



# EXPERIMENTAL MEASURE OF THE AUDIENCE FACTOR OF SCIENTIFIC JOURNALS

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## ABSTRACT

The file presents an experimental measure of journal impact, based on a novel normalization of Garfield's Journal Impact Factor (Thomson-Reuters). The field-dependence of impact levels is corrected on the citing side (the propensity and immediacy to cite in citation sources) rather than on the cited side as usual ex post field-normalization. The AF measure shown here does not depend on a particular field-nomenclature.

[Presentation of the Audience Factor \(AF\)](#)

### Tables FA v0.2 (2006) :

[Journals ranked by decreasing AF](#) (PDF)

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***The Audience Factor (AF) is a field-normalized, experimental variant of the Impact Factor of scientific journals.***

## BACKGROUND

The reputation of journals is very unequal, referees and committees are the gatekeepers in charge both of scientific quality and conformity to the journal standards, with high rates of rejection in prestigious journals. A milestone of scientometrics was the quantitative measure of this reputation or notoriety, the Journal Impact Factor built by E. Garfield (1972) and issued in the Journal of Citation Reports (1975). It describes the academic visibility of a journal by the average citation of its articles.

The dissemination of an explicit hierarchy of journals among the scientific community, through the ISI's Journal Citation Report (JCR), made clearer the terms of competition for the access to most visible media, and soon gained a great popularity in evaluation. It is not exaggerated to state that the impact factor played, and still plays, a key role in the self-organization of the scientific community. It is also the instrument that attracted the most criticism, firstly because of general issues of citation analysis it introduced on a large scale, secondly of some specific technical imperfections, but lastly and especially because of misuses in evaluation procedures, disregarding its characteristics and limitations. Some of these limitations are clear from the definition and largely documented in an abundant literature (see for example the review by W. Glänzel & H. Moed, 2002).

Let us only review the particular limitations of IF:

- IF is a citation average, which summarizes the unequal values recorded for individual papers in the journal. It is then quite dangerous, especially for evaluation purposes, to reduce the visibility of institutions or individual scientists to this average value which may strongly differ from their actual citations. A classical reference on this point is Seglen (1997). Among indicators directly complementary to the IF, the RCR "relative citation ratio" (A. Schubert & W. Glänzel, 1983) describes the intra-journal competition.
- IF is based on too short a window, a serious issue for "slow" disciplines. Variants of the impact factor based on a wider citation window (5 years instead of 2) are now available from Thomson-Reuters.
- IF is slightly flawed in terms of "types of documents" present at the numerator and the denominator, a point made by H. Moed & T. Van Leeuwen (1995).
- IF does not control for differences amongst fields or types of research. Field-dependence, especially, is a recurrent question in citation analysis. Soon after impact factor was invented, scholars strove to propose a variety of "field-normalizations", made easy if one picks the JCR field classification scheme (ca. 170 fields for hard sciences) as the reference.

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## IMPACT FACTOR AND FIELD DIVERSITY

In its initial definition (E. Garfield, 1972), for a year  $t$ , the Impact Factor of a journal is the ratio of citations received to number of articles, calculated on the years  $t-1$  and  $t-2$ . The standard impact factor of a journal in 2006, for example, is calculated as the ratio of the number of citations received by the journals' articles in 2004 and 2005, and of the number of articles in 2004-2005. It is a particular measure of average citations by article. Beyond the canonical IF published every year in the Journal of Citation Reports (ISI now Thomson-Reuters), numerous variants have been proposed, including the Thomson-Reuters' 5-years version.

The standard Impact Factor is a gross measure, sensitive to discipline effects. There are several reasons why the unevenness of the average IF is so large across scientific fields. A main reason is the difference in the propensity to cite, and to cite rapidly (within the citation window considered) across research communities. Differences in citing behavior stem from social habits of communities with respect to the degree of specialization and the structure of scientific issues within



each field. A field that is generous and quick in its citations will tend to exhibit a higher impact factor than a field where the average length of bibliographies in citing articles is short and directed towards old articles, outside the citation window - for example in slowly evolving fields.

The other main cause of inequalities is the citation exchanges across domains. A field positioned as an exporter of knowledge or information will in principle gather citations from outside - and conversely for importers.

It may be noticed that the size of the field as such does not directly matter, a point made by E. Garfield in Current Contents in 1976 (see E. Garfield, 1999). If we take the limiting case of a closed field without exchanges of citation, both the numerator and the denominator of the IF are proportional to the size of literature of the field - under certain conditions of definition of citing and cited sets. The size of the fields might affect referencing behavior and thus have an indirect influence through other field features such as the degree of specialization. In fact, at the subject category level or the aggregate discipline level, correlation between field size and aggregate field impact factor is quite low. If the field size does not influence the average impact, it affects the upper bound.

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## FIELD-NORMALIZED IMPACT FACTOR

Field-normalized IF is obtained by a variety of methods, cardinal or ordinal. The simplest is the ratio to field average. These methods ex post, after calculation of field statistics, drastically reduce all causes of distortion: referencing habits, but also advantages in import-export or growth. Moreover, in the usual definitions, the normalization depends on how fields are delimited, then is classification-dependent. References on ex-post normalized IF may be found in the bibliography of articles cited below.

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## INFLUENCE MEASURES

In 1976, G. Pinski and F. Narin (1976) proposed the influence weight, using an iterative weighting of sources of citation. For example a citation from Nature receives a greater weight than a citation from an average journal, because Nature is itself more cited. Similar indexes of influence (see references below) are now calculated using Google-like algorithms, for example C. Bergstrom's "eigenfactor" based on Thomson-Reuters data, Scimago index (F. de Moya-Anegon) based on Scopus data, and others such as Red Jasper index (A. Lim). In typical implementations, those algorithms also neutralized the across-fields discrepancies, but this effect is immersed in the reinforcement links of influence. Some versions of these indexes present questionable treatments of journal self-citations. However, influence measures are very promising to study knowledge flows.

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## AUDIENCE FACTOR

The principle of the Audience Factor (M. Zitt & H. Small, 2008) is to correct one of the causes of inequality, the propensity to cite (and to cite rapidly) at the source, the citing side, rather than ex post on the cited side. The AF does not control other causes of inequality, differential growth amongst fields and citation transactions (import-export) between fields.



Technically, the AF normalization consists of weighting citations emitted by a journal: the weight is inversely proportional to the average length of the "active references" list in the citing community. "Active" means that only those references falling in the chosen citation window are considered. The above-mentioned article suggests options, depending on how the citing community is delineated.

One is to consider the citing journal itself as a micro-community, with the advantage of producing a classification-independent AF. The shortcoming of this approach is too narrow a view of communities and a fragile statistical basis: an ad hoc treatment of the tails of distribution is necessary to avoid on the one hand over-estimation of the references from scarcely citing journals such as trade journals, and on the other hand an under-estimation of the references from journals with very long bibliographies such as reviews journals. The examples given in the article (version 0.1 of the AF, citation window: 5 years) followed this option.

The second option mentioned consists in calculating the bibliography length on the field level rather than the journal level, a much more robust approach but missing the distinct advantage of independence regarding classifications systems.

The present version 0.2 (see below) is intended to make the best of both options.

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## EXPERIMENTAL VERSION OF AF

*Year 2006, 5 years citation window, excluding Social Sciences and Humanities*

Compared to the two versions above, version 0.2 adopts an intermediary solution, which is likely to be rather robust, without ad hoc treatment, while retaining the advantage of a classification-free measure. The main difference between versions 0.1 and 0.2 is the basis of calculation of bibliography length. The new version estimates the propensity to cite in the community represented by the neighborhood of the citing journal A under scrutiny. The neighborhood considered, defined in terms of journals, will be large if the domain is open and not dense, narrow if it is dense and closed. Allowing large variations of the neighborhood is a way to address, quite partially, the delicate issue of reference sets for normalization (M. Zitt, S. Ramanana, E. Bassecouard, 2005). A quite robust method based on length two paths was developed for defining the neighborhood in this v0.2 version. It is ruled by the choice of a single parameter. The details of the method will be published later.

Data were provided by Thomson-Reuters and used by permission for the experiments. They bear on the year 2006. In Table 1, journals are ranked by decreasing AF (except for journals with  $AF < 0.5$ , where the alphabetical order is used). In Table 2, rows are sorted alphabetically by title. The "active" references used in the weighting process correspond to a citation window of 5 years. Note that the 5 years window is chosen for reliability, but at the expense of a loss of journals not documented throughout the full period. The notation 'a' in 0.2a refers to an option concerning citation sources. In this option, citations to a cited journal (say B) from all available sources are counted and the weighting of citations from sources with incomplete information is extrapolated from sources with complete information citing B. Information is typically incomplete for journals assigned both to SCI and SSCI-A&HCI (for example *Econometrica*) and several journals in computer science/communication. The ratio of all sources over complete sources is coded in Table 1 from \*\*\* (good) to \* (fair). Data for 123 journals with a ratio superior to 2.6 are not considered significant, whatever the level of impact. The list of these is given in Table 3. The all science norm used for AF includes citations to these journals. In the option 0.2b (not shown) only citations from well-informed sources are counted, without extrapolation.

We stress the fact that this is an experimental version, subject to correction or improvement.

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## CONCLUSION

As expected, AF and IF exhibit a fairly strong correlation. The across-domain part of variance is efficiently neutralized by AF, but not of course the inequality of journal visibility within their particular community. Moreover, in contrast with usual field-normalized IF, the advantage of trans-field visibility for generic journals present in the IF is kept in the AF measure.

Michel Zitt, January 2010

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Literature on impact factor is abundant. We only mention below a few milestones and reviews where references can be found.

## IMPACT FACTOR

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- Scimago journal ranking : <http://www.scimagojr.com/journalrank.php> (F. de Moya-Anegon)

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## AUDIENCE FACTOR

### v0.1

- Zitt M., Small H. (2008) Modifying the Journal Impact Factor by Fractional Citation Weighting: the Audience Factor, *Journal of the American Society for Information Science and Technology*, vol 59, n°11, pp. 1856-1860 [Article](#)
- Zitt M., Small H. (2008b) Field normalization of impact factors: a citing side approach, 10th International conference on Science & Technology indicators 17-20 Sept. Vienna (AUT)

### v0.2

- Zitt M., Citing-side normalization of Journal Impact: a robust variant of the Audience Factor (forthcoming in *Journal of Informetrics*, 2010) [Article](#)

### **Background**

- Zitt M., Ramanana-Rahary S., Bassecoulard E. (2005). Relativity of citation performance and excellence measures: from cross-field to cross-scale effects of field-normalisation, *Scientometrics*, vol 63, n°2, pp. 373-401. [Article](#)

### **Another method of citing-side normalization: the SNIP (Source-Normalized Impact per Paper)**

- Moed, H.F. Measuring contextual citation impact of scientific journals, forthcoming in *Journal of Informetrics*, 2010 [arxiv.org/pdf/0911.2632](http://arxiv.org/pdf/0911.2632)

### **A comparison**

- Waltman, L., van Eck, N.J., The relation between Eigenfactor, audience factor, and influence weight, forthcoming in 2010 [arxiv.org/pdf/1003.2198](http://arxiv.org/pdf/1003.2198)

### **Recent debates on impact normalization (forthcoming)**

- Opthof T., Leydesdorff L. Caveats for the journal and field normalization in the CWTS ("Leiden") evaluation of research performance, forthcoming in *Journal of Informetrics*, 2010 [arxiv.org/pdf/1002.2769](http://arxiv.org/pdf/1002.2769)
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## RELATED ARTICLES: ABSTRACTS AND LINKS TO PDF

### JOI 2010 (FORTHCOMING)

#### References:

Zitt M. Citing-side normalization of journal impact: a robust variant of the Audience Factor (forthcoming in *Journal of Informetrics*, 2010) [PDF](#)

#### Keywords:

AUDIENCE FACTOR, IMPACT FACTOR, NORMALIZED IMPACT, CITING-SIDE NORMALIZATION, SOURCE NORMALIZATION, JOURNAL IMPACT

#### Abstract:

The principle of a new type of impact measure was introduced recently, called the "audience factor" (AF). It is a variant of the journal impact factor where emitted citations are weighted inversely to the propensity to cite of the source. In the initial design, propensity was calculated using the average length of bibliography at the source level with two options: a journal-level average or a field-level average. This citing-side normalization controls for propensity to cite, the main determinant of impact factor variability across fields. The AF maintains the variability due to exports-imports of citations across field and to growth differences. It does not account for influence chains, powerful approaches taken in the wake of Pinski-Narin's influence weights. Here we introduce a robust variant of the audience factor, trying to combine the respective advantages of the two options for calculating bibliography lengths: the classification-free scheme when the bibliography length is calculated at the individual journal level, and the robustness and avoidance of ad-hoc settings when the bibliography length is averaged at the field level. The variant proposed relies on the relative neighborhood of a citing journal, regarded as its micro-field and assumed to reflect the citation behavior in this area of science. The methodology adopted allows a large range of variation of the neighborhood, depending on the local citation network, and partly alleviates the "cross-scale" normalization issue. Citing-side normalization is a general principle which may be extended to other citation counts.

[http://www.elsevier.com/wps/find/journaldescription.cws\\_home/709551/description#description](http://www.elsevier.com/wps/find/journaldescription.cws_home/709551/description#description)

[PDF](#)

### JASIST 2008

#### References :

Zitt M. and Small H. (2008). Modifying the Journal Impact Factor by Fractional Citation Weighting: the Audience Factor, *Journal of the American Society for Information Science and Technology* vol 59, n°11, pp. 1856-1860. [PDF](#)  
JEL: A 140

**Keywords:**

SCHOLARLY JOURNALS, JOURNAL EVALUATION, IMPACT FACTOR, INFLUENCE FACTOR, INFLUENCE WEIGHT, NORMALIZED IMPACT

**Abstract:**

A new approach to the field normalization of the classical journal impact factor is introduced. This approach, called the audience factor, takes into consideration the citing propensity of journals for a given cited journal, specifically, the mean number of references of each citing journal, and fractionally weights the citations from those citing journals. Hence, the audience factor is a variant of a fractional citation-counting scheme, but computed on the citing journal rather than the citing article or disciplinary level, and, in contrast to other cited-side normalization strategies, is focused on the behavior of the citing entities. A comparison with standard journal impact factors from Thomson Reuters shows a more diverse representation of fields within various quintiles of impact, significant movement in rankings for a number of individual journals, but nevertheless a high overall correlation with standard impact factors.

<http://www3.interscience.wiley.com/journal/119882546/abstract>

[PDF](#)

## SCIENTOMETRICS 2005

**References :**

Zitt M., Ramanana-Rahary S. and Bassecoulard E. (2005). Relativity of citation performance and excellence measures: from cross-field to cross-scale effects of field-normalisation, *Scientometrics*, vol 63, n°2, pp. 373-401. [PDF](#)  
JEL: A 140

**Keywords :**

EXCELLENCE MEASURES; CITATION ANALYSIS; NORMALISATION; SCIENTIFIC RESEARCH; ORDERED STRUCTURE; RANDOM STRUCTURE ; BIBLIOMETRICS; SCIENCE CITATION INDEX; IMPACT FACTOR; RELATIVE IMPACT; SCIENTIFIC SPECIALTIES; CLASSIFICATION OF SCIENCE; ORDINAL METHODS; OBSERVATION LEVEL

**Abstract:**

As citation practices strongly depend on fields, field normalisation is recognised as necessary for fair comparison of figures in bibliometrics and evaluation studies. However fields may be defined at various levels, from small research areas to broad academic disciplines, and thus normalisation values are expected to vary. The aim of this project was to test the stability of citation ratings of articles as the level of observation --- hence the basis of normalisation --- changes. The study was conducted on articles in the full SCI range, for publication year 1998 with a 4-year citation window. Citation ratings have been observed at the five embedded levels of a realistic structure of the scientific production based on ISI subject categories and their aggregates at various scales: all science, large academic discipline, sub-discipline, speciality and journal. Correlations on this empirical set have been benchmarked against two fictitious sets keeping the embedded aggregates of articles, with a redistribution of citation figures to emulate either a totally ordered or a random structure of science, expected to give a "worst case" and a "best case" for the stability of normalised citation indicators. Among various normalisation methods, we selected a simple ranking method (quantiles), based on the citation score of the article in each particular aggregate (journal, speciality, etc.) it belonged to at each



level. The results show that: (a) the average citation rankings of articles substantially change with the level of observation (b) observation at the journal level is very particular, the results differ greatly in all test circumstances from all the other levels of observation. The comparison of the empirical set (c) the lack of cross-scale stability is confirmed when looking at the distribution of individual trajectories of articles across the levels; (d) when considering the top-cited fractions, a standard measure of excellence, it is found that the contents of the 'top-cited' set is completely dependent on the level of observation. The instability of impact measures should not be interpreted in terms of lack of robustness but rather as the co-existence of various perspectives each having their own form of legitimacy. A follow-up study will focus on the micro levels of observation and will be based on a structure built around bibliometric groupings rather than conventional groupings based on ISI subject categories.

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