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RECOMMENDATIONS/SUGGESTIONS

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CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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A SURVEY OF STATISTICAL DISTRIBUTION OF JOURNAL IMPACT FACTORS

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ABSTRACT

In this survey, statistical distributions of journal impact factors (JIF) are discussed in brief as given by several authors since the beginning and the development of JIF from Gross and Gross (1927) to Garfield (2006) and more is discussed. Several authors discussed varied statistical distributions and no uniqueness solution is emerged in their distributions.

KEYWORDS
Impact Factor, Journal Citation Report, Statistical Distributions.

INTRODUCTION

Seglen (1997) found that evaluating scientific quality is a disreputably difficult problem and having no standard solution. True experts in the field should examine the published scientific results according to established rules for the assured quality. In practice, however, the tradition of peer review system is usually in vogue by committee formed with general competence rather than with the specialist's insight. Committees lean, therefore, to resort to secondary criteria like crude publication counts, journal prestige, the reputation of authors and institutions and estimated importance and relevance of the research field.

Mishra (2010 a) found that University Grants Commission of India notified on 23rd September 2009 about its regulation on 'Minimum Qualifications for Appointment of Teachers and other Academic Staff in Universities and Colleges and Measures for the maintenance of standards in higher education'. Accordingly, publication of research papers/articles in reputed journals has become an important factor in assessment of the academic performance of teachers in Universities and Colleges in India. One of the measures of reputation and academic standard of a journal is the so-called JIF. JIF is the ratio of the total number of citations received by papers published in the journal minus self citations to the total number of papers published in the journal in previous two years and it is discovered by Eugene Garfield, the founder of the Institute for Scientific Information (ISI), in 2006 and ISI is now part of Thomson Reuters. Impact of a journal should not be confused with impact of an article or author; even something as small as a title change affects the impact factor (Garfield, 1994).

JIF are based on two aspects, namely, on the number of publications of a journal and the number of citations those publications received. In short, publications are marks of a journal's effort or activity whereas citations are a mark of a journal's effect or impact. In academia, most of the readers are writers as well. When authors do not cite correctly or when they do read, but do not write (and hence do not cite), journal impact indicators have a serious problem. Stock (2009) found that there are discipline-specific citation behaviours. Therefore, it is not possible to compare JIF across disciplinary borders.

Many authors such as Dube (1966, 1970), Brookes (1970), Tadikamalla (1980), Brown (1980), Sichel (1985), Matricciani (1991), Budd (1992), Egghe and Rao (1992), Hurt and Budd (1992), Rousseau (1993), Burrell (2005), Glanzel (2006), Bensman (2008), Egghe (2009), Mishra (2010 b & c) and others derived statistical distribution of JIF of their own. No uniformity or generality is emerged in their findings. Each has given different finding. One of the reasons seems to be the use of different data (kinds and qualities of papers and time periods) used in their findings. Their findings are based on empirical works only and no solid theory and statistical test are derived for statistical distributions.

DEVELOPMENT OF JIF

Archmbault and Larivieri (2009) found origin and development about JIF in US University and college librarians who wanted to use an objective method to select journals for their holdings. This gave an important consideration about the method allowed for the identification of high impact journals in scientific fields and a method was then developed to determine the journal impact measures based on self-citations. It was then decided to use two-year citation window. This method was firstly developed by Gross and Gross (1927) after compilation of a list of relevant journals using subjective approach. The use of journal impact (JI) calculation has emerged as journal citation report (JCR) from Thompson scientific work. It was developed specially to cater the needs of US librarians. International Statistical Institute scaled up the emergence and evolution of this method in 1970s by creating a self fulfilling prophecy and has continued for 30 years to publish the JCR. By creating a centre stage, the measures of JIF made a selective promotion for US journals, which could then be picked up, read and increasingly cited by researchers. They found that this practice produced adverse effects when measures of JI were used to evaluate scientific production across fields. Gregory (1937) produced a colossal study using the Gross and Gross method to identify key journals in 27 fields relevant to medicine. Brown (1956) published a monograph entitled 'Scientific Serials' on collecting citations from several journals and covering eight fields of science. Fuyuno and Cyranosky (2006) revealed few examples on cash earning on 'impact game' played for the publications.

Garfield (2006) found that the idea of an impact factor in science was mentioned in 1955 when the experimental genetic citation index was published with support from the National Institutes of Health. Irving H. Sher and Eugene Garfield created JIF to help select additional source of journals. Credit is to be given to Eugene Garfield for the development of computational formula of JIF. Epstein (2007) and Brumback (2009) also mentioned about the 'impact game' to be played in number of ways. The debate over whether to include journal self citations is as old as the methods to measure the journal impact. Althouse et al. (2008) found that E. Garfield published his 1972 paper in science describing the role of impact factor in bibliometric studies; he provided the table of the highest-impact journals in science based on 1969 data. Gross and Gross (1927), Epstein (2007), Brumback (2009) and many authors mentioned to exclude those citations, if any. Garfield (2006) adopted Martyn's and Gilchrest's concepts and gave the computational formula of JIF as

$$\text{JIF in t +1 year} = \frac{A}{B} \qquad (1)$$

where A = No. of Citations a Journal Receives in t and t - 1 years
B = No. of Articles Published in t and t - 1 years

A natural generalization of Garfield's impact factors (IF) is obtained by considering IF over different time periods (Rousseau 1988) as

$$IF(n) = \frac{\sum_{k=1}^{n} c(k)}{\sum_{k=1}^{n} p(k)} \qquad k = 1, 2, 3, \ldots, n \qquad (2)$$

For k = 2, i.e., IF(2) is actually Garfield's JIF. (2) is the generalized form of (1) and (1) is a particular case of (2) when k = 2.

Alternative method such as citation rates (CR) of scientific journals by the Institute for Scientific Information was also popular and CR is also known as the JIF by that time which is calculated as the mean CR of all articles contained in the journal. This is published annually and is widely regarded as a quality ranking for journals. The results are published as the 'Science Citation Index (SCI)'. On the basis of SCI and authors' publication lists, the annual citation rate of papers by a scientific author or research group is thus calculated. Citation habits and citation dynamics vary from person to person and also from research fields as to make evaluative comparisons. The citation impact of a research field is directly proportional to the mean number of references per article, which varies considerably from field to field. Garfield (2006) concluded that 'C. Hoeffel expressed JIF is not a perfect tool to measure the quality of articles but there is nothing better and it has advantage of already being in existence and is, therefore, a good technique of scientific evaluation'.

The h-index, the most popular of statistics mentioned here, was proposed by J. E. Hirsch (Hirsch 2006) in order to measure the scientific output of a researcher by focusing on the high-end tail of a person's citation distribution. Substituting a single number for publications counts and citation counts was its goal. The h-index provides a combination of both quantity (number of papers) and quality (impact, or citations to these papers) (Glanzel 2006). The m-index, proposed by J. E. Hirsch (Hirsch 2006), is the h-index divided by the number of years since person's first paper. Intension is to compensate junior scientists because they have not had time to publish papers or gain many citations. The g-index, proposed by L. Egghe (Egghe 2006), is the largest n for which the n most cited papers have a total of at least n citations. Hirsch's h-index does not take into account the fact that some papers in the top n may have extraordinary high citation counts. The purpose of g-index is to compensate for this. Hirsch also claims that one can use the h-index to compare two scientists. But neither of these assertions is supported by convincing evidence. Ogden and Bartley (2008) found that JIF speak something about a journal's citation performance and their shortcomings. They discussed seven types of shortcomings and one of the seven shortcomings is about completely misrepresent of total current citation rate for the journal in two cited years.

Glanzel (2010) found rapid growth in the citation analysis, especially journal metrics, over the last decade. The most notable developments include – relative citation rate, the h-index, article influence, sclmago journal rank and source-normalized impact per paper. In most fields, research results are communicated via papers scholarly journals, although conference proceedings, books and patents may also play a role. These publications cite earlier research the authors have found useful or wish to respond to in some way and, in turn, attract citations from researchers who find their work worth citing. He then discussed that between two journals A and B, IF of A is twice that of A. Does this mean that each paper from A is invariably cited more frequently than any paper from B?

The h-index is one of the most successful metrics and it was originally created to compare individual researchers. It is the number of papers by a particular author that receives h or more citations. The h-index has proved highly popular; it too suffers from some of the same issues as the IF such as bias and misuse.

STATISTICAL DISTRIBUTIONS

As we know, citation statistics are used in ranking papers, people and programmes and no specific model is specified. Model suggested by the data is used and it is often vague. Citation data behave differently and in this situation no unique statistical distribution is suggested to be used. Several authors suggested using different distributions based on their empirical results. Some of them are described as. Merton (1968, p.58) discussed that "the Matthew effect consists in the accruing of greater increments of recognition for particular scientific contributions to scientists of considerably repute and the withholding of such recognition from scientists who have not yet made their mark". He then coined the term Matthew effect which means that often-cited papers get cited more often and influential authors gain more influence. Irwin (1975) found the general waring (GW) distribution is a hypergeometric distribution based on empirical study and he discussed some of its properties in which its first four moments are finite. Latter he explored the long-tailed GW distribution. Certain negative Binomial distribution is limiting form of the GW distribution under finite case. The simple waring distribution was fitted by maximum likelihood to the observed distribution of the number of filarial worms on 2600 mites without computation of standard errors of GW distribution. He then gave Newbold's accident distribution (Newbold 1927) in which GW distribution was fitted and showed some improvement on Newbold's negative Binomial distribution. The continuous analogue of the GW distribution is then obtained and it is in general of Pearson's type VI and the successive moments of the GW distribution and the corresponding type VI become infinite for the same value of ρ. The continuous analogue takes the type V form when both parameter values tend to infinity. The analysis used by him classifies all Pearson's types according to the values of parameters of hypergeometric form which they are derived. Ijiri and Simon (1974) derived from Pareto distribution designing an empirical test and used a mathematical model. Tol (2009) then estimated the coefficients using the method of ordinary least squares and concluded that top papers are cited more often than one would one would expect on the basis of their rank, provided famous paper attract more citation. Tadikamalla (1980) found a comprehensive idea about the Burr (types II. III and XII) and the related distributions such as Logmax, exponential gamma (Dube 1966, 1970), compound Weibull, Weibull, logistic, log-logistic and 2p-kappa family of distributions and concludes that Burr type III and type XII distributions can be used to fit almost in any unimodal data and are comparable to the Pearson and the Johnson system of distributions. Egghe (1988) discussed for a general relationship between the impact factor and the average number of citations per year. Matricciani (1991) and Egghe and Rao (1992) have shown that citation curves are best described through lognormal distribution. Hurt and Budd (1992) have argued in favour of Weibull distribution. Rousseau (1993) applied Weibull and lognormal distributions and obtained t^m to reach maximum of average number of citations, where t^mdenotes time period for becoming maximum journal impact factor. Further, if number of publications varies widely from year to year nothing much can be said about the impact factor. Borokhovich et al. (2000) first examined the determinants of social science citation index (SSCI) impact factors for three finance journals and concluded based on empirical study that use of the SSCI impact factor as a means of identifying the most influence journals in finance appears to be justified. Their results also show that impact factors are good indicators of long-term influence. Burrell (2005) found that for many purposes, the distribution is best motivated via a familiar informetric scenario of a population of sources producing items over time leading to a stochastic process from which the univariate, bivariate and multivariate forms of the GW distribution are natural consequences. Three-parameter family named the GW distribution was given a ready interpretation in the modelling of accident data. Glanzel (2006) attempted to interpret theoretically some properties of the h-index, giving the underlying citation distribution, on the basis of extreme-value statistics. Specifically, the dependence of the h-index on the basic parameters of the distribution and on the sample size was discussed using Gumbel's characteristic extreme values. Greenwood (2007) used Bayesian Markov chain Monte Carlo methods to estimate the uncertainty associated with journal performance indicators on citations to journals in research and experimental medicine in 2005. He then found that only the top and bottom few journals could place any confidence in their rank position. Intervals were wider and overlapping for most journals. Bensman (2008) examine probability structure by analyzing the distributions of 2005 JIF for science and social science journals. The Science journals behaved as negative Binomial distribution whereas social science journals fit Poisson distribution model. Both IF distributions were positively skewed – the SCI much more than the social science – indicating excess variance. Tol (2009) found that famous papers by famous authors are cited most. This implies that there are 'increasing returns to scale' in influence, and that Merton's (1968) Matthew effect is real and can be found in data believing that recognized authors gain more recognition as Merton argued. However, the Matthew effect as defined and measured here implies that the relationship between citation numbers and quality is different at the top end of the distribution than at the bottom end. Mishra (2010 b) found that Burr-XII, Dagum or Johnson SU distribution are the best fit to logarithmic of JIF using data on JIF of the major discipline groups (such as Chemistry, Statistics, Psychology, Economics, Engineering, Physics, Biology and Social Sciences) for 2006 and found statistical distribution of JIF is characteristically asymmetric and non-mesokurtick. Even the distribution of $\log^{10}$ (JIF) exhibits conspicuous and non-mesokurticity. He then concluded that Johnson SU distribution is the best choice to fit the $\log^{10}$ (JIF) data. The distribution of log ^{10} (JIF) has become more skewed and leptokurtic, possibly suggesting the Matthew effect in operation, which means that more cited journals, are cited even more over time. Mishra (2010 c) studied the over-the-sample stability of the estimated parameters of statistical distributions of JIF data of 2008. His findings are based on empirical work and he concluded that Johnson SU distribution exhibits the stability for logarithmic of JIF-2008 data which will be the best fit here and forecasts the same to be in other years too. Pan and Hong (2011) briefly analyzed the 2009 publication status based on empirical findings only and concluded that there is a significant increase in number of scientific papers related to a specific area as dental due to more care taken by government.

CONCLUDING REMARKS

The model suggested by the data is in general use and it is often vague. Behaviour of citation data shows differently and no unique statistical distribution is recommended for the use by the authors. IF is not a perfect tool to measure the quality of articles but there is nothing better and it has the advantage of already being in existence and is, therefore, a good technique for scientific evaluation. It is most difficult to have an article accepted in each of the best journals which have a high IF. h-index and g-index are alternative measures of journal impacts which are two relatively new citation metrics.

All JIF are not comparable as Stock (2009) concluded that JIF across disciplinary borders are not possible to compare. The best course of action therefore seems to be redesigning the tool from the ground up. Statistical distributions by some authors are based on JIF while others are based on functions of JIF such as $\log^{10}$ (JIF), etc across disciplinary borders. None has used the same data on JIF in deriving the statistical distribution. I agree with Rousseau (1988) who concluded that more research is needed to find the exact distribution for all types of citation curves. Giving credit to Eugene Garfield for the discovery of computational formula of JIF is not only appropriate but also legitimate.

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