



JOURNAL IMPACT MEASURES

WOLFGANG GLÄNZEL

Centre for R&D Monitoring and Dept MSI, KU Leuven
MTAK, Dept. Science Policy & Scientometrics, Budapest, Hungary

(In collaboration with Juan Gorraiz, University of Vienna, Library and Archive Services, for esss)

ECOOM

1. INTRODUCTION
2. THE JOURNAL IMPACT FACTOR – HISTORY
3. IF VARIANTS – DEFINITION, CALCULATION AND PROPERTIES
4. AGEING-RELATED MEASURES

“Journal impact measures” (JIM) characterise the role of scientific journals in the network of documented scholarly communication. *Impact Factors* and related measures based on citations given or received by journals are used in bibliometrics for various purposes.

- The Impact Factor is an influence indicator defined as a journal's mean citation rate.
- Ageing measures such as cited/-ing half life reflect the obsolescence of information published in scientific journals.
- The Mean Response Time (Schubert and Glänzel, 1996) measures the reception speed of papers published in a journal.
- The Price Index (Price, 1970) measures the “hardness” of science on the basis of the distribution of the items of a journal's reference list.

≡ The Journal Impact Factor – History ≡

The ISI Impact Factor (IF) simply relates the citations a journal has received in a given year to the number of papers it has published in the preceding two years.

The “Impact Factor” was first used as a measure for comparing journals independently of “size” and to help select journals for the SCIENCE CITATION INDEX (SCI).

📖 GARFIELD & SHER, *American Documentation*, 1963

It goes back to the assumption by Gross and Gross in chemistry that most frequently cited journals are most relevant to the field and thus the most valuable journals for a library to purchase.

📖 GROSS & GROSS, *Science*, 1927

The Journal Impact Factor – History

Garfield soon recognised the power of the IF for journal evaluation and considered it also a journal performance indicator.

📖 GARFIELD, *Science*, 1972

Nowadays, the ISI impact factor has probably become the most frequently used bibliometric measure worldwide, and has obtained a very strong ‘market’ position. It actually represents a paradigm in bibliometrics and information science.

Todorov and Glänzel have characterised this measure as follows.


“Journal citation indicators are commonly used as general measures for various journal characteristics and research impact by different participants in the publication, dissemination, and evaluation process of scientific knowledge...

Many librarians, information scientists and, sociologists of science already consider journal citation analysis as a practical alternative to subjective judgement.

Authors may take citation measures from JCR and use them as possible indicators of journal characteristics.

Lists of ranked SCI journals may help potential and real users to identify sources with significant contributions.

Editors and publishers may relate high citation impact to a successful editorial practice and policy.”

 TODOROV & GLÄNZEL, *Journal of Information Science*, 1987

Strengths of the IF: Comprehensibility, stability and fast availability.


Flaws have provoked critical discussions about correctness and use.

In their state-of-the-art report, Glänzel and Moed have summarised several flaws.

1. There is no normalisation for reference practices and traditions in the different fields and disciplines.
2. “There is no distinction in regard to the nature and merits of the citing journals” (Tomer, 1986).
⇒ Introduction of Eigenfactor and Influence Factor scores
3. There is a bias in favour of journals with large papers (e.g. review journals tend to have higher impact factors).
4. Citation frequency is subject to age bias.

The Journal Impact Factor – Pros and Cons II

5. There is no indication of the deviations from this statistic.
6. The average time for a journal article from publication to peak in citations is not always two years, or as Garfield (1986) writes “if we change the two-year based period used to calculate impact, some type of journals are found to have higher impacts”.
⇒ Introduction of the 5-year IF provided at least a synchronous solution.
7. One single measure might not be sufficient to describe citation patterns of scientific journals.
8. The concept of citable document is not operationalised adequately. As a result, journal impact factors published in ISI’s Journal Citation Reports are inaccurate for a number of journals.
9. In the calculation of JCR impact factors, errors are made due to incorrect identification of (cited) journals.
⇒ Solved for some journals.

 GLÄNZEL & MOED, *Scientometrics*, 2002

The Impact Factor is part of the *Journal Citation Reports* (JCR).

Two editions are provided as part of InCites by Clarivate Analytics, the “Science Edition” and the “Social Sciences Edition”.

- Journals are aggregated to Subject Categories. Both editions overlap since several journals are assigned to both editions. Furthermore, several Subject Categories are also covered by both editions with different journal coverage.

From the statistical viewpoint, the *Impact Factor* and *Immediacy Index* are mean values. They are defined as mean citation rates

$$\frac{c_n}{\sum_{i=j}^k p_i},$$

where p_i is the number of papers published in the journal in year i and c_n the number of citations received by the papers in year n .

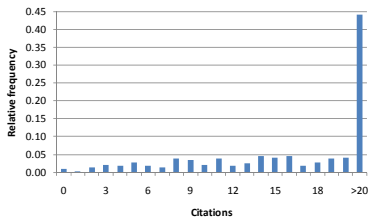
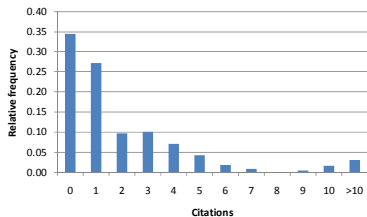
- For the standard Impact Factor we have $j = n - 2$; $k = n - 1$,
- for the Five-Year Impact Factor we have $j = n - 5$; $k = n - 1$,
- for the Immediacy Index, we have $j = k = n$.

Note that Impact Factors are synchronous measures.

- ➡ The citation year is fixed and relates backwards to variable publication windows in the past

Properties of the IF

The citation distribution of two journals for PY=2007-2008 and CY=2009
(left: *Scientometrics*¹ – IF=2.00, $f_0 = 0.346$; right: *Nature Medicine*² – IF=24.35, $f_0 = 0.010$)



Source: Clarivate Analytics Web of Science Core Collection

Citation counts according to the JCR

All indicators used in the JCR are based on calculations made on reference lists of all papers published in citing and cited journals. Journal identification in the reference lists is made on the basis of thesauri built for source titles and the publication year.

Citation counts according to the JCR

All indicators used in the JCR are based on calculations made on reference lists of all papers published in citing and cited journals. Journal identification in the reference lists is made on the basis of thesauri built for source titles and the publication year.

Citation counts according to the WoS

In the SCIE and SSCI, citations are determined through paper-by-paper match of the source paper and the items in the reference list of citing papers.

Citation counts according to the JCR

All indicators used in the JCR are based on calculations made on reference lists of all papers published in citing and cited journals. Journal identification in the reference lists is made on the basis of thesauri built for source titles and the publication year.

Citation counts according to the WoS

In the SCIE and SSCI, citations are determined through paper-by-paper match of the source paper and the items in the reference list of citing papers.

- ➡ Calculation of the Impact Factor on the basis of citation counts from the SCIE/SSCI is not possible.

The denominator in the definition of the IF is based on articles and reviews. In the numerator all citations are counted.

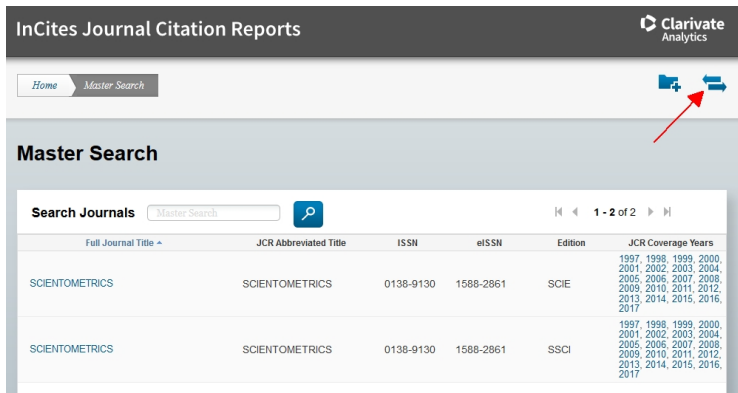
Example: “3-year impact measures” for selected journals

Journal	Mean Citation Rate			
	Total	Articles	Reviews	Letters
SCIENCE	32.86	42.30	145.35	0.41
NATURE	32.88	49.73	96.07	3.93
LANCET	5.25	17.55	14.68	1.99
CELL	75.68	74.82	78.63	75.64
ANGEW CHEM INT ED	11.01	9.37	32.03	19.00
J ACQ IMMUN DEFIC SYND HUM R	4.05	4.64	39.00	1.04
INT J RAD ONCOL BIOL PHY	3.52	4.15	35.00	0.37
J PHYS CONDENS MATTER	2.72	2.47	9.57	3.99

Source: GLÄNZEL AND MOED, *Scientometrics*, 2002

Journal Impact measures in the JCR

Journal impact measures as presented in the 2017 JCR




InCites Journal Citation Reports

Clarivate Analytics

Home Master Search

Master Search

Search Journals 

1 - 2 of 2

Full Journal Title	JCR Abbreviated Title	ISSN	eISSN	Edition	JCR Coverage Years
SCIENTOMETRICS	SCIENTOMETRICS	0138-9130	1588-2861	SCIE	1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017
SCIENTOMETRICS	SCIENTOMETRICS	0138-9130	1588-2861	SSCI	1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017

Source: Clarivate Analytics InCites Journal Citation Reports

Journal Impact measures in the JCR

Journal impact measures as presented in the 2016 JCR

TITLE	IMPACT_FACTO	IMMEDIACY_INDE	SYR_IMP	EIGENFACTOR	NORM_EIGENF	ARTL_INFLUENCI
Abacus-A Journal of Accounting Finance and Business Stud	1.119	0.720	1.321	0.00048	0,05465	0.296
Academy of Management Annals	11.115	1.333	16.191	0.00876	1,006	8.960
Academy of Management Learning & Education	2.426	0.229	3.796	0.00235	0,26957	1.041
ACADEMY OF MANAGEMENT JOURNAL	7.417	1.080	11.901	0.02758	3,16597	5.776
Academy of Management Perspectives	4.943	0.720	7.156	0.00539	0,61834	3.071
ACADEMY OF MANAGEMENT REVIEW	9.408	1.897	13.630	0.01279	1,46818	6.443
ACADEMIC PSYCHIATRY	1.395	0.491	1.349	0.00203	0,23295	0.384
Academia-Revista Latinoamericana de Administracion	0.237	0.000	0.392	0.00007	0,00752	0.047
ACCIDENT ANALYSIS AND PREVENTION	2.685	0.500	3.244	0.02219	2,54748	0.914
Accounting Auditing & Accountability Journal	2.732	0.596	2.991	0.00158	0,18174	0.505
ACCOUNTING AND BUSINESS RESEARCH	0.911	0.357	1.565	0.00077	0,0882	0.431
Accounting and Finance	1.396	0.132	1.654	0.00120	0,13787	0.344
Accounting Horizons	1.218	0.517	1.564	0.00157	0,18075	0.536

Source: Clarivate Analytics InCites Journal Citation Reports

Journal Impact measures in the JCR

Journal impact measures as presented in the 2017 JCR

Key Indicators													
Year ▾	Total Cites Graph	Journal Impact Factor Graph	Impact Factor Without Journal Self Cites Graph	5 Year Impact Factor Graph	Immediacy Index Graph	Citable Items Graph	Cited Half-Life Graph	Citing Half-Life Graph	Eigenfactor Score Graph	Article Influence Score Graph	% Articles in Citable Items Graph	Normalized Eigenfactor Graph	Average JIF Percentile Graph
2017	8,766	2.173	1.532	2.389	0.560	375	6.8	8.2	0.01...	0.502	99.20	1.24...	65.365
2016	7,831	2.147	1.476	2.346	0.476	351	6.7	8.0	0.01...	0.530	97.15	1.23...	68.179
2015	6,436	2.084	1.278	2.313	0.388	348	6.3	8.2	0.00...	0.488	98.56	1.08...	77.186
2014	5,805	2.183	1.182	2.316	0.334	338	6.5	7.8	0.00...	0.431	100.00	0.87...	84.363
2013	5,129	2.274	1.524	2.294	0.329	255	6.5	8.1	0.01144	0.677	97.65	1.26...	85.977
2012	4,555	2.133	1.297	2.207	0.449	254	6.5	7.1	0.00...	0.599	98.82	Not ...	86.426
2011	4,048	1.966	1.207	2.443	0.378	217	5.9	7.0	0.01...	0.680	97.70	Not ...	81.709
2010	3,602	1.905	1.220	2.415	0.173	226	6.4	7.1	0.00...	0.583	98.67	Not ...	79.636
2009	3,508	2.167	1.603	2.793	0.328	189	6.2	7.5	0.00...	0.608	98.94	Not ...	83.593
2008	2,492	2.328	1.750	2.295	0.391	128	5.6	6.9	0.00...	0.501	100.00	Not ...	87.204

Source: Clarivate Analytics InCites Journal Citation Reports

Comparison and ranking of Impact Factors

The mathematical-statistical interpretation allows the comparison between different IFs. It goes without saying that this exercise is only legitimate within the same (narrow) subject field.

The “Aggregate Impact Factor” of selected Categories (both JCR Editions 2009)

Rank	Subject Category	Median IF	AIF
2	cell & tissue engineering	3.263	6.475
3	cell biology	3.308	5.825
31	physics, particles & fields	2.034	3.264
57	chemistry, analytical	1.776	2.638
63	energy & fuels	1.395	2.550
93	oceanography	1.151	1.895
129	acoustics	0.840	1.454
131	crystallography	1.451	1.433
148	statistics & probability	0.940	1.213
150	materials science, ceramics	0.434	1.207
167	mathematics	0.633	0.777
172	engineering, petroleum	0.404	0.494
173	engineering, marine	0.280	0.121

Source: Clarivate Analytics InCites Journal Citation Reports

A further problem in the use of the Impact Factor results from interdisciplinarity and multiple assignments of journals to Subject Categories.

Example: The journal *Bioinformatics* in different subject categories – JCR 2009

Rank	Subject Category
-------------	-------------------------

2	mathematical & computational biology
---	--------------------------------------

9	biochemical research methods
---	------------------------------

14	biotechnology & applied microbiology
----	--------------------------------------

Comparison and ranking of Impact Factors

Subject category measures in the JCR 2017

The screenshot displays the InCites Journal Citation Reports interface. At the top, the title "InCites Journal Citation Reports" is on the left, and the Clarivate Analytics logo is on the right. Below the title bar, there are navigation tabs for "Home" and "Category Rankings", with "Category Rankings" being the active tab. To the right of the tabs are three icons: a download arrow, a folder with a plus sign, and a double arrow. The main content area is divided into a left sidebar and a main table. The sidebar contains a "Go to Journal Profile" section with a "Master Search" input field and a search icon, a "Select Journals" button with a left arrow, and a "Select Categories" button with a dropdown arrow. Below these is a list of categories, with "ANTHROPOLOGY" selected and a scroll bar to its right. The main table has two tabs: "Journals By Rank" and "Categories By Rank", with "Categories By Rank" being the active tab. The table title is "All Journal Categories ranked by Number of Journals". Below the title is a "Customize Indicators" section. The table itself has the following columns: Category, Edition, Articles, Total Cites, Median Impact Factor, Aggregate Impact Factor, and Aggregate Immediacy Index. The data row shows "INFORMATION SCIENCE & LIBRARY SCIENCE" in the Category column, "SSCI" in the Edition column, "4,305" in the Articles column, "132,560" in the Total Cites column, "1.180" in the Median Impact Factor column, "2.004" in the Aggregate Impact Factor column, and "0.469" in the Aggregate Immediacy Index column.

Category	Edition	Articles	Total Cites	Median Impact Factor	Aggregate Impact Factor	Aggregate Immediacy Index
INFORMATION SCIENCE & LIBRARY SCIENCE	SSCI	4,305	132,560	1.180	2.004	0.469

Source: Clarivate Analytics InCites Journal Citation Reports

Despite serious advantages provided by more advanced journal metrics (by Clarivate Analytics, Elsevier, Scimago and others – to be discussed later in Part 2), the Impact Factor is still one of the most popular journal indicators.

Reasons, are

- simplicity,
- robustness,
- suitability for elementary mathematical manipulations without loss of interpretability.

The Impact Factor can be considered *one (but not the only)* “performance” measure of journals, can be obtained from empirical citation distributions as *statistical functions*.

The Impact Factor can be considered *one (but not the only)* “performance” measure of journals, can be obtained from empirical citation distributions as *statistical functions*.

- The Impact Factor is by no means a performance measure of individual articles published in the journal in question nor of the authors of these papers.

📖 SEGLEN, *BMJ*, 1997

📖 NEUBERGER & COUNSELL, *Eur. J. Gastroenterol. Hepatol.*, 2002

Some critical comments on policy applications

The Impact Factor evolved to an evaluation tool as it plays an important part in the evaluation of research groups and individuals.

The IF seems to have become the common currency of scientific quality in research evaluation and has already influence on scientists' funding and career. (📄 SEVINC, *Swiss Medical Weekly*, 2004)

Some critical comments on policy applications

The Impact Factor evolved to an evaluation tool as it plays an important part in the evaluation of research groups and individuals.

The IF seems to have become the common currency of scientific quality in research evaluation and has already influence on scientists' funding and career. (📄 SEVINC, *Swiss Medical Weekly*, 2004)

According to van Raan, the Impact Factor is the “poor man’s” tool for citation analysis (📄 ADAM, *Natur*, 2002).

Some critical comments on policy applications

The Impact Factor evolved to an evaluation tool as it plays an important part in the evaluation of research groups and individuals.

The IF seems to have become the common currency of scientific quality in research evaluation and has already influence on scientists' funding and career. (📖 SEVINC, *Swiss Medical Weekly*, 2004)

According to van Raan, the Impact Factor is the “poor man’s” tool for citation analysis (📖 ADAM, *Natur*, 2002).

Several journals have been accused of manipulating their Impact Factor. 📖 SMITH, *BMJ*, 1997; 📖 WEINGART, *Scientometrics*, 2005

Some critical comments on policy applications

The Impact Factor evolved to an evaluation tool as it plays an important part in the evaluation of research groups and individuals.

The IF seems to have become the common currency of scientific quality in research evaluation and has already influence on scientists' funding and career. (📖 SEVINC, *Swiss Medical Weekly*, 2004)

According to van Raan, the Impact Factor is the “poor man’s” tool for citation analysis (📖 ADAM, *Natur*, 2002).

Several journals have been accused of manipulating their Impact Factor. (📖 SMITH, *BMJ*, 1997; 📖 WEINGART, *Scientometrics*, 2005)

👉 The often observed normative way of IF use should be avoided.

Example for the role of the Impact Factor



“American Journal of Transplantation is the leading journal in its field

New impact factor for 2005 – 6.002 –

Still the #1 transplantation journal

(Ranked second in the surgery category)”

Source: <http://www.blackwellpublishing.com/journal.asp?ref=1600-6135&site=1>
Accessed on 15 September 2006

The journal half-life

- Journal half-life is an obsolescence indicator for literature. It is adopted from physics, where it measures the speed of radioactive decay.

The journal half-life

- Journal half-life is an obsolescence indicator for literature. It is adopted from physics, where it measures the speed of radioactive decay.
- The citing and cited half-life is actually defined as the time period beginning with the publication year in which half the citations are given or received, respectively.

The journal half-life

- Journal half-life is an obsolescence indicator for literature. It is adopted from physics, where it measures the speed of radioactive decay.
- The citing and cited half-life is actually defined as the time period beginning with the publication year in which half the citations are given or received, respectively.
- The JCR provides these indicators in the JCR for journals and subject categories along with the IF data.

The journal half-life

- Journal half-life is an obsolescence indicator for literature. It is adopted from physics, where it measures the speed of radioactive decay.
- The citing and cited half-life is actually defined as the time period beginning with the publication year in which half the citations are given or received, respectively.
- The JCR provides these indicators in the JCR for journals and subject categories along with the IF data.
- The JCR provides these indicators in the JCR for journals and subject categories along with the IF data.

Half-life – A measure of ageing and obsolescence

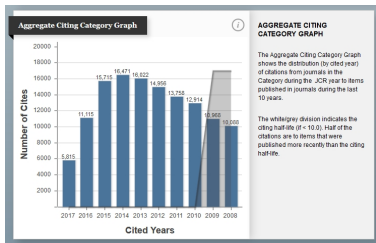
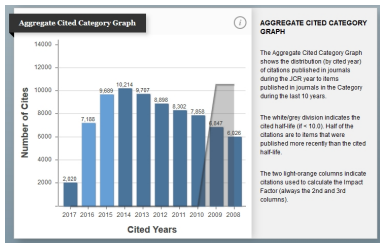
Ageing measures for the journal Scientometrics as presented in the 2017 JCR

Key Indicators													
Year ▾	Total Cites Graph	Journal Impact Factor Graph	Impact Factor Without Journal Self Cites Graph	5 Year Impact Factor Graph	Immediacy Index Graph	Citable Items Graph	Cited Half-Life Graph	Citing Half-Life Graph	Eigenfactor Score Graph	Article Influence Score Graph	% Articles in Citable Items Graph	Normalized Eigenfactor Graph	Average JIF Percentile Graph
2017	8,766	2.173	1.532	2.389	0.560	375	6.8	8.2	0.01...	0.502	99.20	1.24...	65.365
2016	7,831	2.147	1.476	2.346	0.476	351	6.7	8.0	0.01...	0.530	97.15	1.23...	68.179
2015	6,436	2.084	1.278	2.313	0.388	348	6.3	8.2	0.00...	0.488	98.56	1.08...	77.186
2014	5,805	2.183	1.182	2.316	0.334	338	6.5	7.8	0.00...	0.431	100.00	0.87...	84.363
2013	5,129	2.274	1.524	2.294	0.329	255	6.5	8.1	0.01144	0.677	97.65	1.26...	85.977
2012	4,555	2.133	1.297	2.207	0.449	254	6.5	7.1	0.00...	0.599	98.82	Not ...	86.426
2011	4,048	1.966	1.207	2.443	0.378	217	5.9	7.0	0.01...	0.680	97.70	Not ...	81.709
2010	3,602	1.905	1.220	2.415	0.173	226	6.4	7.1	0.00...	0.583	98.67	Not ...	79.636
2009	3,508	2.167	1.603	2.793	0.328	189	6.2	7.5	0.00...	0.608	98.94	Not ...	83.593
2008	2,492	2.328	1.750	2.295	0.391	128	5.6	6.9	0.00...	0.501	100.00	Not ...	87.204

Source: Clarivate Analytics InCites Journal Citation Reports

Half-life – A measure of ageing and obsolescence

Citing half-life of biochemistry & molecular biology (left) and mathematics (right)



Source: Clarivate Analytics InCites Journal Citation Reports

Price Index – A measure of the “hardness of science”

The age structure of the reference items of scientific publications reflect characteristics concerning the “hardness” of scientific literature.

📖 PRICE, *Citation measures of hard science ...*, 1970

The share of references not older than five years in all references of a journal to distinguish between hard science, soft science, technology, and non science.

This share is called *Price Index*.

Although not provided in the JCR, it is easy to calculate for both subject categories and journals.

- ➡ Ageing indicators help to better understand and interpret impact-factor type journal measures since *fast ageing journals* and journals in *fast ageing fields* are expected to have *higher citation impact* than those in slowly ageing fields like applied sciences, mathematics and social sciences.

Price Index – A measure of the “hardness of science”

A citing subject category as presented in the 2009 JCR

Citing Category Data								i
	Cited Journal	# Citing	All Yrs ▼	2017	2016	2015	2014	2013
1	ALL Journals	88	222,474	5,815	11,115	15,715	16,471	^
2	MIS QUART	60	4,145	34	57	139	216	
3	SCIENTOMETRICS	45	3,956	108	369	353	452	
4	J AM SOC INF SCI TEC	73	2,879	0	2	2	1	
5	INFORM SYST RES	49	2,104	8	35	74	122	
6	COMPUT HUM BEHAV	56	1,625	29	190	229	246	
7	RES POLICY	53	1,369	5	30	58	85	
8	J MANAGE INFORM SYST	49	1,313	9	37	80	84	
9	MANAGE SCI	49	1,271	3	25	30	34	
10	J INFORMETR	38	1,269	53	211	157	159	
11	INFORM MANAGE-AMSTER	51	1,201	5	36	109	114	
12	THESIS	78	1,148	7	44	95	93	
13	ORGAN SCI	50	1,099	0	8	9	24	
14	GOV INFORM Q	44	991	18	78	107	130	
15	J DOC	55	971	19	43	51	63	▼

Source: Clarivate Analytics InCites Journal Citation Reports

Price Index – A measure of the “hardness of science”

Price Index calculated for seven categories on the basis of the 2009 JCR

Subject category	cited years		Price Index
	all	last 5	
Cell biology	576915	220490	38.2%
Physics, particles & fields	398225	145150	36.4%
Engineering, civil	283316	82305	29.1%
Sociology	181660	43901	24.2%
Anthropology	137351	31769	23.1%
Mathematics	389650	78445	20.1%
History & philosophy of science	57873	11486	19.8%

Source: Clarivate Analytics InCites Journal Citation Reports

Thank you very much for your attention!

ECOOM
Centre for R&D Monitoring

KU LEUVEN

FACULTY OF ECONOMICS
AND BUSINESS

EFMD
EQUIS
ACCREDITED



Professor Dr. Wolfgang Glänzel

Wolfgang.Glanzel@kuleuven.be
feb.kuleuven.be/Wolfgang.Glanzel

Researcher ID: A-6280-2008

ORCID: 0000-0001-7529-5198

Scopus Author ID: 7003697821

MR Author ID: 74130