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THE ECONOMICS OF CITATION IMPACT METRICS

Abstract: *The purpose of this paper is to gain a deeper understanding of the nexus between the use of citation counts as a measure of scientific impact, citations as indicator of scientific impact, citation distributions of scientific papers, citation analysis as a tool in journal evaluation, and the validity and reliability of citation counts in research assessments. The mainstay of the paper is formed by an analysis of the extent to which the impact factor indicates the quality of a journal, the biases of the impact factor, excessive orientation towards the impact factor, citation counts and impact factors as quality indicators to judge journals, and the use of the impact factor as a metric of journal status.*

Keywords: *impact factor, citation analysis, journal evaluation, scientific quality*

JEL classification: D83, I23, O3

1. Introduction

Considerable research attention has focused on the impact factor as a marker of quality of articles in certain academic settings, the impact factor's establishment as a crucial criterion of evaluation and achievement, the pressure resulting from the need to publish in high impact factor journals, the potential for abuse and manipulation of the traditional impact factor, and the use of JIFs as the primary measure of research quality. The theory that we shall seek to elaborate here puts considerable emphasis on metric-based assessments of scholarly impact, acceptance of impact factors as an accurate representation of the quality of a paper published in a given journal, the application of the tool of fractional counting of citations to journal evaluation, and the reliance on IF to evaluate scientific quality.

2. The Citation Impact of Research Findings: The Use of Citation Counts as a Measure of Scientific Impact

The IF of a journal gives the mean number of citations received by papers published in that journal (IFs may have an influence on future citations).[1] *Citations to an article during the year in which it was published are never counted in the IF score* (IFs fail to account for skewness in the distribution of citations).[2] The IF may be viewed as a measure of prestige of a journal and indirectly of authors publishing in those journals. Self-citation beyond 20% is suspect of abuse (the journal's IF is higher and prestige enhanced by self-citation). Excessive self-citation may cause a large shift in a journal's IF. Self-citation may substantially affect a journal's IF com- pared with IFs of other journals in the same specialty, and can bias how a journal is perceived.[3] The ISI IF and the citation data on which it is based enjoy widespread acceptance (the IF is the mean citation rate of articles published in a particular journal over a 2-year period). Usage of scholarly resources as recorded by digital information services is a means to study the scholarly community. Considerable deviations can occur between impact as it is perceived by particular scholarly disciplines and the ISI IF.[4] The Journal Impact Factor (JIF) counts the number of citations received, but ignores any information about the sources of those citations. The scientific literature is a network of scholarly articles, connected by citations. The ranking of journals should be done solely with the aim of improving our ability to search and do science (citation analysis, cannot be a substitute for critical reading and expert judgment).[5]

The citation rate of a journal is quantified as its impact factor (the impact factor is a good technique for scientific evaluation). A journal's impact factor is based on the numerator, which is the number of citations in the current year to any items published in a journal in the previous 2 years, and the denominator, which is the number of substantive articles published in the same 2 years.[6] Impact is primarily a measure of scientific utility, originality and merit determine the quality of an article, whereas journal impact factor (IF) is the indicator for a journal's perfor- mance. Reduction in publication lag time increases IF, and free FUTON (full text on the net) increases the IF and enables rapid dissemination (online availability of full text articles increases circulation and readership of the journal, and increases the IF). Upcoming journals encourage open access without any subscription fee. Citation indicates an article has influenced scientific community. Reduction in the number of citable articles in denominator increases IF (editors should restrict the number of review and original articles). Reviews are an amalgamation of several original works of a topic in depth. Publication in a high impact journal may enhance the impact of the article.[7] The academic publication process should remain transparent and impartial to biasing influences.[8]

The journal impact factor has become the common currency of "scientific quality," assessing the citation rates of articles within a journal rather than of any given article (the range of impact factors reflects approximately the scientific standing of a journal). Impact factors are the best currently available measure, but do not reflect fully the perceived quality of the journal (the fact that impact factors are used to assess quality of output distorts the pattern of submissions). Journal

impact factors reflect the journal rather than the article, journal impact factors will vary with time in both absolute numbers and rankings, impact factors say nothing about the stringency of the peer review process, editors may take into account the future citation rates of a manuscript in deciding whether to offer publication, impact factors may be manipulated by both authors and editors (a high rate of self-citing can affect the impact factor, whereas mini-reviews can attract citations rapidly and in large numbers), and greater availability of the journal can increase the impact factor substantially.[9]

The distribution of IFs of articles within a journal is skewed (giving articles the average citation value of the publishing journal does not reflect their actual citation rates), individual articles' citation rates determine the IF, and the use of citation analysis and IFs has become a surrogate measure of research quality (authors are often judged and funded based solely on the number of publications in "high-impact" journals).[10] The IF says nothing about a quality or popularity of an article: calculating a personal impact factor provides an accurate measure of an individual's citation rate.[11]

The measuring of the IF and its use as a scientometric indicator for research evaluation purposes reflect on the measuring instrument and influence the area that the IF claims to measure. The quality of the article plays a central role in the hierarchy of influencing factors: the IF is promoted to the status of preferred characteristic of a journal selected for publication, and may be an indicator of the assertive potential of a journal but not of its quality.

The IF may be interpreted as an indicator of the quality of a journal because of the correlation between a high rejection rate of manuscripts submitted to journals and a high IF (reasons given for rejection may be associated with the degree of specialization of the submitted manuscripts and the journal's target readership). *The long-term outcome of the reflexivity of the IF is a shift in the journal's structure and content*. A high IF ensures that good-quality studies are submitted, and forms the basis for an increasing circulation, and higher advertising revenue. The quality of an individual article cannot be assessed with reference to the IF of the journal (there are complex relationships between the quality and results of a study and publication bias).[12]

3. The Citation Impact of Research Findings: The Use of Citation Counts as a Measure of Scientific Impact

Unquestioning subservience to the citation or impact factor "game" within the research community may change the nature of academic scholarship. Citation rates and impact factors do not necessarily equate with the uptake of research findings. The growing hegemony of publication outputs encourages a number of abuses within the publication process.[13] Author self-citations affect the impact factor of a journal. When examining the contribution of authors' self-citations to impact factors one should first count the number of citations in the text, and then discriminate between different kinds of author self-citations.[14]

Author self-citation refers to citing one's previous publications in a new publication, allowing an author or group to expand on previous hypotheses,

referring to established study designs and methods, and justifying further investigations on the basis of prior results. Citations build connectivity between publications, but *self-citations, when pervasive, might falsely validate the conclusions of an author or group*, and may artificially inflate an article's importance to the general scientific community.[15] The evaluation of research worldwide depends on a measure of citations to journals. Publishing in journals with high IF has become important for hiring scientists, grants, and promotion, although *the IF is a highly polemic metric*.[16]

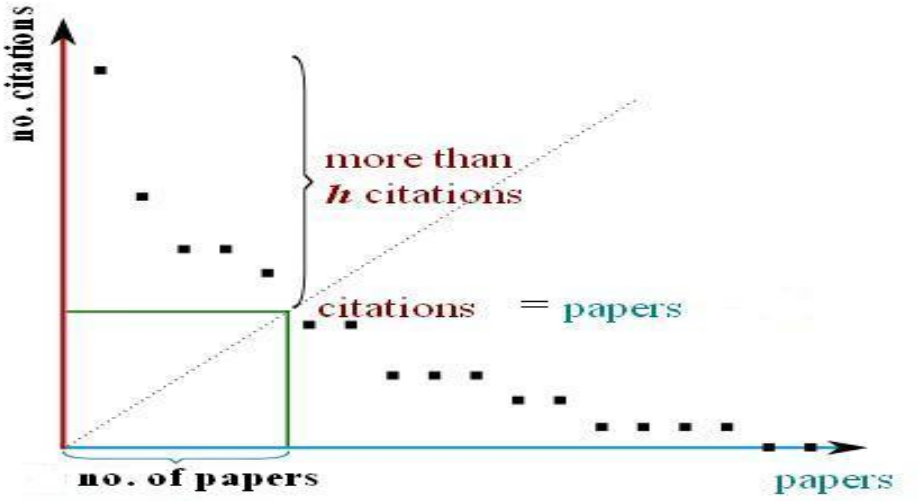
The balance between objective experiment and subjective imagination can vary enormously (science is to be favored when subjective imagination is kept in check): *self-citations are an integral part of the way we advance in science, and less self-citation rates and more international cooperation produce better science*.[17] The citation counts of the publications correspond with the authors' own assessments of scientific contribution (citations have the highest accuracy in identifying either major or minor contributions, but they are not a reliable indicator of scientific contribution at the level of the individual article). In the construction of relative citation indicators, the average citation rate of the subfield is more appropriate as a reference standard than the journal citation rate (review articles are cited more frequently than other publication types).[18] The influence of an author can be measured by the number of citations to the author in published articles in the field.[19]

Documenting citation trends may establish benchmarks for citation impact by career stage, add to metrics for comparing programs as complements(or alternatives) to reputation ratings, and identify high-impact articles, scientists and programs. Number of works published, prestige of the outlets in which they were published, and number of times the works have been cited are indicators of scientific impact. Citation counts are influenced by factors other than scholarly merit: there are different citation patterns across fields, and low citation counts are ambiguous indicators of scientific impact. *Any citation (pro or con) may be evidence of impact and influence on the accumulation of knowledge*. Articles can influence thinking and subsequent research without being cited regularly, one heavily-cited article may overwhelm the impact of the entire corpus of works, getting articles or books published is more an indicator of productivity than impact, and for programmatic research, self-citation is a meaningful indicator of impact. Citation impact metrics represent only part of scientific impact and quality as citation impact is one aspect of how academic scientists contribute to knowledge, although it is valid, relatively objective and straightforward to compute.[20]

The Hirsch spectrum(*h*-spectrum) is a tool that is derived from *h* and defined as the distribution representing the *h*-indexes associated to the authors of a specific journal, in a specific interval of time (this distribution provides an image of the author population of one journal for a period of interest). The *h*-index for journals is calculated taking into consideration the articles published by a specific journal in a precise time period. The citation accumulation process of the papers requires a certain amount of time to become stable (*h* for journals is not suitable to evaluate the most recently published journals).

The academic reputation of a journal's author group is not the equivalent of the reputation of the journal. *h*-spectrum represents a different way for evaluating and comparing the reputation of journals (*h* is the most suitable indicator for the construction of a journal-spectrum), and a "snap-shot" of the author population of a specific journal. *h*-spectrum can be a reliable tool for evaluating a journal at the very moment of the publication, and is related to the reputation of one journal's authors, whereas ISI-IF is related to the citations effectively accumulated by one journal's articles. The *h*-spectrum provides a reference for the (potential) authors of a scientific journal, performs rough comparisons between different journals within the same scientific field, and helps a journal's editorial staff to periodically monitor the effect of the paper selecting policy.[21]

Figure 1. H-index for the number of publications and the number of citations per publication



Source: Adaptation of H-index for publications

4. Case Study: Addleton Academic Publishers, New York

Addleton Academic Publishers is a US-based academic publishing house located in New York, NY. It is best known for its academic books and journals of high quality on a wide range of subjects, primarily in the humanities and social sciences, listed in first-rate international databases such as Scopus, ProQuest, IBSS, EBSCO, Cabell's, etc. In spring 2011, SAGE was interested in purchasing all Addleton journals. SAGE (Thousand Oaks, CA) is a leading international publisher of journals (630+), books, and electronic media for academic, educational, and professional markets. Addleton Academic Publishers is partner of DeepDyve – the largest online rental service for professional and scholarly research articles, aggregating millions of articles across thousands of journals from the world's leading publishers, including Springer, Nature Publishing Group, Wiley-Blackwell and more. We have selected 7 Addleton journals for our investigations and

calculated their authors' h-index average value, their acceptance rates, and their citation rates. The citation statistics have been collected using Google Scholar, all the databases in **Table 1**, and Contemporary Science Association Databases (an aggregator associated with Addleton AP) as search engines. We have identified a positive correlation between the frequency of the journals, the relevance of indexing services, and the authors' h-index average value (**Table 1**).

Table 1. List of selected journals and their authors' h-index average value

Journal name	Acronym & Frequency	**Outstanding indexing services**	**The authors' h-index average value**
Economic, Management and Financial Markets	EMFM (4 times a year)	Business Source Complete, Cabell's, CEEOL, DeepDyve, EBSCO, EconLit, Gale, IBSS, Index Islamicus, ProQuest, Ulrich's	6.23
Linguistic and Philosophical Investigations	LPI (once a year)	CEEOL, DeepDyve, EBSCO, Gale, ProQuest, Ulrich's	2.24
Analysis and Metaphysics	AM (once a year)	CEEOL, DeepDyve, EBSCO, Gale, Humanities International Complete, Humanities International Index, Index Islamicus, ProQuest, The Philosopher's Index, Ulrich's	2.36
Contemporary Readings in Law and Social Justice	CRLSJ (2 times a year)	Academic Search Complete, Cabell's, CEEOL, DeepDyve, EBSCO, Gale, HeinOnline, IBSS, Index Islamicus, Legal Collection, ProQuest, Scopus, Ulrich's	4.47
Journal of Research in Gender Studies	JRGS (2 times a year)	CEEOL, DeepDyve, EBSCO, Gale, HeinOnline, Index Islamicus, ProQuest, Ulrich's	1.98
Review of Contemporary Philosophy	RCP (once a year)	CEEOL, DeepDyve, EBSCO, Gale, Humanities International Complete, Humanities International Index, Index Islamicus, ProQuest, Scopus, The Philosopher's Index, Ulrich's	2.98
Geopolitics, History, and International Relations	GHIR (2 times a year)	CSA Worldwide Political Science Abstracts, CEEOL, DeepDyve EBSCO, Gale, IBSS, Index Islamicus, IPSA, Index Islamicus, Political Science Complete, ProQuest, Ulrich's	3.78

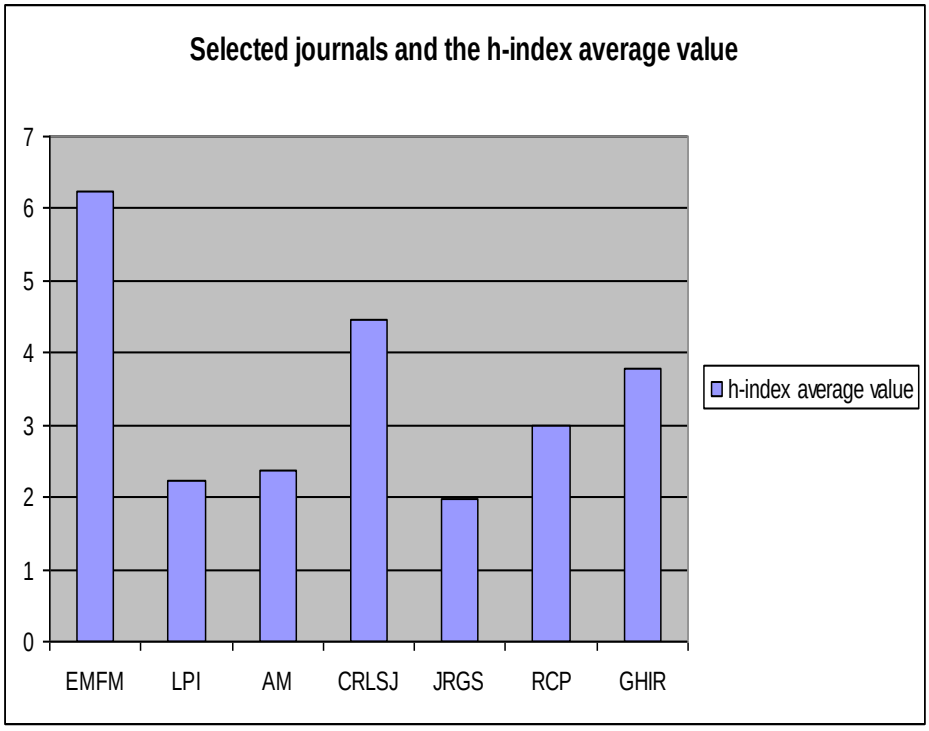
Source: Addleton AP reports and authors' own calculations

From the data presented above we could observe that the h-index average value is positively correlated with the frequency of the journals: the most important one

is EMFM (6.23) with a frequency of four times a year and the less significant ones are the most recent journals and the ones that are published once or two times a year. For example, LPI and AM are published just once a year, CRLSJ and JRGS are published two times a year.

We also have identified a positive correlation between the evolution of the journals, their acceptance rates (**Table 2**) and their citation rates (**Table 3**).

Figure 2. Selected journals and their authors' h-index average value



In Table 2 we could observe the evolution of acceptance rates for different journals, for example EMFM's acceptance rate was 37.65% in 2006 and 21.67% in 2012, whereas LPI had an acceptance rate of 34.26% in 2006 and 19.34% in 2012. Also, AM, has an acceptance rate of 29.44% in 2006 and 18.45% in 2012, but RCP has an acceptance rate of 28.65% in 2006 and 22.28% in 2012.

Thus, the acceptance rates are positively correlated with the evolution of the journals:

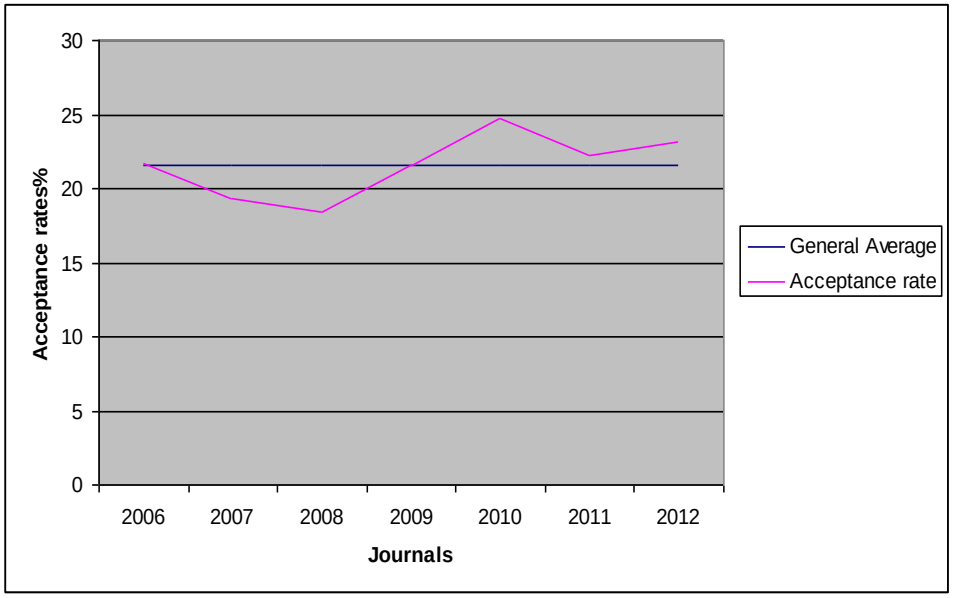
Table 2. List of selected journals and their acceptance rates

Journal	Acceptance rates (%)						
	2006	2007	2008	2009	2010	2011	2012
EMFM	37.65	32.22	26.45	24.34	23.47	22.49	21.67
LPI	34.26	32.15	28.48	25.54	22.18	21.30	19.34
AM	29.44	27.33	25.98	24.03	22.14	20.77	18.45
CRLSJ	x	x	x	28.67	24.65	23.11	21.55
JRGS	x	x	x	x	x	26.65	24.76
RCP	28.65	27.15	26.67	24.33	23.16	22.78	22.28
GHIR	x	x	x	27.23	25.64	24.11	23.18

Source: Addleton AP reports and authors' own calculations

The general average for accepted papers is 21.60%, but most of the journals have the acceptance rate around 20%, whereas the highest rate is for GHIR with 23.18%. (Figure 3)

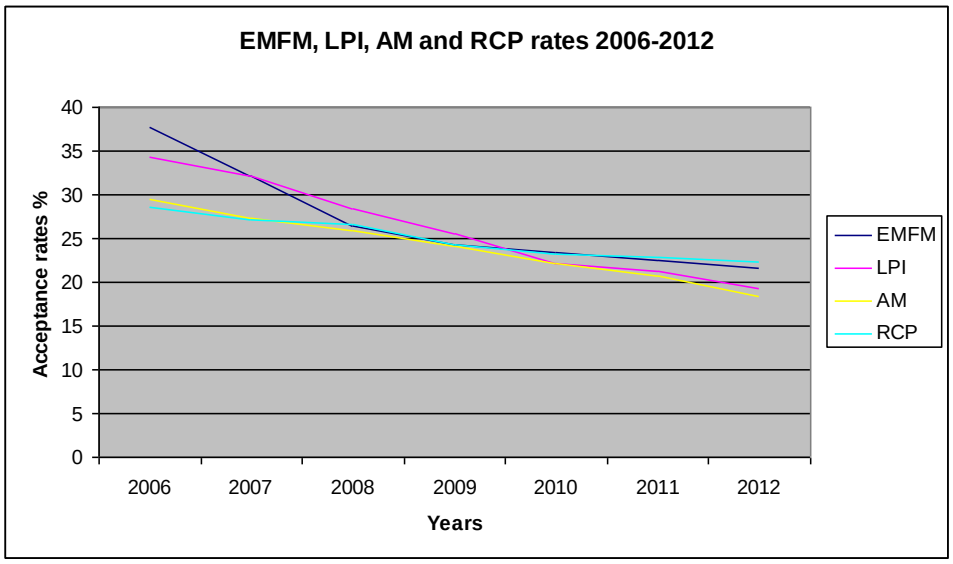
Figure 3. Acceptance rates for papers in Addleton journals



The oldest four journals presented in Figure 4 have a similar evolution regarding their acceptance rates for 2006-2012. Thus, EMFM started with 37.65% acceptance rate in 2006 and ended with 21.67% in 2012, the second journal LPI

started with 34.26% acceptance rate in 2006 and ended with a rate of 19.34% in 2012, the third journal AM indicated 29.44% in 2006 and 18.45% in 2012. The last journal presented in Figure 4 is RCP with a 28.65% rate in 2006 and 22.28% in 2012.

Figure 4. Evolution of the acceptance rates for Addleton journals 2006-2012



In Table 3 we noticed that EMFM recorded a citation rate of 2.34% in 2006 with a positive evolution every year and in 2012 the citation rate reached 12.42%. LPI recorded a citation rate of 1.92% in 2006 and after a positive evolution at the end of 2012, the citation rate reached 6.36%. The most outstanding evolution of citation rates rate was recorded by CRLSJ, from 3.42% in 2009 to 10.14% in 2012.

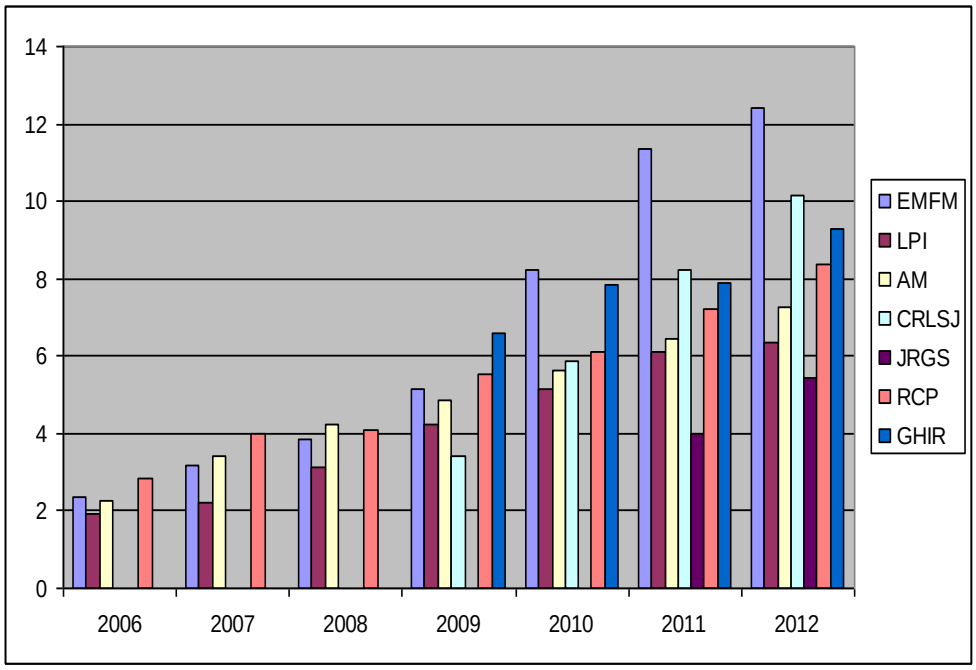
Table 3. List of selected journals and their citation rates

Journal	Citation rates (%)						
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
EMFM	2.34	3.16	3.84	5.14	8.25	11.35	12.42
LPI	1.92	2.23	3.14	4.25	5.15	6.12	6.36
AM	2.26	3.40	4.23	4.88	5.64	6.45	7.25
CRLSJ	x	x	x	3.42	5.89	8.22	10.14
JRGS	x	x	x	x	x	3.97	5.42
RCP	2.85	3.98	4.11	5.53	6.13	7.22	8.37
GHIR	x	x	x	6.57	7.82	7.88	9.29

Source: Addleton AP reports and authors' own calculations

The evolution of citation rates is presented in Figure 5 for all the journals, and EMFM has the most significat citation rate at the end of 2012 (12.42%), followed by CRLSJ, with 10.14% citation rate.

Figure 5. Citation rates for Addleton journals 2006-2012



5. Metrics of Journal Performance that Involve an Analysis of Citation Frequency

Increased potential audience does not necessarily imply a greater number of citations, experience and prestige affect the number of references in a given publication, and authors use fewer references in their writings as they become more experienced.[22] *The influence of a prestigious journal may reach down all the way into specialties to the level of strategic interventions* (the citation networks among journals contain both a hierarchical stratification and a network structure). The positions of individual journals on the borders between specialties remain difficult to determine with precision. Fractional counting of the citations may solve the problem of normalization among different citation practices (one can normalize the IFs using fractionated citation counts).

The distributions resulting from fractional counting of the citations may be comparable among fields of science (differences in citation potentials cannot be used statistically to distinguish among fields of science).[23] The percentage of reviews (PR) has increased with time, and it varies substantially with major

scientific field and by country. The Science Citation Index (SCI) is subject to various errors, such as statistical variation and inequality of basic parameters. Citations may be misleading especially when the parameters of the target and norm groups are not the same.[24] The number of Nobel Prize achievements can be used as a criterion of validation, whereas conventional bibliometric indicators such as number of papers and citations, and share of top 1% of highly cited papers cannot be validated. The high-citation tail of the citation distribution holds the information about the research level of countries and institutions (the shape of the tail may be of crucial importance to quantify research performance).[25]

The universality-of-citation-distributions claim has less validity when shorter time periods are used for counting citations. Fields with a relatively low average number of citations per publication have non-universal citation distributions (deviations from the universality of citation distributions can only be partly explained by random effects). Claiming citation distributions to be universal for all fields of science is not warranted, whereas the universality claim becomes more justifiable when uncited publications are excluded from the analysis.[26] The journal in which an article is published is a key determinant of the dissemination of results. Citations are determined by many factors other than quality: they may be selected because of their accessibility in electronic databases, scholars may select the articles they cite because they have a professional interest in promoting a given line of research, or because of the utility of a citation to support a particular opinion, or to influence peers or decision makers, an article may be cited because it is written by a productive research group whose members often cite each other, or because it was published in a first-rate journal. The concentration of citations on a small number of articles may be explained by the practice of extracting citations from reference lists in other articles (an article that was ever cited is more likely to be cited again). Journals may obtain a high impact factor by the frequent citation of a limited number of their articles only. An article can be cited because it makes unacceptable or provocative claims that need to be refuted. The impact factor is not corrected for self-citation, and should not be used to assess the quality of individual articles or the output of research groups or of individual researchers.[27] Good science requires a more proactive role from editorial offices. An impact factor should rely only on complete and correct citations, *reinforcing quality control through the whole journal publication chain*.[28]

The author selects a journal on the basis of traits such as journal impact factor, likelihood of acceptance, and likelihood of rapid decision. The likelihood of rejection increases with increasing journal impact factor (the probability of rejection is a function of the quality of one's paper). The number of papers published may be a driver of impact, impact factor itself may be a driver of rejection rate, and rejection rate may be the driver of impact.[29] Publication success of the reviewer and scientific age relate to the reported rejection rates recommended by reviewers (variation in rejection rate by reviewer attributes represents a potential reviewer bias): *selection of referees should be balanced on a per manuscript basis by publication record in the top-tier journals* (novelty is a key element required for publication in top-tier journals). Peer review improves science and gives our work credibility, whereas the selection of a given reviewer

can affect the fate of a paper.[30] Research quality is usually rated by the size of the publication audience or readership. Highly regarded studies end up in the relatively few top-ranking journals. Rigorous self-assessment can enable researchers to arrive at a reasonable estimation of the relative merit of their work. A lower ranked self-assessment probably does not mean a lower probability of publication.[31] High citation counts may not always equal scientific excellence (the global scientific importance of super-cited papers *remains somewhat contentious*). Editors have often sought ways to manipulate their own journal's score: a journal can encourage its authors to cite other articles previously published in the same journal, another technique used for increasing the impact factor is the review article (a journal can choose to publish a higher proportion of literature reviews compared to original research articles), a journal may choose to focus on research topics that naturally generate a high number of citations, journals may choose to publish articles that are particularly controversial or deal with inherently controversial issues, whereas the publication of a journal's entire contents online, for free, represents another strategy. Open access to scientific literature online offers substantial benefits for the scientific community: free online access facilitates the dissemination of scientific information via email links or discussion groups, and free access addresses an equity issue for countries that cannot afford expensive journal subscriptions. Impact factors represent a major consideration for the scientific community, striving for outstanding impact factor is understandable in today's competitive publishing environment, the ideal way to increase one's impact factor is to attract and publish better material, whereas the advent of an impact factor marked a turning point in the global development of scientific publication and referencing systems.[32]

6. Conclusions

The results of the current study converge with prior research on the strengths and weaknesses of the impact factors, metrics of journal performance[33] that involve an analysis of citation frequency,[34] IFs as the primary criterion in assessing research quality,[35] and the misuse of the impact factor to evaluate a researcher's career. The findings of this study have implications for IFs as scientific quality measures of journals,[36] the direct correlation between the scientific quality[37] and citation count of an article, the determination of impact[38] through the use of bibliometric measures,[39] and the use of citations for assessing research impact[40] or quality.
We presented several results of a research performed for Addleton Academic Publishers located in New York: we selected a number of significant journals and we identified a positive correlation between the frequency of the journals, the relevance of indexing services, the evolution of citation rates, the rhythm of acceptance rates, and the authors' h-index average value.

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