# Bibliometric Rankings of Journals Based on the Thomson Reuters Citations Database

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**Abstract:** Virtually all rankings of journals are based on citations, including self citations by journals and individual academics. The gold standard for bibliometric rankings based on citations data is the widely-used Thomson Reuters Web of Science (2014) citations database, which publishes, among others, the celebrated Impact Factor. However, there are numerous bibliometric measures, also known as research assessment measures, based on the Thomson Reuters citations database, but they do not all seem to have been collected in a single source. The purpose of this paper is to present, define and compare the 16 most well-known Thomson Reuters bibliometric measures in a single source. It is important that the existing bibliometric measures be presented in any rankings papers as alternative bibliometric measures based on the Thomson Reuters citations database can and do produce different rankings, as has been documented in a number of papers in the bibliometrics literature.

**Keywords:** Research assessment measures, Impact factors, Bibliometric measures.

*"All citations data are useful, but some are more useful than others."*

Chang and McAleer (2015)

## 1. INTRODUCTION

Virtually all bibliometric rankings of journals are based on citations data, or transformations thereof, including self citations by journals and individual academics. The gold standard for bibliometric rankings based on citations data is the widely-used Thomson Reuters Web of Science (2014) citations database, which publishes, among others, the celebrated Impact Factor.

The Thomson Reuters journal citations database is undoubtedly the benchmark against which other well-known databases, such as SciVerse Scopus, Google Scholar and Microsoft Academic Search, the RePEc database for Economics, Finance, Accounting and related disciplines, and the SSRN database for the Social Sciences, are compared. The most well-known journal rankings measures are based on the Thomson Reuters citations database, and the most well-known and widely-used rankings measures are the Thomson Reuters 2-year impact factor (2YIF) and 5-year impact factor (5YIF), both of which include journal self citations. For some serious issues relating to unprofessional and coercive journal self citations see, for example, Chang *et al*. (2013).

There are numerous bibliometric measures, also known as research assessment measures, based on the Thomson Reuters citations database, but they do not all seem to have been collected in a single source. The purpose of this paper is to present, define and compare the most well-known Thomson Reuters bibliometric measures in a single source.

It is important that the existing bibliometric measures be presented in any rankings papers as alternative bibliometric measures based on the Thomson Reuters citations database can and do produce different rankings. Such changes in journal rankings have been documented in a number of papers in the bibliometrics literature (see, for example, the papers given in the list of references).

The remainder of the paper proceeds as follows. Section 2 discusses the 16 Thomson Reuters bibliometric citations measures using daily and annual data for numerous disciplines that are listed in the Thomson Reuters citations database. Section 3 gives some concluding comments, and emphasizes that bibliometric rankings measures based on the Thomson

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Reuters citations database can and do produce different rankings

## 2. BIBLIOMETRIC CITATIONS MEASURES USING DAILY AND ANNUAL DATA

As discussed in Chang *et al*. (2011a, b, c), the bibliometric measures are intended as descriptive statistics to capture journal citations and impact, and are not based on any theoretical models. Hence, in what follows, no optimization or estimation is required in calculating the alternative bibliometric measures.

It is well known that, with three exceptions, namely Eigenfactor, Article Influence and Cited Article Influence, existing bibliometric measures are based on citations data and are reported separately for the Sciences and Social Sciences. The annual bibliometric measures given below are calculated for a Thomson Reuters Journal Citations Reports (JCR) calendar year, which is the year before the annual bibliometric measures are released. For example, the bibliometric measures were released in late-June 2014 for the JCR calendar year 2013.

The definitions and descriptions of the bibliometric measures discussed in this paper have been analysed critically in, for example, Chang, McAleer and Oxley (2011a, b, c) and Chang, Maasoumi and McAleer (2014). As the definitions may not be widely known, and have not been collected in a single source, the purpose of this paper is to present, define and compare the 16 most well-known Thomson Reuters bibliometric measures.

For further details, see Chang *et al*. (2011a, b, c, d, 2014a, b, c, 2015) for a number of Thomson Reuters disciplines such as economics (which incorporates econometrics and numerous journals in finance and accounting), agricultural, energy, environmental and resource economics, business - finance (which also includes a number of journals in accounting), tourism & hospitality, statistics & probability, neuroscience, and journals from 20 separate disciplines in the sciences.

### 2.1. Annual Bibliometric Measures

As mentioned above, with three exceptions, namely Eigenfactor, Article Influence and Cited Article Influence, existing bibliometric measures are based on citations data and are reported separately for the sciences and social sciences. The bibliometric measures may be computed annually or updated daily. The annual bibliometric measures given below are calculated for a Journal Citations Reports (JCR) calendar year, which is the year before the annual bibliometric measures are released. For example, the bibliometric measures were released in late-June 2014 for the JCR calendar year 2013. Twelve well-known such measures are given in this sub-section.

#### *(1) 2-Year Impact Factor Including Journal Self Citations (2YIF)*

The classic 2-year impact factor including journal self citations (2YIF) of a journal is typically referred to as “the impact factor”, is calculated annually, and is defined by Thomson Reuters (2014) as “Total citations in a year to papers published in a journal in the previous 2 years / Total papers published in a journal in the previous 2 years”. The choice of 2 years by ISI is arbitrary. It is widely held in the academic community, and certainly by the editors and publishers of journals, that a higher 2YIF is better than lower.

#### *(2) 2-Year Impact Factor Excluding Journal Self Citations (2YIF*)*

Thomson Reuters (2014) also reports a 2-year impact factor without journal self citations (that is, citations to a journal in which a citing paper is published), which is calculated annually. As this impact factor is not widely known or used, Chang *et al*. (2011b) refer to this bibliometric measure as 2YIF*. Although 2YIF* is rarely reported, a higher value would be preferred to lower.

#### *(3) 5-Year Impact Factor Including Journal Self Citations (5YIF)*

The 5-year impact factor including journal self citations (5YIF) of a journal is calculated annually, and is defined by Thomson Reuters (2014) as “Total citations in a year to papers published in a journal in the previous 5 years / Total papers published in a journal in the previous 5 years.” The choice of 5 years by ISI is arbitrary. Although 5YIF is not widely reported, a higher value would be preferred to lower.

#### *(4) Immediacy, or Zero-Year Impact Factor Including Journal Self Citations (0YIF)*

Immediacy is a zero-year impact factor including journal self citations (0YIF) of a journal, is calculated annually, and is defined by Thomson Reuters (2014) as “Total citations to papers published in a journal in the same year / Total papers published in a journal in the same year.” The choice of the same year by ISI is arbitrary, but the nature of Immediacy makes it clear

that a very short run outcome is under consideration. Although Immediacy is rarely reported, a higher value would be preferred to lower.

### *(5) 5YIF Divided by 2YIF (5YD2)*

As both 2YIF and 5YIF include journal self citations, if it is assumed that journal self citations are uniformly distributed over the 5-year period for calculating 5YIF, their ratio should eliminate the effect of journal self citations and capture the increase in the citation rate over time. In any event, the impact of journal self citations should be mitigated with the ratio of 5YIF to 2YIF. A dynamic bibliometric measures is defined by Chang *et al*. (2014) as 5YD2 as "5YD2 = 5YIF / 2YIF". In the natural, physical and medical sciences, where citations are observed with a frequency of weeks and months rather than years, it is typically the case that 5YIF < 2YIF (see Chang *et al*. (2011c, d, 2014a, 2015), Chang and McAleer (2013a)), whereas the reverse, 5YIF > 2YIF, seems to hold generally in the social sciences, where citations tend to increase gradually over time (see Chang *et al*. (2011a, b, 2012, 2013b, c)). Thus, emphasizing the different speeds at which citations are accrued over time, a lower 5YD2 would be preferred to higher in the sciences, while a higher 5YD2 would be preferred to lower in the social sciences.

### *(6) Eigenfactor (or Journal Influence)*

The Eigenfactor score (see Bergstrom (2007), Bergstrom and West (2008), Bergstrom, West and Wiseman (2008)) is calculated annually (see www.eigenfactor.org), and is defined as: "The Eigenfactor Score calculation is based on the number of times articles from the journal published in the past five years have been cited in the JCR year, but it also considers which journals have contributed these citations so that highly cited journals will influence the network more than lesser cited journals. References from one article in a journal to another article from the same journal are removed, so that Eigenfactor Scores are not influenced by journal self-citation." The value of the threshold that separates 'highly cited' from 'lesser cited' journals, as well as how the former might 'influence the network more' than the latter, are based on the Eigenfactor score of the citing journal. Thus, Eigenfactor might usefully be interpreted as a quality weighted citations score, or a "Journal Influence" measure, namely "Total citations, excluding journal self citations, in the previous 5 years, weighted by journal quality" (see Chang, Maasoumi and McAleer (2014)). A higher Eigenfactor score would be preferred to lower.

### *(7) Article Influence (or Journal Influence per Article)*

Article Influence (see Bergstrom (2007), Bergstrom and West (2008), Bergstrom, West and Wiseman (2008)) measures the relative importance of a journal's citation influence on a per-article basis. Despite the misleading suggestion of measuring "Article Influence", as each journal has only a single "Article Influence" score, this bibliometric measure is actually a "Journal Influence per Article" score (see Chang, Maasoumi and McAleer (2014)). Article Influence is a scaled Eigenfactor score, is calculated annually, is standardized to have a mean of one across all journals in the Thomson Reuters database, and is defined as "Eigenfactor score divided by the fraction of all articles published by a journal in the previous five years", or equivalently, "Total citations, excluding journal self citations, in the past 5 years, weighted by journal quality, divided by the fraction of all articles published by a journal". A higher Article Influence would be preferred to lower.

### *(8) Impact Factor Inflation (IFI)*

The ratio of 2YIF to 2YIF* is intended to capture how journal self citations can inflate the impact factor of a journal, whether this is an unconscious self-promotion decision made independently by publishing authors or as an administrative decision undertaken by a journal‟s editors and/or publishers. Chang *et al*. (2011b) define Impact Factor Inflation (IFI) as "IFI = 2YIF / 2YIF*". The minimum value for IFI is 1, with any value above the minimum capturing the effect of journal self citations on the 2-year impact factor. A lower IFI would be preferred to higher.

### *(9) H-STAR*

ISI has implicitly recognized the inflation in journal self citations by calculating an impact factor that excludes self citations, and provides data on journal self citations, both historically (for the life of the journal) and for the preceding two years, in calculating 2YIF. Chang *et al*. (2011c) define the Self-citation Threshold Approval Rating (STAR) as the percentage difference between citations in other journals and journal self citations. If HS = historical journal self citations, then Historical STAR (H-STAR) is defined as "H-STAR = [(100-HS) - HS] = (100-2HS)". If HS = 0 (minimum), 50 or 100 (maximum) percent, for example, HSTAR = 100, 0 and -100, respectively. A higher H-STAR would be preferred to lower.

### *(10) 2Y-STAR*

If 2YS = journal self citations over the preceding 2-year period, then the 2-Year STAR is defined by Chang

*et al*. (2011c) as "2Y-STAR = [(100-2YS) – 2YS] = (100-2(2YS))". If 2YS = 0 (minimum), 50 or 100 (maximum) percent, for example, 2Y-STAR = 100, 0 and -100, respectively. A higher 2Y-STAR would be preferred to lower.

### *(11) Escalating Self Citations (ESC)*

As self citations for many journals in the sciences and social sciences have been increasing over time, it is useful to present a dynamic bibliometric measure that captures such an escalation over time. The difference 2YS – HS measures Escalating Self Citations in journals over the most recent 2 years relative to the historical period for calculating citations, which will differ across journals. A dynamic biliometric measure is defined by Chang, Maasoumi and McAleer (2014) as "ESC = 2YS – HS = (H-STAR – 2YSTAR) / 2". Given the range of each of H-STAR and 2Y-STAR is (-100, 100), the range of ESC is also (-100, 100), with -100 denoting minimum, and 100 denoting maximum, escalation. A lower ESC would be preferred to higher.

### *(12) Index of Citations Quality (ICQ)*

Chang and McAleer (2014a, b, 2015) argue that, as 2YIF and 5YIF both include journal self citations, excluding journal self citations is a positive development in constructing any new bilbiometric measure based on citations. As Article Influence and 5YIF are both calculated over a five-year period, with the former denoting "quality weighted citations" and the latter measuring "total citations", ICQ is defined as: ICQ = AI / 5YIF = "Quality weighted citations in the past 5 years, excluding journal self citations" / "Total citations in the previous 5 years, including journal self citations". A higher ICQ would generally be preferred to lower:

## 2.2. Daily Updated Bibliometric Measures

Some bibliometric measures are updated daily in the Thomson Reuters citations database, and are reported for a given day in a calendar year rather than for a JCR year. Four well-known such measures are given in this sub-section.

### *(13) Citation Performance Per Paper Online (C3PO)*

ISI reports the mean number of citations for a journal, namely total citations up to a given day divided by the number of papers published in a journal up to the same day, as the "average" number of citations. In order to distinguish the mean from the median and mode, the C3PO of an ISI journal on any given day is defined by Chang *et al*. (2011a) as "C3PO (Citation Performance Per Paper Online) = Total citations to a journal / Total papers published in a journal." A higher C3PO would be preferred to lower. [Note: C3PO should not be confused with C-3PO, the Star Wars android.]

### *(14) h-Index*

The h-index (Hirsch, 2005)) was originally proposed to assess the scientific research productivity and citations impact of individual researchers. However, the h-index can also be calculated for journals, and should be interpreted as assessing the impact or influence of highly cited journal publications. The h-index of a journal on any given day is based on historically cited and citing papers, including journal self citations, and is defined as "h-index = number of published papers, where each has at least h citations." The h-index differs from an impact factor in that the h-index measures the number of highly cited papers historically. A higher h-index would be preferred to lower.

### *(15) Papers Ignored - By Even The Authors (PI-BETA)*

This bibliometric measure captures the proportion of papers in a journal that has never been cited, As such, PI-BETA is, in effect, a rejection rate of a journal after publication. Chang *et al*. (2011a) argue that lack of citations of a published paper, especially if it is not a recent publication, reflects on the quality of a journal by exposing: (i) what might be considered as incorrect decisions by the members of the editorial board of a journal; and (ii) the lost opportunities of papers that might have been cited had they not been rejected by the journal. Chang *et al*. (2011c) propose that a paper with zero citations in ISI journals can be measured by PI-BETA (= Papers Ignored (PI) - By Even The Authors (BETA)), which is calculated for an ISI journal on any given day as "Number of papers with zero citations in a journal / Total papers published in a journal." As journals would typically prefer a higher proportion of published papers being cited rather than ignored, a lower PI-BETA would be preferred to higher.

### *(16) Cited Article Influence (CAI)*

Article Influence is intended to measure the average influence of an article across the sciences and social sciences. As an article with zero citations typically does not have any (academic) influence, a more suitable measure of the influence of cited articles would seem to be Cited Article Influence (CAI). Chang *et al*. (2011c) define CAI as "CAI = (1 - PIBETA)(Article Influence)". If

**Table 1: Bibliometric Measures based on the Thomson Reuters Citations Database**

| Bibliometric Measures | Source |
|---|---|
| 2YIF | Thomson Reuters (2014) |
| 2YIF* | Chang *et al*. (2011b) |
| 5YIF | Thomson Reuters (2014) |
| Immediacy (0YIF) | Thomson Reuters (2014) |
| 5YD2 | Chang *et al*. (2014) |
| Eigenfactor (or Journal Influence) | Bergstrom (2007), Bergstrom and West (2008), Bergstrom, West and Wiseman (2008); correct interpretation given in Chang *et al*. (2014) |
| Article Influence (or Journal Influence per Article) | Bergstrom (2007), Bergstrom and West (2008), Bergstrom, West and Wiseman (2008); correct interpretation given in Chang *et al*. (2014) |
| IFI | Chang *et al*. (2011b) |
| H-STAR | Chang *et al*. (2011c) |
| 2Y-STAR | Chang *et al*. (2011c) |
| ESC | Chang *et al*. (2014) |
| ICQ | Chang and McAleer (2014a, b, 2015) |
| C3PO | Chang *et al*. (2011a) |
| h-index | Hirsch (2005) |
| PI-BETA | Chang *et al*. (2011a) |
| CAI | Chang *et al*. (2011c) |

PI-BETA = 0, then CAI is equivalent to Article Influence; if PI-BETA = 1, then CAI = 0. As Article Influence is calculated annually and PI-BETA is updated daily, CAI may be updated daily. A higher CAI would be preferred to lower.

## 3. CONCLUDING REMARKS

It is well known that virtually all rankings of journals are based on citations, including self citations by journals and individual academics. The gold standard for bibliometric rankings based on citations data is the widely-used Thomson Reuters Web of Science citations database, which publishes, among others, the celebrated Impact Factor. However, there are numerous bibliometric measures, also known as research assessment measures, based on the Thomson Reuters citations database, but they have not been collected in a single source.

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