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Measuring journal performance for multidisciplinary research: An efficiency perspective

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ABSTRACT

One of the flaws of the journal impact factor (IF) is that it cannot be used to compare journals from different fields or multidisciplinary journals because the IF differs significantly across research fields. This study proposes a new measure of journal performance that captures field-different citation characteristics. We view journal performance from the perspective of the efficiency of a journal's citation generation process. Together with the conventional variables used in calculating the IF, the number of articles as an input and the number of total citations as an output, we additionally consider the two field-different factors, citation density and citation dynamics, as inputs. We also separately capture the contribution of external citations and self-citations and incorporate their relative importance in measuring journal performance. To accommodate multiple inputs and outputs whose relationships are unknown, this study employs data envelopment analysis (DEA), a multi-factor productivity model for measuring the relative efficiency of decision-making units without any assumption of a production function. The resulting efficiency score, called DEA-IF, can then be used for the comparative evaluation of multidisciplinary journals' performance. A case study example of industrial engineering journals is provided to illustrate how to measure DEA-IF and its usefulness.

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1. Introduction

Measuring journal performance has been a matter of concern for science policy makers as well as various stakeholders in academia, such as librarians, researchers, and editors. Undoubtedly, the most commonly used measure of journal performance or quality is the journal impact factor (IF), published annually in the Journal Citation Reports (JCR) produced by Thomson Reuters. The use of the IF as an indicator of journal quality is underlain by the assumption that citation frequency accurately measures a journal's importance to its end users (Saha, Saint, & Christakis, 2003). Due to its comprehensibility, robustness, simplicity, and availability, the IF has been increasingly popular and widely used for various purposes (Franceschet, 2010): librarians make subscription decisions under limited funds by referring to journals' IFs; researchers are eager to submit their work to journals with a high IF; editors and publishers of journals with a favorable IF employ it as a means of advertising their journals; universities adopt the IF as a criterion for the promotion and tenure decisions of their faculty members; and governmental funding boards judge scientists for grant allocation based on the IF (Cameron, 2005; Dong, Loh, & Mondry, 2005; Sombatsompop, Markpin, & Premkamolnetr, 2004).

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However, the deficiencies of the IF have also been extensively reported in previous studies (Amin & Mabe, 2000; Archambault & Larivière, 2009; Bordons, Fernández, & Gomez, 2002; Cameron, 2005; Dong et al., 2005; Glänzel & Moed, 2002; Ha, Tan, & Soo, 2006; Seglen, 1997; van Leeuwen & Moed, 2002). The use of the IF has been criticized from four points of view: representativeness, coverage, operational definition, and field-dependency. Firstly, the IF of a journal is not statistically representative of individual articles published in the journal. Seglen (1997) found that the most cited 15% of the articles account for 50% of the citations, and the half of the articles account for 90% of the citations. Since the IF only measures average article citation rates, it cannot be used as a measure of individual articles. The second issue is associated with the narrow coverage of the database used to calculate the IF. Web of Knowledge provided by Thomson Reuters currently covers about 12,000 journals which is less than 10% of all journals throughout the world (estimated as 126,000 in Seglen (1997)). The database has also a preference for English language American journals. Books are not even included as sources in the database even though a substantial fraction of scientific output is published in the form of books. Thirdly, the IF has some technical problems with its operational definition. The IF of a journal is defined as the average number of citations received per paper published in the journal in a given year during the two preceding years (Garfield, 1955). One of the problems is the article types included in the numerator and the denominator are not consistent. Only citable items such as articles, notes, and reviews are included in the denominator while the numerator contains citations to all types of publications including editorials, letters, and meeting abstracts. The composition of types of articles also influences on the IF since reviews are more likely to be cited than original research papers. Inclusion of self-citations in the numerator is also controversial, and this will be further discussed later. Another important operational issue is the two-year citation window. A strong temporal bias may occur under such a short time frame because faster publication will likely result in higher IFs. A field with short publication lags enjoys high portion of citations to recent articles, which leads to higher IFs. The short window is one of the main reasons causing the significant field-to-field variation of the IF, combined with different citation dynamics which will be discussed right after.

The fourth issue is field-dependency of the IF, which is exactly what this study seeks to resolve. The level of the IF significantly differs across research fields and subject areas. The variation is mainly attributed to different citation densities and citation dynamics across fields (Dong et al., 2005; Seglen, 1997). Citation density—the mean number of references per article—varies considerably from field to field. It is well known that the IF is a function of citation density in a research field; thus, a field that has higher citation density is likely to have a higher IF (Garfield, 2006). Articles in rapidly growing fields such as biochemistry tend to cite a lot more recent references than more durable fields such as mathematics. This is known as citation dynamics, and it has a significant effect on IF because citations within only two years are counted in calculating the IF. A large portion of citations are captured in IFs in highly dynamic fields, while durable fields have a smaller fraction of short-term citations and hence have lower IFs (Dong et al., 2005; Seglen, 1997; Sombatsompop et al., 2004).

For these reasons, it is not generally recommended that the IF be used to compare journals from different fields. Nonetheless, the misuse of the IF in evaluating researchers and research institutes in different fields has been increasingly frequently observed (Pudovkin & Garfield, 2004). In an effort to make cross-field comparisons possible, some normalization procedures have been developed to accommodate the variation in IFs across fields (Marshakova-Shaikevich, 1996; Owlia, Vasei, Goliaei, & Nassiri, 2011; Pudovkin & Garfield, 2004; Ramírez, García, & Del Río, 2000; Sen, 1992). Those normalization procedures are only focused on calculating the relative positions of journals within each subject category, rather than explicitly considering different citation densities and citation dynamics across categories (Dorta-González & Dorta-González, 2013). Consequently, such normalization approaches cannot be applied to a comparative evaluation of multidisciplinary journals although citation analysis is the most common technique for measuring output of multidisciplinary research (Wagner et al., 2011). Many multidisciplinary journals are affiliated with multiple categories and thus a normalized procedure produces different scores for a single journal. What is worse is that some categories in JCR are multidisciplinary themselves. Even if some journals are classified into the same category, their IFs are highly dependent on the citation characteristics of the disciplines with which each journal is connected. Therefore, the requisite for measuring the performance of multidisciplinary journals is to explicitly capture different citation densities and citation dynamics across fields.

The tenet of this paper is that an efficiency-based measure can be a good remedy for measuring the performance of multidisciplinary journals. Basically, the IF is a productivity measure defined as the ratio of outputs (the number of citations) to inputs (the number of articles). In other words, the IF can be viewed as an indicator of how productive journals' citation generation processes are. However, the number of articles published in a journal is not the only input of the journal's scientific dissemination process. Our perspective is that the number of references to be cited and the time lag between publication and subsequent citation are also critical inputs to produce citations; thus, we explicitly consider the two factors that influence the IF—the citation density and citation dynamics of the fields to which a journal is related—as inputs of the knowledge dissemination of the journal. To accommodate multiple inputs in measuring productivity with an unknown production function, this study employs data envelopment analysis (DEA), which is a multi-factor productivity model for measuring the relative efficiency of decision making units (DMUs) without any assumption of the functional form of a production function. By incorporating the two field-dependent factors, citation density and citation dynamics, as well as the number of articles as inputs of the process of DMUs (journals), DEA produces their efficiency scores, called DEA-IF, as a measure of journal performance. The obtained DEA-IF can be used for comparative evaluation of multidisciplinary journals' performance because it mirrors different citation-related characteristics of the various fields in which each journal is involved.

Another important issue in calculating the IF is the inclusion of journal self-citation. There has been a long debate over whether to include journal self-citations (Archambault & Larivière, 2009). Since self-citation substantially influences the total level of a journal's citation and plays an important role in forming the IF (Falagas & Alexiou, 2008), some editors are

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