A uniform scale model for Impact Factors of Chinese and English journals based on expert experience and data fusion

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Abstract—**Although existing studies have covered journal impact factor from many aspects, how to set up a uniform scale model for impact factors of Chinese and English journals is still a problem to be solved and receives more attention in recent years: since current methods such as data classification and statistical classification are too ambiguous, they tend to turn impact factors of ten-plus journals into one, usually leading to massive information loss during data conversion, thus they fail to provide scientific and rational evaluation findings. With journal impact factor being one of important indices for the quality of academic papers and academic levels, the adoption of an effective uniform scale system for Chinese and English journals' impact factors has become a hot spot both for literature research institutions and universities. The paper proposes a conversion model of impact factors based on expert experience and data fusion, which is established by taking into account of expert views towards academic journals in Chinese and English within a certain field as well as objective evaluations of impact factors from the journals.**

Keywords- Journal impact factor; Academic achievement evaluation; data fusion; Uniform scale model; expert experience

I. INTRODUCTION

Journal impact factor is one of the important indicators for the quality of academic journals and academic levels. Impact factor (**IF**) was devised on the *Science* magazine by Eugene Garfield in 1955; with the *Science Citation Index* being officially launched in 1961, it received more attention from the academic circle. The impact factor of an academic journal is a measure reflecting the average number of citations to recent articles published in the journal regardless of publication year, publication frequency, paper length and the number of published articles. It is frequently used as a proxy for the relative importance of a journal and the appraisal of scientific achievements [1]. Thus it is of great importance to introduce the impact factor into citation analysis and journal evaluation. [2] The introduction of impact factor eliminates the influence of article volume published on journal quotations [3-4].

Statistical analysis of domestic scientific journals was conducted in 1988 by Institute of Scientific and Technical Information of China (ISTIC), and seven indices of 1227 kinds of source journals including impact factor were studied for the first time in 1990; citation databases were established in 1994, in which the disciplines and majors of source journals roughly reflected the panorama of scientific research in China; *Scientific Journal Citation Reports* compiled from 1997 brought in many other journal evaluation indices [5].

Existing literatures relating to impact factor focus on the following aspects. Researchers like Wang Jianhua studied the formation mechanism of impact factor from the definition formula, analyzed factors affecting impact factor, and probed into reasons for impact factor deviation and its consequences [6]. Researchers represented by Li Chao investigated the single-index evaluation and multi-index evaluation of journal evaluation research in China in terms of perspectives, research highlights, methods and practice [7]. Researchers like Wang Juan held that impact factor must be used within the fields and Chinese journals and English journals must be evaluated respectively from the perspective of discipline application range [8-17]. Researchers represented by Wang Chao studied distribution characteristics of impact factor from current journal evaluation methods, meanwhile bringing in methods such as HIF index, the most probable value and open access to represent impact factor level of journals on the whole[18-20]. Researcher like Huang Hefang elaborated on the correlations of 15 frequently used quantitive indices of journals [21]. Through the analysis of impact factor, the commonly used index, researchers represented by Wang Jinling shared the idea that multi-index evaluation system should be established by combining quantitative evaluation and qualitative evaluation [22].

Although existing studies have covered journal impact factor from many aspects, how to set up a uniform scale model for impact factors of Chinese and English journals is still a problem to be solved and receives more attention in recent years: since current methods such as data classification and statistical classification are too ambiguous, they tend to turn impact factors of ten-plus journals into one, usually leading to massive information loss during data conversion, thus they fail to provide scientific and rational evaluation findings.

The paper comes up with a uniform scale model for impact factors of Chinese and English journals based on expert experience and data fusion, the effectiveness of which is demonstrated through the employment of empirical analysis.

II. THE MODELLING IDEA FOR THE UNIFORM SCALE MODEL FOR IMPACT FACTORS OF CHINESE AND ENGLISH JOURNALS BASED ON EXPERT EXPERIENCE

How to build an effective uniform scale model for impact factors of Chinese and English journals has been one of the puzzles for literature statistics research institutes, institutions of higher learning and scholars. The paper puts forward a uniform scale model for impact factors of Chinese and English journals based on expert experience and data fusion. The impact factor conversion model is worked out through analyzing expert experience within the fields, the basic idea can be described as follows.

Firstly, the authors send questionnaires to experts in different fields. And two top-level Chinese and English academic journals are named respectively by experts within the fields; meanwhile the factor of standard deviation marking different academic levels of the two journals are given by the experts, also called conversion factor. For example, an expert in the field of management names Journal of Management Sciences in China and Management Sciences as top-level Chinese and English journals within his field. And he thinks the conversion factor of the two journals is ten times. At the same time, parameters influencing the conversion factor of IF are provided and experts are asked to write down weighted values of each parameter in evaluation. Then after analysis and summary of questionnaires as well as equalization of conversion factors given by experts, the average conversion factor η' is obtained, and then we get the conversion factor for impact factors η of Chinese and English journal. In the process of modelling, parameter choices and equation shall firstly be based on expert experience. The accuracy and effectiveness of the model shall be tested and verified repeatedly. The model involves in many indices and decision rules, so the calculation of IF conversion factor shall take those factors into consideration. 。
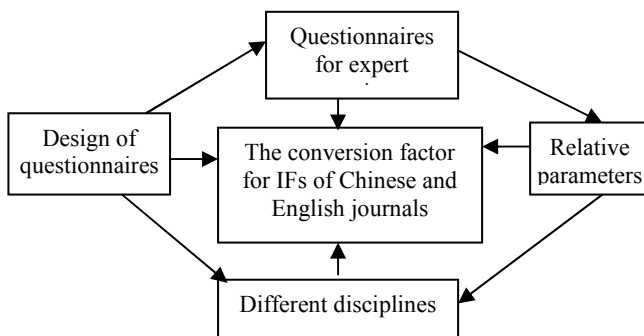
The process of modelling is shown in figure 1：

Figure 1. Modelling process for the uniform scale model for impact factors of Chinese and English journals based on expert experience

III. A UNIFORM SCALE MODEL FOR IMPACT FACTORS OF CHINESE AND ENGLISH JOURNALS BASED ON EXPERT EXPERIENCE

The paper proposes an applicable conversion method: based on expert surveys, the conversion factor for IFs of Chinese and English journals is worked out and then a uniform scale model is established.

A. Expert surveys

Information needed for expert surveys:

—The name of top-level Chinese and English journals recommended by experts within the fields;

— Experts' views and definitions on the multiple relationship between the Chinese journal IF and the English journal IF;

—Questionnaires adopted in the paper involve many journal indices including total citations, diffusion factor, journal cited half-life, the proportion of papers with fund aids, the proportion of international papers, the average number of writers, the number of citing magazines. Besides, parameters such as discipline application range, article volume published and non-self-cited rate are also factors to be considered.

Questionnaires are designed as shown in Table 1.

TABLE I.   QUESTIONNAIRE FOR A UNIFORM SCALE MODEL FOR IMPACT FACTORS OF CHINESE AND ENGLISH JOURNALS

Your major belongs to：
☐Science
☐Engineering
☐Economics&Management
☐Liberal arts

Evaluation indices	When we use a uniform scale model for impact factors of Chinese and English journals, which weighting value do you think is appropriate for the index? If "insignificant", please tick the number 1; if "significant", please tick the number 13; if between "insignificant" and "significant", please tick any number between 1 and 13 to represent your ideas.
1 Discipline classification	1 2 3 4 5 6 7 8 9 10 11 12 13
2 Total citations (5 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13
3 The proportion of papers with fund aids(1.5 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13
4 The proportion of international papers(1.5 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13
5 The number of citing magazines (2.5 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13
6 Reprint rate of secondary literation(1.5 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13
7 Journal cited half-life(3 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13
8 Non-self-cited rate(1.5 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13
9 Journal current year download rate(1.5 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13

10 Article volume published(2 times of amplification factor)	1 2 3 4 5 6 7 8 9 10 11 12 13
11 Which do you think is the most appropriate conversion factor?	
12 Please name top-level Chinese and English journals within your field.	

B. Data fusion analysis of expert surveys

Based on current research on impact factors, the paper carries out statistical analysis of expert surveys, calculates several parameters for the uniform scale model and sets up a complete scale model.

$\bar{\eta}$ is the conversion factor for impact factors of Chinese and English journals,

$$\bar{\eta} = \frac{1}{r}\sum_r \frac{\eta_i \omega(trcn)level(trcn)}{\omega(tren)value(\delta)level(tren)} \cdot \frac{|\cos\phi_i|(R_1-R_2)^2 P_1 Q_1 T_1}{(R_1+R_2)^2 P_2 Q_2 T_2} \quad (1)$$

Where $\eta_i \in (0,100)$, η_i are impact multiples of the Chinese journal versus the English journal given by experts.

$$\varphi_i \sim P(\lambda)$$

ϕ_i follows Poisson distribution, λ=3   (2)

$$level\ (tren) = \begin{cases} 1, & \text{if the IF of the English journal is higher or} \\ & \text{equals the citation index of the Chinese} \\ & \text{journal (SCI, SSCI, A\&HCI)} \\ 0.6, & \text{if the IF of the English journal is lower} \\ & \text{than the citation index of the} \\ & \text{Chinese journal (SCI, SSCI, A\&HCI)} \\ 0.2, & \text{if the IF of the English journal is zero or none} \end{cases} \quad (3)$$

$$level\ (trcn) = \begin{cases} 1, & \text{first tier journals} \\ 0.6, & \text{second tier journals} \\ 0.3, & \text{third tier journals} \end{cases} \quad (4)$$

$$value(\delta) = \ln\frac{[level(tren)-level(trcn)]^2}{10}\int_0^{10}\frac{\delta-1}{(\delta+10)^2}, \delta \sim N(12.54, 5.10^2) \quad (5)$$

$$R_1 = \begin{cases} 3.5, & \text{if the Chinese journal covers many disciplines} \\ 8.2, & \text{if the Chinese journal belongs to a certain discipline} \\ \emptyset_i, & \text{if uncertain} \end{cases} \quad (6)$$

$$R_2 = \begin{cases} 2.3, & \text{if the English journal covers many disciplines} \\ 9.1, & \text{if the English journal belongs to a certain discipline} \\ \emptyset_i, & \text{If uncertain} \end{cases} \quad (7)$$

Where r is the number of experts in the fields participating in the survey, $\omega(trcn)$ is the IF of the Chinese journal, $\omega(tren)$ is the IF of the English journal, $level(tr)$ is the classification of the journal, $value$ is the weight of the journal within the fields, representing its importance, R_1, R_2 are quantifications indicating the disciplines that the Chinese and English journals cover, P_1, P_2 are the current year download rates of the Chinese and English journals, Q_1, Q_2 are numbers of citing magazines of the journals, T_1, T_2, μ_i are multiples given by experts on the discipline coverage of the Chinese journal compared with the English journal, which can be regard as a statistic process obeying Poisson distribution, tr is the surveyed magazine, $tren$ is the surveyed English magazine, $trcn$ is the surveyed Chinese magazine, and current-year index refers to citations of current-year papers published in the magazine, which is an index for immediate reaction rate of the journal.

IV. ANALYSIS OF EXAMPLES

A. Data sources

According to the model established, we have surveyed nearly 10 universities in Beijing, Tianjin, Shanghai, Xi'an, etc and standardized the data to facilitate calculations.

Among the total 64 questionnaires, the number of valid questionnaires is 57, meeting the minimum number of samples for statistical analysis.

B. The impact factor conversion program based on dynamic adjustment

To facilitate the conversion program of impact factors, the paper adopts the program written in the Python programming language. Questionnaire data are input in the standard form, which realizes real-time calculations and adjustments of the conversion factor. Thus, the factor can be dynamically adjusted as Questionnaires increase.

C. Verification plan

To verify the effectiveness of the model proposed, the conversion factor calculated from the model is applied to evaluate academic papers of a prominent scholar. Compared with the academic rating given by the University where he works, the effectiveness of the model is demonstrated.

D. Result analysis

The conversion factor, that is unit ratio of the Chinese impact factor and the English impact factor, is calculated based on expert surveys; the total number of papers published, the total score of the scholar, the total contribution score of the papers and the academic rating given by the University are listed; then those data are employed to verify the model.

CONCLUSION

The objective and fair evaluation of scientific achievements is a basic yet important step in scientific

research orientation and scientific resource allocation. A uniform scale model for impact factors of Chinese and English journals is established based on a statistical model: expert experience on academic levels and impact of the Chinese and English journals within a certain field as well as current impact factors of the journals are taken into consideration. Then by applying the uniform scale model, the simplified conversion factor is worked out for assessing academic levels of teachers in universities and colleges.

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