Journal Citation Reports.

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