

# Memorandum

**AAST**

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– A Scholarly Peer-Reviewed Open Access Journal –

**Scientific Research Publishing Inc.**

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<http://www.ProfScholz.de>

**E-Mail:** [info@ProfScholz.de](mailto:info@ProfScholz.de)

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Dieter Scholz

# Journal Metrics

## 1 Introduction

Journal metrics investigated here are metrics about journal impact. The most prominent metric is the Journal Impact Factor (JIF) (Thomson Reuters 2014a) by Thomson Reuters based on data in the Web of Science (WOS) (Thomson Reuters 2014b) calculated only for those journals included in the WOS and published in the closed access Journal Citation Reports (Thomson Reuters 2014c).

There are many metrics, some of them claimed to be better than the JIF (see below). Metrics are calculated on an underlying database. Other databases frequently in use for journal metric calculations are Elsevier's closed access Scopus (Elsevier 2014a) and the open access research database Google Scholar (Google 2014a). Theoretically any metric can be calculated based on any available database. Interestingly, metrics defined originally for the assessment of researcher's impact can also be applied to calculate journal impact (and vice versa).

Taking everything into account, the question of investigation is: What are the best journal metrics to assess Open Access journals (for their impact) and how can these metrics best be calculated?

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Author information: Editor-in-Chief of AAST. Member of the Advisory Board of SCIRP.

Author ID: ORCID: <http://orcid.org/0000-0002-8188-7269>

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### SCIRP's President

Prof. Dr. Huaibei ZHOU (Address: see Principal Place of Business)

### Principal Place of Business

Scientific Research Publishing Inc.  
Building 5, Headquarters Space of Optical Valley  
Tangxun Lake North Street 38  
East Lake High-Tech Development Zone  
WUHAN 430223, Hubei Province, CHINA

### International Mail Address

Scientific Research Publishing Inc.  
P.O.Box 54821, IRVINE, CA 92619-4821, USA

## 2 Journal Assessment

In the **assessment** of (Open Access) journals it is differentiated between:

1. Degree of fulfillment of “international editorial conventions” (Testa 2012, Elsevier 2014b)
2. Degree of fulfillment of Open Access criteria (DOAJ 2014a, DOAJ 2014b, OASPA 2014, PLOS 2014)
3. Quality of layout, copy editing, typesetting, and graphics,
4. Intellectual quality of the papers,
5. **Performance** of the journal,
6. Reputation of the journal.

1. ... can be designed into the journal with careful observation of the criteria (however, inclusion in WOS or Scopus requires much more),
2. ... can be designed into the journal with careful observation of the criteria,
3. ... can be achieved through proper set up and staff training and their careful, professional work,
4. ... can be influenced by the review process; depends on authors submitting; influenced by elements 5 and 6,
5. ... result from the team effort of readers, authors, reviewers, editors, and publisher,
6. ... builds up over the years through all other points (elements 1 to 5).

Journal **reputation** is difficult to measure and not the topic of this Memorandum. An attempt to measure reputation is made anyway in Appendix A, where a **Journal Reputation Factor** (JRF) is presented.

The (research) **performance** of the journal consists of these numerical values:

1. amount of output (**productivity**)
2. quality of output (approximated by **rejection rate** and **impact**)
3. **publication speed**

Metrics for **productivity** are e.g.:

- number of issues published
- number of items published (total), **P**
  - number of original research papers
  - number of review papers
  - ...
- number of pages published (total)
  - number of original research paper pages
  - number of review paper pages
  - ...

Numbers of productivity can be measured from the start of a journal or for only one calendar year. Higher numbers show higher productivity.

## Rejection Rate

- **number of rejected submissions**
  - number failed in publisher's check
    - number failed in plagiarism check
    - number failed in hoax check
  - number failed in preliminary review
    - number failed due to content out of scope
    - number failed due to content insufficient
    - number failed due to spelling and/or grammar
    - number failed due to authors typesetting
  - number failed in full review
- number accepted
- number withdrawn
  - number withdrawn before peer review (cheap for review process)
  - number withdrawn after peer review (expensive for review process)

number submitted = number rejected + number accepted + number withdrawn

These numbers can be expressed in absolute numbers for one calendar year or divided by the total number of submissions in a given year to give the rates:

- **Rejection Rate**
- Acceptance Rate
- Withdrawal Rate

Sum of the three rates is 100 %.

A high Rejection Rate of a journal is often seen as an indication for high quality, because the journal appears to be very selective and will apparently filter out only the best manuscripts for publication.

## Publication Speed

Average time from "Submission" to "Preliminary Review"

Average time from "Preliminary Review" to "First Review Summary"

Average time from "First Review Summary" to "Revision"

Average time from "Revision" to "Acceptance"

Average time from "Acceptance" to "Author's Formatted Version"

Average time from "Author's Formatted Version" to "Publication"

Average total time from "Submission" to "Publication"

Shorter average times show higher publication speed.

## 3 Basic Journal Metrics for Impact

The quality of a journal's output is numerically approximated by the journals rejection rate and foremost by its impact. This memorandum looks specifically at metrics for journal impact.

The quality of a journal is made up of the quality of all its items (papers). It is difficult to measure the quality of the papers directly without a review assessment by knowledgeable people in the field of all items in the journal. As this is clearly too time consuming, an alternative process has to be found, which at best works automatically on a computer and is based on some form of counting as it was done already for productivity, speed and rejection rate.

If a paper is cited, it is generally considered to be a proof for its quality. It is assumed the paper is cited because it contains an interesting message. This is a valid assumption; however, it should be pointed out that paper can also be cited, because its faults are being pointed out.

### **Impact metrics leading towards the number of citations**

- number of index entries (will probably enhance journal page visits)
- number of journal page visits (will probably enhance downloads)
- number of downloads (will probably enhance citations)
- number of citations **C** on WOS, Scopus, or Google

Total number of all papers published in the journal (all years; counted at end of year yyyy)<sup>1</sup>: **P**

$$\mathbf{P} = \mathbf{P}(\text{yyyy})$$

Total number of papers published during a full year year yyyy<sup>2</sup>: **Pyyyy**

$$\mathbf{Pyyyy} = \mathbf{P}(\text{yyyy}) - \mathbf{P}(\text{yyyy-1})$$

Number of years of journal operation<sup>2</sup>: **Y**

Total number of papers per year of journal operation<sup>2</sup>: **P / Y**

Total number of citations (counting across all papers; all years; counted at end of year yyyy): **C**

$$\mathbf{C} = \mathbf{C}(\text{yyyy})$$

Total number of citations during a full year year yyyy (counting across all papers): **Cyyyy**

$$\mathbf{Cyyyy} = \mathbf{C}(\text{yyyy}) - \mathbf{C}(\text{yyyy-1})$$

Total number of self citations (counting across all papers; all years; counted at end of year yyyy):

$$\mathbf{Cself} = \mathbf{Cself}(\text{yyyy})$$

**Self-cite rate: Cself/C**

Average number of **citations per paper: C/P** (*1. basic journal impact metric*)

Total number of **citations per year of journal operation: C/Y** (*2. basic journal impact metric*)

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<sup>1</sup> This value is still a measure for productivity; see Section 2.

<sup>2</sup> This value is important for accession into WOS or Scopus; see Section 2.

Number of **unique** authors who published in the journal (i.e. sum of the authors across all papers – no authors is counted more than once): **A**

Number of **all** authors who published in the journal (i.e. sum of the authors across all papers – some authors may be counted more than once): **Aa**

Average number of **authors per paper**: **Aa/P**

Number of **all** papers authors could claim to have written: **Pa = Aa**

Average number of **papers per author**: **Pa/A**

These metrics are inspired by Harzing (2014a).

### **Example**

Paper 1: AuthorA, AuthorB

Paper 2: AuthorB, AuthorC, AuthorD

Paper 3: AuthorA, AuthorE

Paper 4: AuthorA, AuthorC

**Aa/P = 9/4 = 2.25 authors per paper**

AuthorA: 3 papers

AuthorB: 2 papers

AuthorC: 2 papers

AuthorD: 1 paper

AuthorE: 1 paper

Pa papers / A authors = **Pa/A = 9/5 = 1.8 papers per author**

Number of all references in all papers in all journal issues: **Ref**

Another interesting measure is the number of references per paper: **Ref/P**

The higher **Aa/P** and **Ref/P** the higher will be the total number of citations **C**. All authors will share the news and distribute their new paper that will make citations more likely. If it is custom to put many references in a paper chances are higher that also the own paper will be cited more often.

### What to calculate for a journal?

**Statistical values:** Y, Cself/C, Aa/P, Pa/A, and Ref/P

**Productivity measures:** P and Pyyyy

**Impact measures:** C, Cyyyy, C/P, and C/Y

## 4 Thomson Reuters Journal Metrics

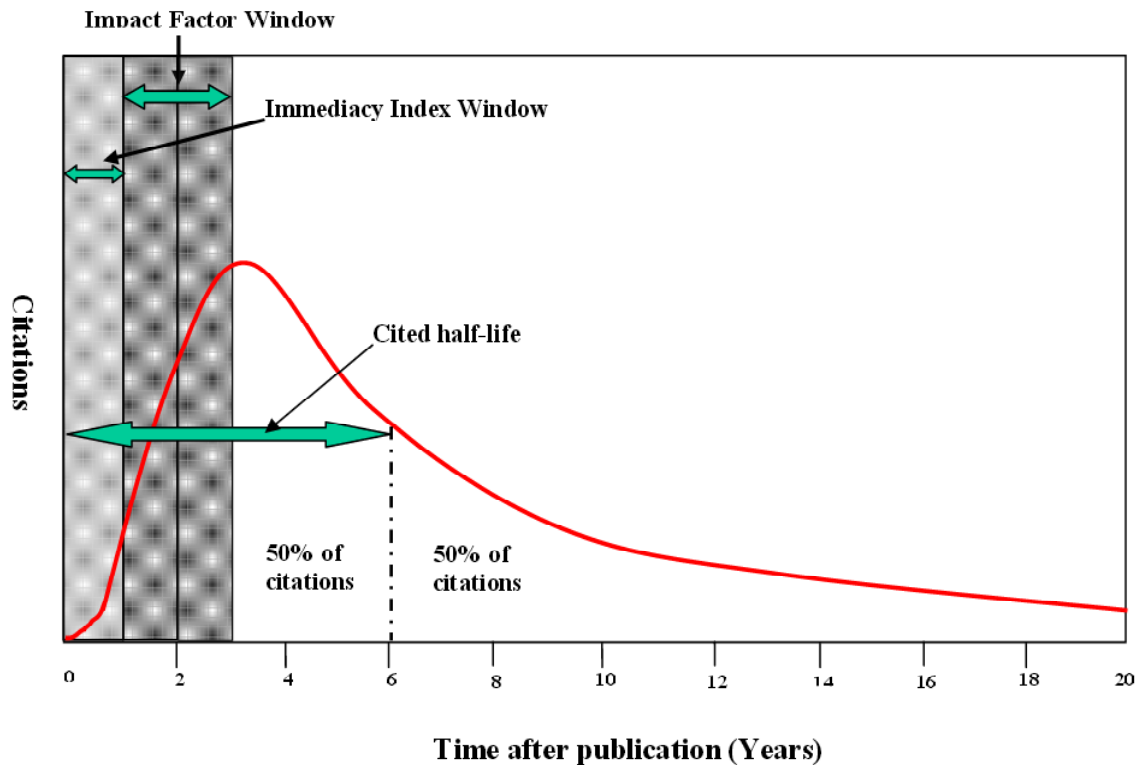
### 4.1 General Definition of the Journal Impact Factor (JIF)

The word “impact” means in this connotation “effect” or “influence”. The word “factor” means in this connotation “parameter” or “coefficient”. An “impact factor” is hence an “influence coefficient”. This term is not licensed. It is part of normal English language. An impact factor for a journal is a **journal impact factor**. I propose the abbreviation **JIF**. The impact factor defined in Section 4.2 follows a certain algorithms. Apparently there were never patents on these algorithms. Therefore, these algorithms can be used freely.

### 4.2 Journal Impact Factor (JCR®JIF) and Other Metrics

The impact factor which is so much talked about is known today as the “Thomson Reuters Impact Factor” also referred to as journal impact factor (Thomson Reuters 2014a). “The impact factor was devised by Eugene Garfield” (Wikipedia 2014a). Garfield (2005) reports himself “In the early 1960s, Irving H. Sher and I [Eugene Garfield] created the journal impact factor to help select journals for the new *Science Citation Index (SCI)*.” “The Institute for Scientific Information (ISI) was founded by Eugene Garfield in 1960. It was acquired by Thomson Scientific & Healthcare in 1992, became known as Thomson ISI and now is part of the Intellectual Property & Science business of Thomson Reuters.” (Wikipedia 2014a). For this reason the impact factor was also called “The ISI® Journal Citation Reports (JCR®) impact factor” (Amin 2000). The impact factor defined in Section 4.2 follows a certain algorithms. Apparently there were never patents on these algorithms. Proprietary are the impact factors calculated based on the Web of Science (WOS) (Thomson Reuters 2014b) and published in a proprietary report the Journal Citation Reports® (JCR®) (Thomson Reuters 2014c). For these proprietary journal impact factors I propose the abbreviation **JCR®JIF**.

Journal Citation Reports provide “quantitative tools for ranking, evaluating, categorizing, and comparing journals. The impact factor is one of these; it is a measure of the frequency with which the ‘average article’ in a journal has been cited in a particular year or period. The annual JCR impact factor is a ratio between citations and recent citable items published. Thus, the impact factor of a journal is calculated by dividing the number of current year citations to the source items published in that journal during the previous” years. (Thomson Reuters 2014a)



**Figure 1:** Generalized citation curve for a paper published 20 years ago from today (Amin 2000)

“The **build-up of citations** tends to follow a curve like that of Figure 1. Citations to articles published in a given year rise sharply to a peak between two and six years after publication. From this peak citations declines over time. The citation curve of any journal can be described by the relative size of the curve (in terms of area under the line), the extent to which the peak of the curve is close to the origin, and the rate of decline of the curve. These characteristics form the basis of the ... indicators impact factor, immediacy index and cited half-life.” (Amin 2000)

“The **impact factor** is a measure of the relative size of the citation curve in years 2 and 3. It is calculated by dividing the number of current citations a journal receives to articles published in the two previous years by the number of articles published in those same years” (Amin 2000)

This is the “normal” impact factor, more precisely called the 2-year journal impact factor (2-JIF) because later also another window length (5 years) is introduced. The abbreviation 2-JIF (and 5-JIF) were used by Dorta-Gonzalez (2013). Speaking about the impact factor calculated and published by Thomson Reuters I propose to add “JCR®”. This gives the abbreviations 2-JCR®JIF and 5-JCR®JIF.

### Calculation of the 2-year journal impact factor (2-JIF)

One year of citations to two years of articles. Example from (Thomson Reuters 2014a)

- A = total cites in 1992
- B = 1992 cites to articles published in 1990-91 (this is a subset of A)
- C = number of articles published in 1990-91
- D = B/C impact factor for 1992

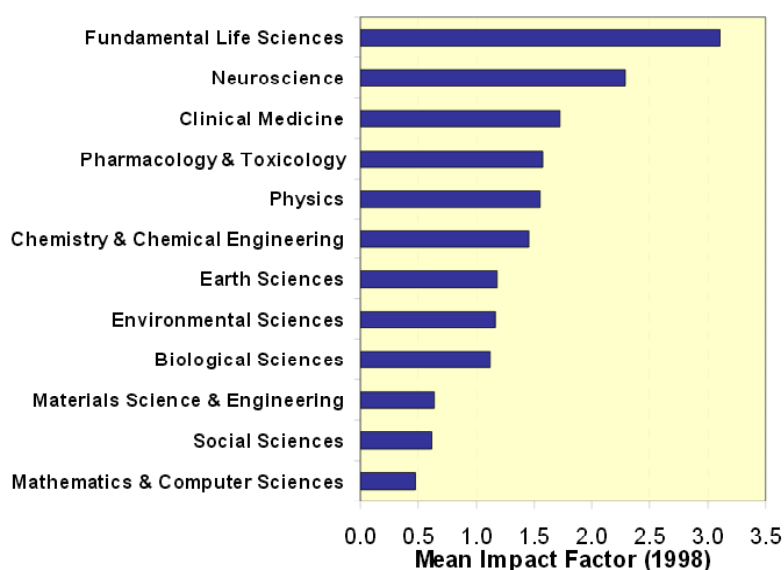
“The **immediacy index** gives a measure of the skewness of the curve, that is, the extent to which the peak of the curve lies near to the origin of the graph. It is calculated by dividing the citations a journal receives in the current year by the number of articles it publishes in that year, i.e., the 1999 immediacy index is the average number of citations in 1999 to articles published in 1999. The number that results can be thought of as the initial gradient of the citation curve, a measure of how quickly items in that journal get cited upon publication.” (Amin 2000)

“The **cited half-life** is a measure of the rate of decline of the citation curve. It is the number of years that the number of current citations takes to decline to 50% of its initial value (the cited half-life is 6 years in the example given in Figure 1). It is a measure of how long articles in a journal continue to be cited after publication.” (Amin 2000)

“Of the three measures described above, the impact factor is the most commonly used and also most misunderstood. [Here are] ... some of the factors that affect the impact factor. The value of the impact factor is affected by sociological and statistical factors. Sociological factors include the subject area of the journal, the type of journal (letters, full papers, reviews), and the average number of authors per paper (which is related to subject area). Statistical factors include the size of the journal and the size of the citation measurement window.” (Amin 2000)

Figure 2 “shows how the absolute value of the mean impact factor exhibits significant **variation according to subject field**. In general, fundamental and pure subject areas have higher average impact factors than specialized or applied ones. The variation is so significant that the top journal in one field may have an impact factor lower than the bottom journal in another area.” (Amin 2000)

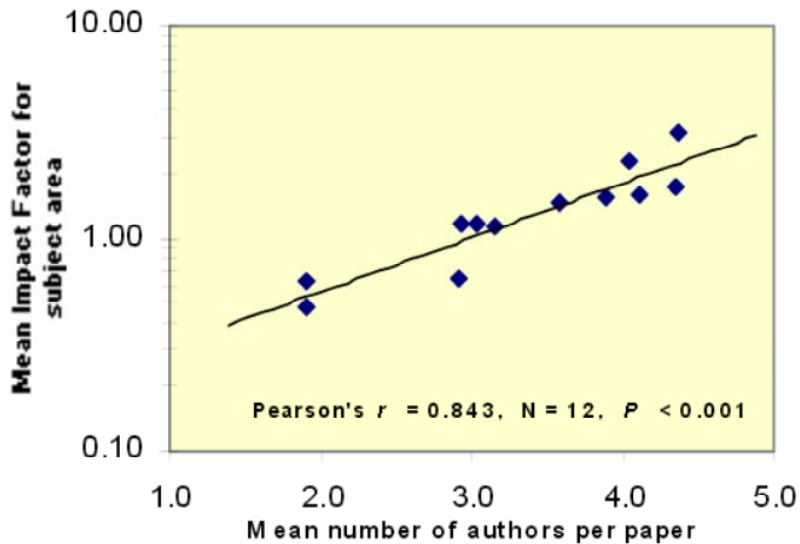
One reason for the variation according to the subject field can be already be that articles in different fields tend to have reference lists of different length. A paper in a field where many other articles are cited will also itself get cited more.



**Figure 2:** Variation of impact factor with subject area (Amin 2000)



Thomson Reuters (2014a) admits this, but does not see a problem in it. “Different specialties exhibit different ranges of peak impact. That is why the JCR® provides subject category listings. In this way, journals may be viewed in the context of their specific field.”



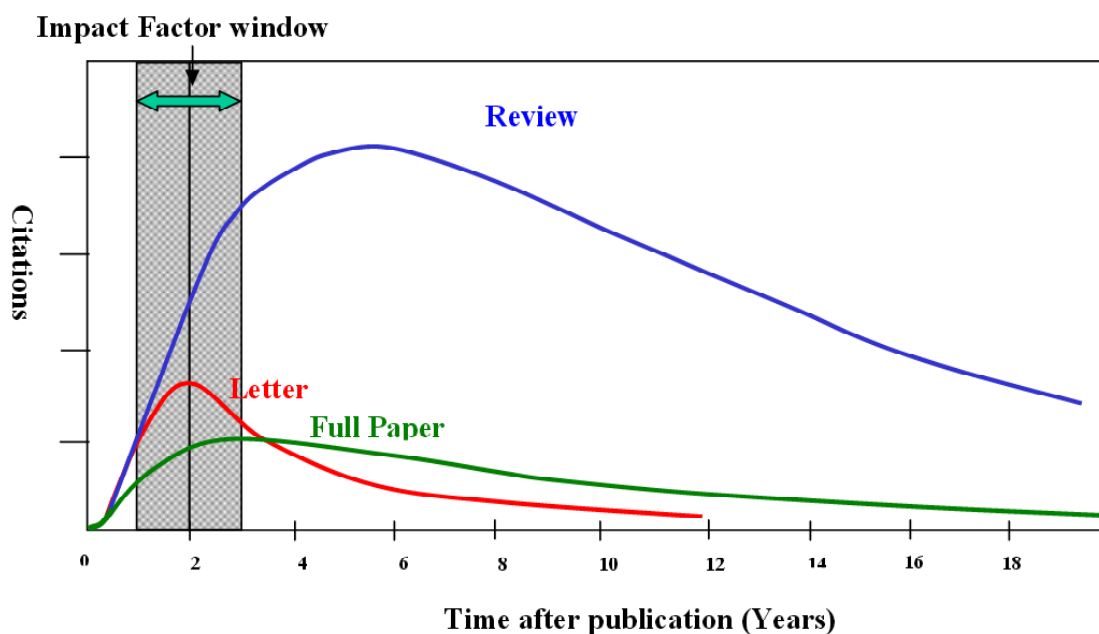
**Figure 3:** Variation of impact factor with number of authors per paper (Amin 2000)

Figure 3 shows “the **phenomenon of multiple authorship**. The average number of collaborators on a paper varies according to subject area, from social sciences (with about two authors per paper) to fundamental life sciences (where there are over four). Not unsurprisingly, given the tendency of authors to refer to their own work, there is a strong and significant correlation between the average number of authors per paper and the average impact factor for a subject area ... So comparisons of impact factors should only be made for journals in the same subject area.” (Amin 2000)

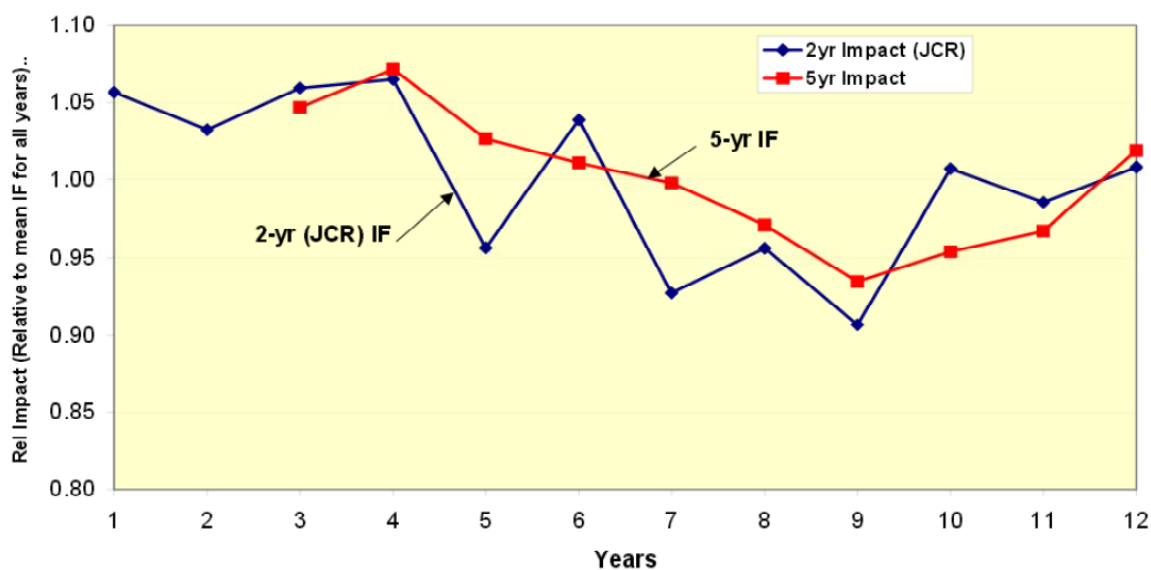
Even within the same subject area there will be significant **variation according to the journal type** depending on how many articles of which type are published. See Figure 4. (Amin 2000)

“Expanding the size of the measurement window from the two years of the standard JCR impact factor can iron out some of the statistical variations. The effects of doing this are illustrated in Figure 5. Here the average two- and **five-year impact factors** for around 200 chemistry journals have been plotted against time. The two-year impact factors show considerable variability, jumping up and down in value each year. The five-year measures, however, while still showing changes over time, present a much smoother curve. A measure that is often used in evaluating a journal or laying claims to its importance is the rank it has by impact factor amongst other journals in its subject area. However, dramatic changes in rank can occur simply by changing the time frame of measurement.” (Amin 2000)

Thomson Reuters (2014a) does not see these dramatic changes in journal rankings. “a five-year impact may be more useful to some users and can be calculated by combining the statistical data available from consecutive years of the JCR ... It is rare to find that the ranking of a journal will change significantly within its designated category.”



**Figure 4:** Impact Factor variation with article (and hence journal) type (Amin 2000)



**Figure 5:** Average two- and five- year impact factors for around 200 chemistry journals (Amin 2000)

### Calculation of the 5-year journal impact factor (5-JIF)

One year of citations to five years of articles. Example adapted from (Thomson Reuters 2014a)

A = total cites in 1992

B = citations in 1992 to articles published in 1987-91 (this is a subset of A)

C = articles published in 1987-91

D = B/C five-year impact factor for 1992

“The **self-cited rate** relates a journal’s self-citations to the number of times it is cited by all journals, including itself.” (Testa 2012)

As known already from Section “3 Basic Journal Metrics for Impact”, total number of citations (counting across all papers; all years; counted at end of year yyyy):

$$C = C(\text{yyyy})$$

Total number of self citations (counting across all papers; all years; counted at end of year yyyy):

$$C_{\text{self}} = C_{\text{self}}(\text{yyyy})$$

**self-cited rate** at end of year yyyy:  $C_{\text{self}} / C$

“For example, journal X was cited 15000 times by all journals, including the 2000 times it cited itself. Its self-cited rate is 2/15 or 13 %. It is entirely normal for authors to reference the prior work that is most relevant to their current results, regardless of the source journal in which the work was published. However, there are journals in which the observed rate of self-citation is a dominant influence in the total level of citation. For these journals, self-citation has the potential to distort the true role of the title in the context of the literature of its subject. Among all journals listed in the 2010 JCR Science Edition, for example, 85 % have self-citation rates of less than 15 %. This shows that self-citation is quite normal for most journals. Significant deviation from this normal rate, however, prompts an examination by Thomson Reuters to determine if excessive self-citations are being used to artificially inflate the impact factor. If we determine that self-citations are being used improperly, the journal’s impact factor will be suppressed for at least two years and the journal may be considered for de-selection from Web of Science.” (Testa 2012)

In order to facilitate comparing journals with different self-cited rates, the impact factor can be corrected by excluding self-citations.

#### **Calculation of the 2-year journal impact factor excluding self-citations (2-JIF ex. self cites)**

One year of citations to two years of articles. Example adapted from (Thomson Reuters 2014a)

- A = total cites in 1992
- B = citations in 1992 to articles published in 1990-91 (this is a subset of A)
- C = 1992 self-citations to articles published in 1990-91
- D = B - C = total citations minus self-citations to recent articles
- E = number of articles published 1990-91
- F = D/E impact factor excluding self-citations for 1992

Further problems are the variation of the impact factor due to various statistical effects and the numerator/denominator problem. (Amin 2000)

### 4.3 Critique About the Use of the Impact Factor

There is abundant critique about the use of the impact factor: “The most misused metric in science“ (Van Noorden 2014). A summary of the critique can be found on Wikipedia (2014a).

“The impact factor was invented to help libraries decide which journals to purchase ... But it has become a seductive yardstick by which to judge the quality of researchers and their papers – angering scientists who say that they are judged by where they publish, rather than what they publish. The result is a race to get into journals with high impact factors, and almost everyone is unhappy with this situation” (Van Noorden 2014)

The inventor of the impact factor Eugene Garfield (2005) is irritated: „it did not occur to me that ‚impact‘ would one day become so controversial. Like nuclear energy, the impact factor is a mixed blessing. I expected it to be used constructively while recognizing that in the wrong hands it might be abused.“

However, Garfield (2005) supports an (outdated?) view by Hoeffel: “Impact Factor is not a perfect tool to measure the quality of articles but there is nothing better and it has the advantage of already being in existence and is, therefore, a good technique for scientific evaluation. Experience has shown that in each specialty the best journals are those in which it is most difficult to have an article accepted, and these are the journals that have a high impact factor. Most of these journals existed long before the impact factor was devised. The use of impact factor as a measure of quality is widespread because it fits well with the opinion we have in each field of the best journals in our specialty.”

Even Thomson Reuters (2014a) itself warns these days: “Users may be tempted to jump to ill-formed conclusions based on impact factor statistics” “Thomson Reuters says that the problem lies in how the impact factor is being used, not in the metric itself.“ (Van Noorden 2014)

American Society for Cell Biology (ASCB) spearheads the critique about Thomson Reuters’ impact factor and its use with the San Francisco Declaration on Research Assessment (DORA): “Do not use journal-based metrics, such as Journal Impact Factors, as a surrogate measure of the quality of individual research articles, to assess an individual scientist’s contributions, or in hiring, promotion, or funding decisions.” (DORA 2014)

“An analysis of available data on individual DORA signers as of June 24, 2013, showed that ... 46.8% were from Europe, 36.8% from North and Central America” (DORA 2014)

The critique from Europe is especially strong, because Thomson Reuters’ database WOS is dominated by American journal titles (see Section 7): „EASE recommends that journal impact factors are used only - and cautiously - for measuring and comparing the influence of entire journals, but not for the assessment of single papers, and certainly not for the assessment of researchers or research programmes either directly or as a surrogate.“ (EASE 2014)

Thomson Reuters has reacted: “... Thomson Reuters says that it will become more transparent over how it calculates impact factors ... The firm, which is headquartered in New York, is also revamping its commercial analysis product, InCites, to add metrics based on individual articles,

and to allow users to make their own calculations. But critics say that more change is needed.” (Van Noorden 2014)

Criticized is also that Thomson Reuters’ database (WOS) from which it calculates the impact factor is not openly available. Admittedly, it may be too naive to hope a database, a company has heavily invested in, will be made openly available.

„data used to calculate the [Thomson Reuters] Journal Impact Factors are neither transparent nor openly available to the public“ (DORA 2014)

„There is only one official, universally recognised impact factor that is generated by **Thomson Reuters**; it is a proprietary measure run by a profit making organisation. It **runs against the ethics and principles of open access**.“ „DO NOT submit papers to a journal based on its impact factor alone.“ (DOAJ 2014b)

The critique goes even beyond Thomson Reuters any impact factor. **All metrics used in sciences are questioned**: „A major problem with metrics is the well-charted tendency for people to distort their own behaviour to optimize whatever is being measured (such as publications in highly cited journals) at the expense of what is not (such as careful teaching).“ (Van Noorden 2014)

#### 4.4 What to calculate for a journal?

The algorithms for the 2-JIF, 2-JIF ex. self cites, and 5-JIF are all given with sufficient detail to perform the calculations and could be used. The 5-JIF would not be suitable for younger journals ( $Y < 5$ ). The immediacy index and cited half-life are less known and may not be considered further. Presenting the self-cited rate is (only) important if the 2-JIF is given, so that the user can be assured self-citing included in this metric (by definition) is only of limited quantity. If only one metric is to be selected from this Section it is probably the **2-JIF ex. self cites**. In contrast to the proprietary impact factor, it should be taken into account the same peer-reviewed scholarly papers in both the numerator and denominator of the equation so that further statistical problems can be avoided.

## 5 Scopus Journal Metrics

Elsevier maintains an informative web page ([www.journalmetrics.com](http://www.journalmetrics.com)) with definitions of journal metrics and search options for journals in Scopus. More definitions and even better search options can be found on Centre for Science and Technology Studies (CWTS) ([www.journalindicators.com](http://www.journalindicators.com)) at Leiden University, Netherlands.

## 5.1 Impact per Publication (IPP)

“The IPP measures the ratio of citations in a year (Y) to scholarly papers published in the three previous years (Y-1, Y-2, Y-3) divided by the number of scholarly papers published in those same years (Y-1, Y-2, Y-3). The IPP metric is using a citation window of three years which is considered to be the optimal time period to accurately measure citations in most subject fields. Taking into account the same peer-reviewed scholarly papers only in both the numerator and denominator of the equation provides a fair impact measurement of the journal and diminishes the chance of manipulation. The IPP is not normalized for the subject field and therefore gives a raw indication of the average number of citation a publication published in the journal will likely receive. When normalized for the citations in the subject field, the raw Impact per Publication becomes the Source Normalized Impact per Paper (SNIP). Note that in the context of the calculation of SNIP, the **Raw Impact per Publication** is usually referred to as **RIP**. Like SNIP, the raw Impact per Publication metric was also developed by Leiden University's Centre for Science & Technology Studies (CWTS).” (Elsevier 2014c)

This metric is similar to the JCR®JIF which is available as 2-JCR®JIF and 5-JCR®JIF. The IPP, in contrast uses a 3-year-window. “Citations [are] from selected sources and selected document types only (RIP and SNIP)” (CWTS 2014a) This eliminates the “numerator and denominator problem” mentioned in Section 4.2 for the JCR®JIF.

## 5.2 Source Normalized Impact per Paper (SNIP)

The SNIP was “created by Professor Henk Moed at CTWS, University of Leiden.” “SNIP measures contextual citation impact by weighting citations based on the total number of citations in a subject field. The impact of a single citation is given higher value in subject areas where citations are less likely, and vice versa. SNIP is defined as the ratio of a journal's Raw Impact per Publication and the citation potential in its subject field. This allows for evaluation of a journal compared to its competition and provides more contextual information, giving a better picture of the impact depending on the citation behavior in the field.” (Holland 2014)

“Citation potential is shown to vary not only between journal subject categories – groupings of journals sharing a research field – or disciplines (e.g., journals in Mathematics, Engineering and Social Sciences tend to have lower values than titles in Life Sciences), but also between journals within the same subject category. For instance, basic journals tend to show higher citation potentials than applied or clinical journals, and journals covering emerging topics higher than periodicals in classical subjects or more general journals.” (Elsevier 2014d)

## 5.3 SCImago Journal Rank (SJR)

“Developed by Professors Félix de Moya, Research Professor at Consejo Superior de Investigaciones Científicas and Vicente Guerrero Bote at University of Extremadura, SCImago Journal Rank (SJR) is a prestige metric based on the idea that 'all citations are not created equal'.

With SJR, the subject field, quality and reputation of the journal have a direct effect on the value of a citation. SJR is a measure of scientific influence of scholarly journals that accounts for both the number of citations received by a journal and the importance or prestige of the journals where such citations come from. It is a variant of the eigenvector centrality measure used in network theory. Such measures establish the importance of a node in a network based on the principle that connections to high-scoring nodes contribute more to the score of the node. The SJR indicator, which is inspired by the PageRank algorithm, was developed for extremely large and heterogeneous journal citation networks. It is a size-independent indicator and it ranks journals by their 'average prestige per article' and can be used for journal comparisons in science evaluation processes.” (Elsevier 2014e)

#### 5.4 Scopus Journal Impact and Rankings

Extensive results for journals in all fields for number of publications P, SNIP, RIP (IPP), and percentage of journal self citation (% self cite) can be found at Centre for Science and Technology Studies (CWTS) (CWTS 2014b). Results for SRJ can be found on Elsevier (2014f), much better however on SCImago (2014) where journal metrics given are SJR, h- index, total docs (last year), total docs (3 years), total refs, total cites (3 years), citable docs (3 years), cites / doc (2years), and ref/doc.

#### 5.5 What to calculate for a journal?

It does not make much sense to recalculate any of the three major Scopus impact measures. IPP is similar to JIP, but JIF is better known. SNIP and SJR require more background and more extensive calculations in the entire database. They can not easily be recalculated. Therefore no metric from Section 5 is selected.

### 6 Other Metrics

There are other metrics available. They do not necessarily try to analyze the citation curve (Figure 1) but work on different ideas.

Metrics defined originally for the assessment of researcher's impact can also be applied to calculate journal impact (and vice versa). This is so because both (journals and researcher) have produced a number of papers over time that get cited. Mathematically there is no difference. Metrics will be explained from the perspective of a journal.

There is a program publicly available that calculates all these metrics for researcher's impact and for journal' impact based on Google Scholar. The **program** is called “**Publish or Perish**”

(Harzing 2014a). The web documentation of the program includes helpful information about these metrics. (Harzing 2014b)

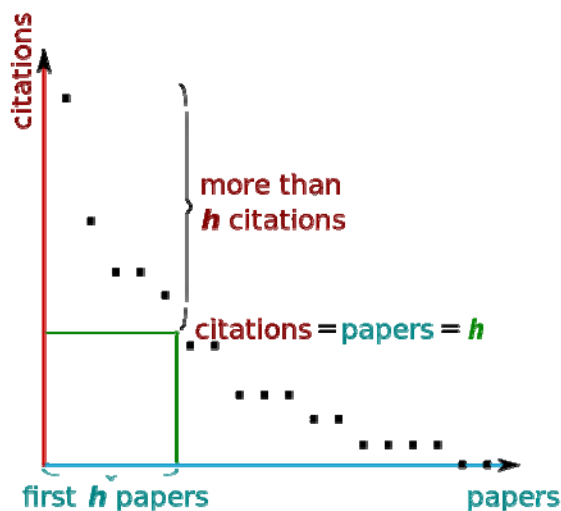
All metrics presented here in this Section can be manipulated through self-citations. This could be avoided, if only citations excluding **self-citation** are considered for the analysis. In the way these indices are used, this is not done.

## 6.1 h-index

The h-index was proposed by J.E. Hirsch (2005) in his paper “An Index to Quantify an Individual's Scientific Research Output”.

A set of articles has index  $h$  if  $h$  of its  $N_p$  papers have at least  $h$  citations each, and the other  $(N_p - h)$  papers have no more than  $h$  citations each.

The h-index provides a combination of both quantity (number of papers) and quality (impact, or citations to these papers). The result is an integer.



**Figure 6:** h-index from a plot of decreasing citations for numbered papers (Wikipedia 2014c)

The h-index is a cumulative index that grows each year. This may be good when measuring the life time achievement of a scientist, but problematic for journal comparison.



**Google Scholar uses the h5-index for journal comparison.** Definition adapted from Google (2014b):

h5-index is the h-index for articles published in the last 5 complete years. It is the largest number h5 such that h5 articles published in 2009-2013 [if we are in 2014] have at least h5 citations each.

h5-index takes into account a window of the 5 last years. This is similar to the 5-year journal impact factor (5-JIF). In a like manner, the variation of the index is reduced. The journal can benefit with this metric from success during the last 5 years of its history, but not from its origin.

## 6.2 m-index

The m-index is another way to eliminate the cumulative nature of the h-index. The **m-index is defined as  $h/Y$** , where  $Y$  is the number of years since the first published paper of the journal. (Wikipedia 2014c)

The m-index will change very little for older journals because the index is determined from the many early years of the journal. The m5-index combines the idea of the m-index and h5-index. It takes the last 5 years to determine impact (to even out too much variation), but gives the number for an average of one year: **m5-index is defined as  $h5 / 5$** .

## 6.3 g-index

The g-index is a cumulative index, suggested by Leo Egghe quoted here from (Wikipedia 2014d):

Given a set of articles ranked in decreasing order of the number of citations that they received, the g-index is the (unique) largest number such that the top  $g$  articles received (together) at least  $g^2$  citations.

The g-index should be evaluated according to the method in the box and can be written as

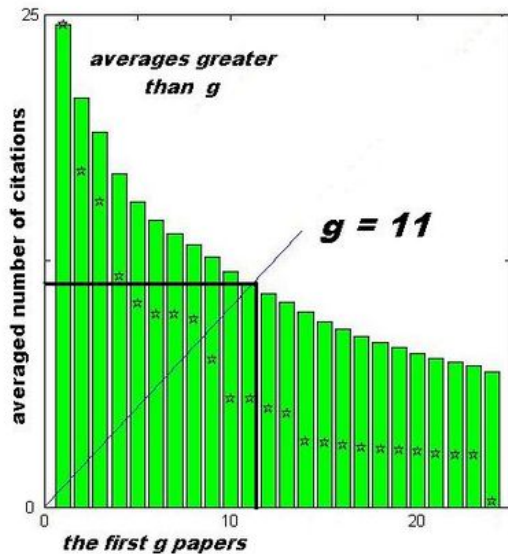
$$g^2 \leq \sum_{i \leq g} c_i$$

Transformed it can be seen that  $g$  is compared with the average of the first  $g$  papers:

$$g \leq \frac{1}{g} \sum_{i \leq g} c_i$$

It aims to improve on the h-index by giving more weight to highly-cited articles.

„Unlike the h-index, the g-index saturates whenever the average number of citations for all published papers exceeds the total number of published papers; the way it is defined, the g-index is not adapted to this situation.“ (Wikipedia 2014d)



**Figure 6:** g-index. The raw citation data, plotted with stars, allows the h-index to also be extracted for comparison from the same chart (Wikipedia 2014d)

## 6.4 i-index

The **i10-index** is a measure developed by Google Scholar. It is the number of publications with at least ten citations. (Wikipedia 2014c) The index is cumulative.

The **i10-5-index** combines the idea of the i-index and h5-index. The i10-5-index is the number of publications with at least ten citations for articles published in the last 5 complete years.

## 6.5 Altmetrics

“Altmetrics are non-traditional metrics proposed as an alternative to more traditional citation impact metrics, such as impact factor and h-index.” (Wikipedia 2014e)

A classification of altmetrics is given by Lin (2013) and (Wikipedia 2014e):

- **Viewed** - HTML views and PDF downloads
- **Discussed** - journal comments, science blogs, Wikipedia, Twitter, Facebook and other media
- **Saved** - Mendeley, CiteULike and other social bookmarks
- **Cited** - citations in the scholarly literature, tracked by Web of Science, Scopus, CrossRef

“**Viewed**: One of the first alternative metrics to be used was the number of views of a paper. Traditionally, an author would wish to publish in a journal with a high subscription rate, so many people would have access to the research. With the introduction of web technologies it became possible to actually count how often a single paper was looked at. Typically, publishers count the number of HTML views and PDF views. As early as 2004, the BMJ published the number of views for its articles, which was found to be somewhat correlated to citations.” (Wikipedia 2014e)

At SCIRP things that could be counted already are

- Number of journal page visits (entering a journal)
- Number of downloads (PDF, HTML, or XML)
- Number of discussions items on all journal articles together (possible future extension, or manual counting)

## 6.6 What to calculate for a journal?

The **h-index** is the classic. The **h5-index** is used by Google Scholar for its journal rankings (so it would need to be included), but h5 makes only sense for journals older than 5 years. All indices are relatively easy to calculate. Readers may be confused, if too many different numbers are given. The **m-index** should be presented to have at least one modern non-cumulative index included valid also for journals younger than 5 years. **i-10-index** is also used by Google Scholar. From the **altmetrics** it would be easy to include what is available as counter on the journal page: **number of journal page visits, number of downloads.**

## 7 Database Comparison – WOS, Scopus, Google Scholar

So far we looked only at the definition of journal metrics. We acknowledged that some metrics are traditionally only applied with certain databases, but theoretically every metric can be applied with any database (if only the algorithm would be known in detail and the database available). In this Section the databases are analyzed on their own.

“A detailed study showed that the Web of Knowledge [now Web of Science, WOS] has strong coverage of journal publications, but poor coverage of high impact conferences. Scopus has better coverage of conferences, but poor coverage of publications prior to 1996; Google Scholar has the best coverage of conferences and most journals (though not all), but like Scopus has

limited coverage of pre-1990 publications. The exclusion of conference proceedings papers is a particular problem for scholars in computer science, where conference proceedings are considered an important part of the literature. Google Scholar has been criticized for producing "phantom citations," including gray literature in its citation counts ... the Meho and Yang study found that Google Scholar identified 53% more citations than Web of Knowledge and Scopus combined, but noted that because most of the additional citations reported by Google Scholar were from low-impact journals or conference proceedings ... It has been suggested that in order to deal with the sometimes wide variation in  $h$  for a single academic [or journal] measured across the possible citation databases, one should assume false negatives in the databases are more problematic than false positives and take the maximum  $h$  measured for an academic [or journal]." (Wikipedia 2014c)

"... [WOS] coverage tends to be heavily concentrated on North American journals. This means that journals that are traditionally more focused towards a non-North American audience might gather more citations in GS [Google Scholar], which includes a larger proportion of non-North American journals." (Harzing 2008)

"journals show a significant improvement in their ranking [better: metrics] when using GS [Google Scholar]" (Harzing 2008)

"We would therefore strongly encourage both individual academics and university administrators to take GS-based impact measures into account when evaluating the impact of both journals and individual academics ..." (Harzing 2008)

"Moreover, the free availability of GS [Google Scholar] allows for a democratization of citation analysis as it provides every academic with access to citation data regardless of their institution's financial means." (Harzing 2008)

But there are also critical voices with respect to the use of Google Scholar: "Google Scholar has been increasingly used in the past six to seven years as a highly efficient information source and service by librarians and other information professionals. The problem is when Google Scholar is touted and used as a bibliometric/scientometric tool and resource in the assessment of the quantity (productivity) and quality (impact) of research publications" "for journal impact factors and the  $h$  - index" "The excess content grossly dilutes the originally worthy collection of scholarly publications. The accuracy, reliability and reproducibility are essential for realistic research assessment through the prism of the quantity (publication counts) and quality (citation counts) of scholarly works. Unfortunately the metadata created by Google Scholar is substandard, neither reliable nor reproducible and it distorts the metric indicators at the individual, corporate and journal levels." (Jacsó 2012)

Summing up, Google Scholar is the only openly available choice. If access is not available to other databases, there is no other choice as Google Scholar. Google Scholar enables a transparent calculation of journal metrics. Google Scholar has certain advantages over WOS or Scopus: Wider coverage especially in areas as engineering. Therefore, Google Scholar should be selected for journal metric calculation of open access journals.

Proposal: As for Thomson Reuters a special abbreviation is introduced, so that it becomes apparent with which database the metric has been calculated. For Google Scholar a “G” is added. This results e.g. in 2-GJIF, or G-h-index,

***What to do?** With Google’s wider coverage, the metrics calculated for a journal with Google Scholar (i.e a 2-GJIF) will most probably be higher than the same metric calculated with WOS or Scopus and can especially not be compared with a 2-JCR®JIF calculated for another journal!*

## 8 Summary and Recommendations

For a publisher it is important to give comprehensive information to readers and authors about its journals. This starts with publisher memberships in publishing organizations and journals being indexed in those databases performing a careful check like WOS and Scopus. Membership and indexing shows the achieved level of quality to readers and authors. To get into WOS or Scopus a publishing history of minimum three years is required. So, **if a journal is not yet ready to be included in these databases** (and also later) it is nevertheless important to **calculate** and provide **statistical data** and data of performance (**productivity and impact**) metrics in numerical form.

The impact factor is certainly the most famous of all journal metrics. But when recalculating and publishing an impact factor **make sure not to leave the impression of delivering a “fake impact factor”**, which is one presented such as to deceive readers or authors by trying to give the impression the impact factor would come from Thomson Reuters.

A program ***Publish or Perish*** (Harzing 2014a) would be available to perform the database search with Google Scholar and to calculate the journal metrics. The well known JIF is not available in the program. Maybe the algorithm is less suitable to calculate the JIF automatically from Google Scholar database information. It was also found that it can be **quite difficult** to collect all papers published in the journal in an automatic search with *Publish or Perish* for the journal under review.

The publications in the journal are all known to the publisher. For this reason, it is not necessary to search for them online. Instead it may be faster and safer to **collect the references to each paper manually**. The results for each paper are **entered into** an **Excel** table that is set up to calculate all journal metrics of interest.

**What to include into the journal?** Here is a list of numerical values that could be published online with a journal. It is based on Section 2 “Journal Assessment”, but provides more detail with respect to numerical values for productivity and impact based on considerations from Sections 3, 4, 5, and 6 (compare at the end of each Section for detailed discussion of metrics that could be selected).

**Statistical values** to include are Y, Cself/C, Aa/P, Pa/A, and Ref/P

**Productivity measures** to include are: P and Pyyyy

**Impact basic measures** to include are: C, C<sub>yyyy</sub>, C/P, and C/Y

**Impact factors** to include are: 2-JIF ex. self cites

**Indices** to include are: h, h<sub>5</sub>, m, (i-10, g)

**Altmetrics** to include are: number of journal page visits, number of downloads

**Prestige:** Journal Prestige Factor (JPF) and Journal Prestige (Appendix A)

The 2-year Google-based Journal Impact Factor (**2-GJIF**) and the **h-index** or **h<sub>5</sub>-index** (depending on journal age) could be shown on the web page. A link “details” would lead to a dedicated page (like today) with more information.

An **Excel table** should be set up to streamline the annual evaluation and to carry results from year to year.

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## Appendix A: Calculation of the Journal Prestige Factor (JPF) and Journal Prestige

This definition of the Journal Prestige Factor (JPF) and Journal Prestige is inspired by the criteria of the „Journal Rating 2001“ of the Wirtschaftsuniversität Wien. The text is quoted from Harzing (2014c). The ranking criteria were originally lumped together into 5 journal ranks and got separated into 8 individual criteria instead. The 8 criteria have each 3 characteristic levels of fulfillment. The 8 criteria with their characteristic levels are:

- **Geographic coverage** of topics, distribution, authorship, readership, editorial board members:
  - world
  - continent
  - nation
- **Language:**
  - international (English)
  - mixed language including English
  - only one language (or more languages) other than English
- **Scope:**
  - entire discipline (e.g. aerospace)
  - sub-discipline (e.g. aeronautics)
  - specialized subject area (e.g. aerodynamics)
- **Contributions:**
  - most contributions are scientifically and methodologically most fastidious and innovative, very frequently pioneer work and milestones of the respective discipline
  - most contributions are scientifically or methodologically innovative
  - most contributions contain scientific results in simplified form to make them easier to comprehend
- **Target readers:**
  - most articles are understandable only for scientists with in-depth method knowledge in the field (PhD level)
  - most articles are understandable for graduates of relevant studies (Master level)
  - most articles are understandable for practitioners with knowledge in the field, but not necessarily with higher academic training (Bachelor level plus practical experience)
- **Authors:**

- most lead author are professors and post-docs
- most lead authors are Phd students
- most lead authors are practitioners with academic training
- **Author competition:**
  - toughest competition of authors from all over the world (very high rejection rate of manuscripts)
  - strong competition of authors from an international realm (high rejection rate of manuscripts)
  - moderate competition of authors (moderate rejection rate of manuscripts)
- **Review process:**
  - at least two external reviewers and editor
  - at least one external reviewer and editor
  - editorial review (at times with internal reviewers), but without external reviewers

So again, there are 8 criteria each of them with 3 characteristics scoring from 3 points (highest fulfillment) to 1 point (lowest fulfillment). All criteria have equal weight. The **Journal Prestige Factor (JPF)** is calculated and the **Journal Prestige** is determined from Table 1. An example evaluation is given in Table 2.

**Table 1:** Assignment of Journal Prestige Factor and Journal Prestige

Journal Prestige Factor	$JPF \leq 2.5$	$2.5 < JPF \leq 1.5$	$1.5 < JPF$
Journal Prestige	A	B	C

**Table 2:** Example evaluation

Geography	3
Language	3
Scope	3
Contributions	2
Target readers	2
Authors	2
Author competition	1
Review process	3
Average	2.38 (B)

Are these 8 criteria also relevant also for WOS or Scopus application? Table 3 has the answer.

**Table 3:** Relevance of criteria for the Journal Prestige Factor on WOS and Scopus application

<b>Criteria important?</b>	WOS	Scopus
Geography	yes	yes
Language	yes	yes
Scope	---	---
Contributions	yes	yes
Target readers	---	---
Authors	---	---
Author competition	---	---
Review process	yes	yes
Average	4 out of 8	5 out of 8

There are more criteria by WOS and Scopus? Both organizations do not have them laid out that clearly to just tick off, but Table 4 tries to provide an answer.

**Table 4:** Additional criteria for application to WOS and Scopus

<b>Additional criteria</b>	WOS	Scopus
Timeliness	yes	yes
Citations in own database	yes	yes
Articles according to scope	---	yes
Readability of abstracts and articles	---	yes
Publication ethics and publication malpractice statement	---	yes
Journal “standing”	yes	yes
Full address information for every author	yes	---
Inclusion of funding acknowledgements	yes	---
Additional criteria	5	6