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Abstract: While the journal impact factor was originally developed to help librarians decide which journals to subscribe to, it has been increasingly used for the evaluation of the performance of individual researchers. The reasons why this practice should never be encouraged are reported in this study based on a literature review. This manuscript presents a critical overview on the international use, by governments and institutions, of the journal impact factor and/or journal indexing information for the assessment of individual researchers. The criticism on this practice is also illustrated through comments provided by Nobel laureates and others. This paper then proposes a rational method for evaluating researchers. As such, this work proposes an improved context for the use of the journal impact factor, so that this metric can be used for the right purpose.

Keywords: indexing databases, journal impact factor, research quality, publications, scientometrics

Uso y abuso del factor de impacto de revistas para evaluar investigadores

Resumen: Si bien el factor de impacto de las revistas se desarrolló originalmente para ayudar a los bibliotecarios a decidir a qué revistas suscribirse, se ha utilizado cada vez más para la evaluación del desempeño de investigadores. Las razones por las que esta práctica nunca debe fomentarse se informan en este estudio basado en una revisión de la literatura. Este manuscrito presenta un panorama crítico sobre el uso internacional, por parte de gobiernos e instituciones, del factor de impacto de las revistas y/o la información de indexación de las revistas para la evaluación de investigadores individuales. La crítica a esta práctica también se ilustra a través de comentarios proporcionados por investigadores reconocidos internacionalmente. A continuación, este artículo propone un método racional para evaluar a los investigadores. Como tal, este trabajo propone un contexto mejorado para el uso del factor de impacto de las revistas, de modo que esta métrica pueda usarse para el propósito correcto.

Palabras clave: indexación de bases de datos, factor de impacto de las revistas, calidad de la investigación, publicaciones, cienciometría.

1. Introduction

The Journal Impact Factor (JIF), calculated by Clarivate Analytics (previously intellectual property of Thomson Reuters), was originally proposed by Sher and Garfield in 1963 [1] as a tool to help librarians identify journals worth purchasing and allowing for interdisciplinary comparisons [2]. The JIF is annually determined per journal as follows:

$$JIF_{year\ n} = \frac{\#\ \text{WoS citations in year } n \text{ to papers published in years } (n\text{-}1) \text{ and } (n\text{-}2)}{\#\ \text{papers published in years } (n\text{-}1) \text{ and } (n\text{-}2) \text{ in journal}} \quad (1)$$

where '# WoS citations' is the number of citations from articles published in journals indexed by Web of Science. A similar metric is the 5-year impact factor (IF), based on five years (instead of two) prior to year *n*. Clarivate Analytics [3] mentions: "the JIF is a journal-level metric, thus it does not apply to individual or subgroups of papers published in the journal, nor to authors of papers, research groups or institutions." Regardless, in many cases, the JIF has become a tool for judging the quality of a journal and, by extent, of the authors publishing in a journal [4, 5]. This metric was published until 2000 on a CD-ROM, which was only used by experts for analysis. Since its publication online in 2002, the metric, however has been misused increasingly [6]. In fact, based on an empirical survey, no relation between the prestige of journals as perceived by peers and the JIF could be found, resulting in the conclusion that the JIF is a poor indicator for journal prestige [7]. Instead, it appears to be more a metric of the assertive potential of a journal.

This article reviews the current use of the JIF for the research evaluations from an international perspective, the criticism on this practice, and proposes a more holistic approach for the evaluation of researchers based on a set of metrics and peer review. The preprint [8] contains additional bibliometric proposals for the interested readers. In the ever-evolving and international landscape of science, we consider it necessary to address the misuse of journal metrics for the evaluation of researchers, and to keep searching for improvements, with the goal of developing fast yet fair evaluation practices.

2. International use of the JIF and indexing information as quality measures for researchers

Deans, sponsors, government agencies, and employment panels use the JIF as a convenient, yet flawed, performance measure [9], and the JIF is increasingly used in tenure and promotion decisions, where tenure depends on publications in journals with a high JIF [10]. Pudovkin [11] mentions that recruitment committees typically just look at the journal titles on the resume of an applicant. In many universities in non-English-speaking countries, only papers in WoS-indexed journals count in hiring as well as tenure and promotion decisions [12]. In what follows, several examples are given of countries and institutions supporting these types of (mis)evaluation. Especially where financial incentives for publications are coupled to the JIF, we find evidence of the JIF distorting the academics' choice of where and what to publish [10].

In the United States and Canada [10], 40% of research-intensive universities and 18% of master's institutions mention the JIF in their review, promotion, and tenure (RPT) documentation. The majority of these mentions were positive – with 87% of RPT documents supporting the use of the JIF for research assessment, 13% expressing caution, and none criticizing this practice strongly. In the RPT documents that mentioned the JIF, the JIF was associated with quality (63%), impact, importance, or significance (40%), and prestige, reputation, or status (20%). The authors concluded that it is necessary to work towards a situation where at research-intensive universities the JIF is not confused with a metric for the quality of a researcher. They also remarked that the JIF features less prominently in RPT documents than previously thought. Despite being published by a private company based in the US and being biased towards US-based publications, the JIF is actually used more in Europe for evaluations and the allocation of funds than in North America [7].

Instituto Superior Técnico, part of the University of Lisbon, considers the JIF quartiles published in WoS and/or Scopus databases to compute a quantitative measure of the scientific performance of its faculty [13]: papers from journals in the 1st (Q1), 2nd or 3rd quartiles are given six, four or two times higher classification than the Q4 counterpart, respectively. IST sometimes disregards or gives less credit to articles not published in Q1/Q2 WoS- [14, 15] or Scopus- [16] indexed journals when hiring faculty.

Ostravská univerzita v Ostravě [17] shows an example in the Czech Republic of a job application requiring a list of publications in WoS-indexed journals and the number of citations provided by that database, meaning that what matters the most is not the content of the publications, but where they are indexed. Furthermore, the inbound citations 'from journals' not indexed in WoS are of no value for that evaluation committee.

Similarly, Spanish law rewards the researchers for publishing in journals that are deemed 'prestigious' by WoS (Q_1, Q_2, Q_3) [18]. In Germany [7], the practice of using the JIF for the evaluation of research and researchers is common, especially for the allocation of research funds and for habilitation decisions. For the allocation of funding in Finland, 1 IF point is considered equal to 7000 USD (reported in 2004) [7].

In Brazil, graduate programs are evaluated with JIFs, by categorizing papers in decreasing journal IF ranges (A1, A2, B1, B2, B3, B4, C) [19]. In 2001, the Brazilian government created a program to affiliate ten doctorates to research centers, and also opened a two-year research fellowship call. The selection criterion for both programs was primarily based on the (i) number of publications and (ii) JIF [20]. A student commented "The adviser doesn´t care about my thesis so much. He believes that a thesis is the consequence of good work, and good work means papers published in good journals" [20].

Chinese policies offering financial reward based on WoS-indexed publications began in earnest in the 1990s, aiming to increase production and international visibility. In some Chinese and Swedish institutions, PhD students should publish at least two articles 'with an average IF' of four to get their degree [5].

In India, recruitment, awards, fellowships and promotions are determined by IF [18].

Researchers in Ecuador [21] are ranked based on their publications, which are categorized as: (i) "Level 1": publications indexed by WoS or Scopus, Q1 or Q2 in Journal Citation Report (JCR [3]) or Scimago Journal Ranking (SJR), (ii) "Level 2": publications indexed by WoS or Scopus, Q3 or Q4 in JCR or SJR, (iii) "Level 3": relevant articles not covered by Levels 1 and 2. For faculty hiring [22] peer-reviewed papers count for 2 points per paper, and a maximum of 4 points, and, additionally, indexed papers count for 2 points per paper for a maximum of 10 points. Ecuadorian universities are ranked based on similar metrics. 74 Ecuadorian academics criticized this practice [23], pointing out that only 242 Latin American journals (out of more than 5000) are indexed in WoS and Scopus, and those typically rank low. We could however argue that the local impact and readership of these journals is important. The metrics result in low ratings for researchers and institutions in the humanities and social sciences. In addition, [7] wrote *"South America, Africa and China, for example, are naturally even more severely affected by this*

development", where "this development" refers to Anglo-American bias of the JIF which will be further discussed in the next section together with the other shortcomings of the JIF.

3. Criticism on the use of the JIF

The (mis)uses of the JIF are well-documented [11, 24], and international applications of the use of the JIF for the wrong purpose (i.e. evaluating researchers instead of journals) were summarized in the previous section. In this section, we look in detail into the reasons why the JIF is not a suitable measure for the quality of a researcher, and highlight some problematic aspects of the JIF itself as well. The main argument against the use of JIF to evaluate scientists is a lack of strong correlation between the value of the JIF and the number of citations of the individual papers published in the journal [25]. Only a fraction of the papers published in a high IF journal receive most citations contributing to the JIF [26], known as the "invitation's paradox" [27]. Seglen [28] reported that 15 and 50 per cent of the most cited papers account for 50 and 90 percent of the citations used to compute the JIF, respectively. Even at the author level, correlation between the article citedness and journal impact level is poor [29]. Moreover, (i) information abounds about classic highly-cited papers that were initially rejected by high IF journals [30, 31], although the rejection rate of high-impact studies varies across journals [32], and (ii) it is suggested that the reproducibility of scientific experiments as well as the methodological soundness and robustness of the experimental design are not related to the JIF [33], and an average lower sample size and statistical power was observed in journals with a higher JIF [34]. The increasing value academia places on a high JIF has led to a authors coveting articles in journals with a high impact factor, and has led publishers to extensively promote their impact factor [10]. The fact that established journals with a JIF are perceived as the most prestigious and as such dominate the publishing landscape, makes it more difficult for authors to embrace open access publishing [10]. Moreover, the following aspects of the JIF itself and its use are problematic [7, 35]: 1) there is a commercial conflict of interest between the company that calculates the JIF and the large publishing houses, and, the interest of these companies is economic and not academic, and authors [7] have criticized the lack of transparency of the WoS in the inclusion or exclusion of source journals. Moreover, journals from these large publishing houses feature too prominently in the database used for calculating the JIF, skewing the JIF towards such journals and disadvantaging learned societies and other similar small publishers; 2) there is a positive bias towards publications in the English language, with over 95% of the included citations from articles in English and North-American journals attracting higher JIFs, as a result of the English and US-centered bias of the JIF. In addition, authors [7] see the loss of German language as a medium for scientific communication, and the ability of German research fields to stand their own is feared to soon be lost. Moreover, some fields such as psychiatry, have an interrelation between the research and the language and scientific culture, so that expressing the findings and work cannot be readily converted to English.; 3) the metric can be manipulated by forcing authors to cite other articles from the same journal; 4) books and contributions to books are not considered, whereas in several disciplines the main findings are brought together in books; 5) conference proceedings are not considered, while in some fields, such as computer science and medical informatics, conference publications are considered the most important; 6) in the numerator of Eq. (1) all citations, including from editorials, letters to the editor, short communications, and conference proceedings, are counted in the numerator, but only articles and reviews are counted in the numerator, so that journals with a large number of editorials etc will have an artificially large impact factor; 7) the traditional JIF only looks at citations from the last two years which results in a bias towards journals that publish research from faster-moving fields and from studies that are carried out over shorter time periods

(so that clinical trials and long-term experimental campaigns are biased against), and this shorter timeframe has resulted in journals putting pressure on editors and reviewers to handle articles in a faster way; 8) journals dedicated to small but active research fields are not able to obtain a larger JIF, since the generated number of citations are lower; 9) in medicine, the use of the JIF results in researchers focusing on basic research and disease-oriented research rather than patient-oriented research, because the former fields generate citations into the latter, resulting in lower JIFs for journals that focus on patient-oriented research; 10) in medicine, the use of the JIF leads to more focus on biomedical basic research with an international impact and less focus application-oriented clinical knowledge for local applications and in psychiatry it leads to more focus on biologic-psychiatric research and less on philosophic-historic approaches; 11) since review articles attract more citations, journals that focus on review articles have a larger JIF, and conversely, case reports and case studies attract less citations and application-based journals have a lower JIF; 12) the use of the JIF has worsened the publication bias towards citeable, positive results and away from negative results; and 13) the impact factor is a reflexive metric: the availability of JIF online influences the quantity the metric aims to measure. As a result, we can observe in some journals a shift in contents and structure to maximize the JIF, not considering if these changes optimize the transfer of information and knowledge in the research community. Moreover, we see an agglomeration of scientific publications towards large publishing houses and the English language, only, and as such we are losing large parts of the diversity of scientific publications. The result of that was expressed by [7] as: "*The ensuing impoverishment of the social discourse in terms of medical knowledge impedes knowledge processes and inhibits the use of medical research findings. Furthermore, confidence in knowledge processes and in (national) science as well as the willingness to show solidarity in funding national research are likely to be affected."*

The 2012 San Francisco Declaration on Research Assessment (DORA) [36] states an article should not be assessed by the JIF. On December 19th 2018 the declaration had received 745 and 13409 online institutional and individual signatures, respectively. These numbers have increased by 28% and 5%, respectively, in 3 months' time, indicating that the declaration remains timely after seven years. All seven research councils of the UK signed DORA in 2018 [37].

Many agree that the IF is not a reliable instrument for evaluating researchers [38-40]. van Raan, said [41]: "*If there is one thing every bibliometrician agrees, is that you should never use the JIF to evaluate research performance for an article or an individual – that is a mortal sin*". Other bibliometricians echo this statement [42].

Table 1 shows criticism of Nobel laureates on the obsession with the JIF to illustrate the observations from this section. This selection of opinions was selected because of their wide availability to the public (YouTube videos) as compared to pay-walled scholarly publications. Schekman, (2013, medicine), said his lab would no longer submit to Nature, Cell, and Science, which are distorting the scientific process and represent a 'tyranny' that must be broken, criticizes restricting the number of accepted papers, and using the JIF as a marketing metric [43].

Table 1. Opinions of Nobel Laureates about the importance placed on JIFs.

Nobel Prize Winner	Field, Year	Question	Quote	Facts and Video Refs

Michael Brown	Medicine, 1985	What do you think of the emphasis placed on IFs?	It's become so bad… when recruiting you should not replace your judgement by some editor's.	[44, 45]
Joseph Goldstein	Medicine, 1985	Is it important to publish in high impact journals?	What counts is really the data. Any great paper is going to be found and read, no matter where it's published.	[46, 47]
Peter Doherty	Medicine, 1996	How important is the JIF?	A lot of people just die to get their paper in Nature and so forth… I don't really care. Don't be too obsessed with this whole status thing… a lot of it is a waste of time.	[48, 49]
Paul Nurse	Medicine, 2001	How can you judge the quality of a researcher?	There's a lot of rubbish published in high profile journals. Some people are not publishing in the highest profile journals because they are in advance of anybody else.	[50, 51]
Martin Chalfie	Chemistry, 2008	What do you think of IFs?	I can categorically say I hate IFs! We've used IFs as a way to judge people, and I think it's horrible. I visited two institutions in Europe and the first thing they told me was the number of papers in high IF journals – they didn't tell me anything about the research.	[52, 53]
Bruce Beutler	Medicine, 2011	Is it important to publish in top journals?	It's quite secondary where you publish, to some degree. The IF really isn't that important. What's important is that you develop an area of science, you make progressive discoveries, and you earn a reputation for solid work.	[54, 55]
Brian Kobilka	Chemistry, 2012	What do you think of IFs?	I'm really worried about the impact of IFs in deciding whether you are a good scientist or not. If you do good work, it will be recognized and will be cited, no matter where you publish.	[56-58]

4. Proposal for the evaluation of researchers

As shown earlier, using the JIF as a measure for the quality of a researcher does not lead to a fair assessment. For a thorough evaluation, a combination of bibliometric indices (such as the newly developed qualitative rating system for researchers [59]) combined with the expert opinion of a committee of peers is recommended [11, 24] – such analyses can be called a "*multidimensional performance-evaluating and performance-stimulating processes*" [7]. The correlation between

the metrics and peer review by experts depends on the field of study [60], and was relatively weak in a case study in Norway [61]. Therefore, the contents of the work of a researcher should be reviewed, across his/her publications and other scholarly activities (conference organization, peer review activities, collaborations with other researchers, participation in technical committees, supervision of students' research projects…). In addition, these evaluation criteria should be clearly communicated to candidates. Carrying out a full review of a researcher's scholarly profile is considered time-consuming, especially for a larger number of applications, but new applications of AI [62] could be extended to assist search committees with the generation of reports. Similarly, Moed [24] suggests the development of an online application that compiles different sources of data to evaluate researchers. When it comes to evaluating the publications of the researcher who is evaluated, a better measure for the quality of a paper could be its number of citations [4, 63-65].

Moreover, in the authors' opinion, hiring decisions should not depend solely on performance metrics, but should include –depending on the position- an interview, a sample lecture, and an analysis of the skills and suitability of the candidate for the position [66]. In such a situation, the hiring committee should consider if the skills of the candidate are complimentary to his/her future colleagues, and how the evaluated researcher would fit in the working environment.

Based on the previous considerations, our proposal for a balanced evaluation of researchers can be summarized to the following five aspects: 1) bibliometric analyses to make an overview of all scholarly output of the researcher; 2) evaluations by peers; 3) citation analysis which allows to frame the researcher's work within the context of the field of study; 4) other scholarly activities, where service to the profession, academia, and peer review activities are considered; and 5) an analysis of how the investigator contributes to the local group/environment, to see if the skills of the researcher are a good fit for the group.

The first aspect, the bibliometric analyses, could potentially be carried out with the assistance of an algorithm, and should consider the following aspects: 1) the number of peer-reviewed publications; 2) the citations of the peer-reviewed publications, excluding self-citations [4, 63-65]; 3) bibliometric indices such as the author's h-index [67] from different aggregator websites (Scopus, Google Scholar, World of Science), platinum h-index [68], and f^2-index [59]. In this analysis, it is important as well to differentiate between papers with the candidate as sole author and collaborative writing. The second aspect, the peer evaluation, is a broader and more individual evaluation of the researcher's profile, and can consist of the following aspects: 1) reading a selection of articles written by the researcher; 2) analysis of depth and breadth of topics the researcher has worked on, as a function of the career stage; 3) funding obtained and projects led; and 4) development of patents, instruments/sensors, surgical techniques and other "artifacts" not captured by publications. The third aspect, citation analysis, is of a more qualitative nature than the first aspect. For this aspect, it's important to look at the citing sources of the articles by the author to assess the impact of the works of the author on the field. This analysis aims to answer the question: "Which further developments, inventions, and practical application were instigated by the work of the researcher?". The fourth aspect, other scholarly activities, gives an idea of the engagement of the researcher with his/her field of study, and should consider the following: 1) service to the profession, which consists of participation in technical committees, scholarly societies, industry advisory panels, and other volunteering contributions to the profession; 2) service to academia, which consists of the participation in university committees; 3) peer review activities, where it should be evaluated if the researcher takes a fair share of reviewing work by

looking at the ratio of number of reviewed articles to number of published articles; 4) editorial activities on journals and books; 5) conference organization, including participation in scientific committees of conferences and organization of sessions. Finally, the fifth aspect, evaluating the fit of the researcher in the group or environment, is arguably the most difficult to judge from a typical application for an academic position. However, past experience may give some information here regarding skills the researcher possesses or not, as well teaching experience, leadership experience, and other parts of the profile that are not expressed in bibliometric data.

Using these five aspects, a search committee can evaluate the overall suitability of a candidate, after which the candidate can then be invited for a campus visit and trial lecture. This procedure in fact resembles some more traditional hiring practices in academia, which over the past decade(s) have sometimes been replaced by more IF-based approaches.

5. Summary

This paper showed the original intention of the journal impact factor, and how it is nowadays used internationally for evaluating the quality of individual researchers. Many academics have criticized this practice. To improve the evaluation of researchers, ideas for a more balanced evaluation based on a variety of metrics, peer review, and skillsets are presented. The goal of this article is contributing to the discussion on how to achieve a more sustainable academia, with a focus on the international context.

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Data availability statement
No datasets are generated for this work.

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