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Analysis on Evaluation and Influencing Factors of Knowledge Exchange Efficiency in Life Science Journals under the Background of High Quality Development

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Abstract

Objective/Significance: Life science and biotechnology is one of the most important, rapidly developing and comprehensive interdisciplinary disciplines since the new century, and is also the focus of global science and technology competition. It has become an important supporting means for scientific decision-making of scientific research management institutions to keep abreast of the latest developments in the field of life science, such as frontier development level and research hotspot, and accurately grasp the research advantages, research trends and main contributions of domestic scientists. The study on the efficiency of knowledge exchange and its influencing factors is of great significance to the high quality development of life science journals. **Method/Process:** Taking 18 life science journals from 2016 to 2021 as the research object, this paper used SBM model and Malmquist index model to conduct static and dynamic analysis on the efficiency of knowledge exchange of journals, and combined with Tobit model to analyze the influencing factors of knowledge exchange efficiency. **Result/Conclusion:** The study found that the overall knowledge exchange efficiency of life science journals was low, and there was still a lack of pure technical efficiency and scale efficiency. The academic quality of journals, publication cycle, publication time and new media integration of journals passed the significance test, which had a significant impact on the knowledge exchange efficiency. The aging speed of journals has no significant effect on the efficiency of knowledge exchange.

Keywords

Life science journals, Knowledge exchange efficiency, Influencing factors, High-quality development

1. Introduction

Academic journals are important carriers of academic information and academic achievements. In the tide of digitization of content information, it is an irresistible trend to participate in multi-media integration across organizations. As an important symbol to show the development of national science and technology and the development of social economy and culture, as well as a carrier for the dissemination of scientific research achievements, the functions of academic journals are not only reflected in the basic functions of information storage and dissemination, but also in the unique social functions of guidance, education, economy and think tank construction [1]. In the process of the transformation of academic journals into new media, no matter the publishing mode, distribution mode, communication channel, audience range, or operating system and mechanism of academic journals will be affected to some extent. With the development of life science and technology and the continuous growth of professional knowledge, the development of academic journals in this field is more rapid than that in the field of humanities and social sciences [2]. In particular, most first-class academic journals in the field of life science are written in English, which provides help for the global dissemination of quality content of journals. Domestic scholars have begun to pay attention to the study of knowledge exchange efficiency of periodicals, but the overall study is not mature and the time span of the study is small, and the description and empirical study of the dynamic evolution law of knowledge exchange efficiency of periodicals are lacking [3].

With global breakthroughs in biotechnology, medical technology and other life sciences, huge potential development space has been created for technological fields such as innovative therapies and precision diagnosis [4]. Most of the representative academic journals in the field of life Science are included in the Science Citation Index (SCI) according to the journal impact factor. Therefore, in this paper, the SBM model and Malmquist index model are used to measure the knowledge exchange efficiency of 18 SCI journals of life sciences from 2016 to 2021, supplemented by in-depth characterization of the dynamic evolution of time series, in order to provide references for promoting the development of Chinese life sciences and related fields.

2. Research Methods and Data Sources

2.1 Research method

(1) SBM model

Data enveloping analysis (DEA), proposed by Charnes A and other famous scholars in the United States, is now widely used in measuring the input and output efficiency of decision-making units. The traditional DEA model is mainly divided into CCR model and BCC model, which has great limitations compared with SBM model. Proposed by Tone K in 2001, SBM (Slacks-Based Measure) model is a relatively perfect DEA expansion model, which can avoid some defects of traditional DEA model and conduct efficiency evaluation more accurately [5]. Currently, it has been widely used, and its expression is as follows:

$$P^* = \min \frac{1 - \frac{1}{m}\sum_{i=1}^{m} s_i^- / x_{io}}{1 + \frac{1}{s}\sum_{i=1}^{s} s_R^+ / y_{ro}}$$

$$s.t.\quad x_o = x\lambda + s^-$$

$$y_o = y\lambda - s^+$$

$$\lambda \geq 0,\quad s^- \geq 0,\quad s^+ \geq 0$$

P^*: The efficiency value of periodical knowledge exchange, and $0 \leq p^* \leq 1$, m and k are the number of input and output factors, x_o and y_o are input and output vectors respectively, x_{io} and y_{io} are elements of input and output vectors respectively, X and Y are input-output matrices, s^- and s^+ are relaxation variables representing input-output, and λ is column vectors. When $p^* = 1$, it indicates that knowledge exchange efficiency is in DEA effective state; when $0 \leq p^* < 1$, the efficiency of knowledge exchange should be improved.

(2) Malmquist index

Malmquist index model was first proposed by Malmquist S in 1953. Rolf Fare et al. combined a non-parametric linear programming method of Malmquist index model with data envelopment analysis (DEA) to measure the dynamic evolution process of efficiency in time series [6]. The formula is as follows:

$$M_{t,t+1}(X_{t+1}, Y_{t+1}, X_t, Y_t) = \left[\frac{D_t(X_{t+1}, Y_{t+1})}{D_t(X_t, Y_t)} \times \frac{D_{t+1}(X_{t+1}, Y_{t+1})}{D_{t+1}(X_t, Y_t)}\right]^{\frac{1}{2}}$$

The calculated Malmquist index can reflect the change of total factor productivity of decision-making unit from the t period to the t+1 period, and reflect the change of knowledge exchange efficiency of life science journals in a certain period. When the index is greater than 1, it indicates the efficiency increase of this period compared with the previous period. When the index is less than 1, it indicates that the efficiency of this period is decreased compared with that of the previous period. When the exponent is equal to 1, the efficiency of this period has not changed from the previous period.

(3) Tobit regression model

Tobit model, proposed by Tobin J in 1958, is applicable to the situation where the value of the explained variable is limited by the range. In this paper, the efficiency of periodical knowledge exchange is taken as the explained variable, and the SBM model is used to measure the efficiency value. The efficiency value is between 0 and 1, and the value is limited by the range [7]. Therefore, the Tobit regression model meets the relevant conditions and is suitable for analyzing the factors affecting the efficiency of periodical knowledge exchange. Its expression is:

$$y^* = \beta' x_i + u_i$$
$$y_i^* = y_i \ if \ y_i^* > 0$$
$$y_i^* = 0 \ if \ y_i^* \le 0$$

Among them, y is the efficiency of periodical knowledge exchange, x_i is the influencing factor and u_i is the error random error term. Tobit regression model is used to carry out panel regression on the factors affecting the efficiency of periodical knowledge exchange and analyze the role of each factor.

2.2 Index Design

Academic journals are a multi-variable input and multi-variable output system. The efficiency of periodical knowledge exchange is actually to measure and analyze the input-output relationship of various journals. The basic purpose of the input-output system is to study the interdependence of journals in knowledge exchange activities [8, 9]. The non-parametric DEA model is used to calculate, and there is no collinearity of input and output indexes, and the collinearity of indexes will not affect the results. However, the excessive number of indicators is easy to cause the model discrimination ability is insufficient, leading to the deviation of the results [10]. The input-output index system is constructed based on these two principles. According to the research on relevant literature, scholars at home and abroad mainly build an index system based on the articles and citations of periodicals, as shown in Table 1.

Table 1. Input-output Index

Index Type	Index Name	Indicator Description
Input Index	Amount of source literature	The total number of periodical papers in the current year is counted to reflect the scale of periodical investment.
	Average citations	The number of references in each paper reflects the absorption capacity of knowledge.
	Fund paper ratio	Statistics of the proportion of funded papers in the total papers
	All articles references	Average number of references per paper
	Average number of authors	Count the average number of authors per paper in an annual journal
Output Index	Influence factor	Measure the academic impact of journals
	Total citation frequency	The paper counts the total number of citations that year.
	Disciplinary diffusion	The ratio of the number of journals cited to the number of journals in the discipline
	Number of citations	Number of journals cited by the evaluated journal
	Citations per article	The average number of citations per paper
	h-index	Evaluate the amount and level of academic output of researchers

On the basis of previous studies, according to the construction principle of input-output index system, this paper reduces the number of indicators as far as possible, selects indicators containing more production factors, and combines the measurement indicators in the Annual Report of Impact Factors of Chinese Academic Journals (Life Sciences). By comparison, in terms of input index, the number of citations and the average number of citations contain more factors of production, which can directly reflect the input scale and knowledge absorption capacity of periodicals [11]. While the ratio of funded papers is an index reflecting the academic quality of journals, it can only express the absorption of high-quality papers, but cannot measure the input of journals accurately. The average number of authors shows the average degree of collaboration between authors, not to mention the input of the journal. Therefore, excluding the index of fund paper ratio and average number of authors, the number of citations and the average number of citations were selected as the input index [12]. In terms of output indicators, compound impact factor and compound total citation are important quantitative indicators to measure the influence of journals, and the number of cited journals is an indicator reflecting the breadth of periodical knowledge diffusion. Through these three indicators, we can intuitively see the response caused by periodical knowledge output [13]. The h index is more used to symbolize the academic ability of authors, and the number of cited journals can reflect the output situation more comprehensively than the subject diffusion. Therefore, excluding the subject diffusion and the h index, the composite impact factor, composite total citations and the number of cited journals are selected. The input-output index system was finally constructed, as shown in Table 2.

Table 2. Input-output Index System of Knowledge Exchange Efficiency of Life Science Journals

Index Type	Index Name	Indicator Description
Input Index	The number of references cited	The total number of citable articles published by a journal within a specified time range
	Average citations	The number of references per article published by a journal in the statistical year
Output Index	Composite total citation	The total number of citable references cited by composite statistical sources in a statistical year
	Compound influence factor	The ratio of the total number of citable references published in the previous two years by composite statistical sources in the statistical year to the total number of citable references published in the journal in the two years
	Number of journals cited	The number of journals cited by a journal in the statistical year

2.3 Data Sources

After research and expert consultation, in this study, 18 representative journals in 5 subject categories (Zoology, Immunology, Cell Biology, Biology and Plant Sciences) were selected based on the JCR database and the ranking of journals in China Science and Technology Journal Citation Report.

The representative Journal of Zoology in China is Zoological Research, while the foreign journal is Journal of Animal Ecology. (2 kinds)

The domestic representative journals of Immunology are Cellular & Molecular Immunology, while the foreign journals are Immunity. (2 kinds)

The representative journals of Cell Biology are Cell Research, Protein & Cell, Cell Discovery and Signal Transduction and Targeted Therapy. The foreign journals are Cell, Nature Structural & Molecular Biology and Nature Cell Biology. (7 kinds)

The representative domestic journal of Biology is Science China Life Sciences, and the foreign journal is eLife. (2 kinds)

The representative domestic periodicals of Plant Sciences are Molecular Plant and Journal of Integrative Plant Biology, while the foreign periodicals are Plant Physiology and Nature Plants. (4 kinds)

The representative journals in the general category are National Science Review (NSR) (1 kind).

Based on ESI subject classification, it is subordinate to the four major subject areas of Biology & Biochemistry, Immunology, Molecular Biology & Genetics, and Plant & Animal Sciences.

3. Data Analysis

3.1 SBM Efficiency Analysis

DEA-Solver Pro5 software was used to calculate the efficiency value of life science journals, and the calculated results were shown in Table 3.

By comparison, the overall knowledge exchange efficiency of life science journals is not high, the gap between journals is large, and the polarization is extremely serious. The knowledge exchange efficiency of foreign periodicals is higher than that of domestic periodicals, but the development momentum of domestic periodicals is stronger than that of foreign periodicals in recent years.

Table 3. Efficiency of knowledge exchange in life science journals from 2016 to 2021

Journals	2016	2017	2018	2019	2020	2021	Mean Value
Journal of Animal Ecology	1	1	1	1	1	1	1
Zoological Research	0.735	0.553	0.482	0.592	0.667	0.624	0.609
Immunity	1	1	1	1	1	1	1
Cellular & Molecular Immunology	0.765	0.795	0.702	0.615	0.715	0.698	0.715
Cell	0.894	0.921	1	0.954	1	0.834	0.934
Nature Structural & Molecular Biology	1	0.952	0.904	0.987	0.814	0.973	0.938
Nature Cell Biology	0.875	0.906	0.932	1	0.978	0.961	0.942
Cell Research	0.536	0.631	0.624	0.638	0.641	0.682	0.625
Protein & Cell	0.756	0.653	0.762	0.807	0.842	0.805	0.771
Cell Discovery	0.695	0.449	0.612	0.534	0.512	0.607	0.568
Signal Transduction and Targeted Therapy	0.573	0.412	0.496	0.587	0.682	0.813	0.594
eLife	1	1	1	1	0.928	0.966	0.982
Science China Life Sciences	0.772	0.736	0.675	0.720	0.745	0.669	0.720
Plant Physiology	0.803	0.876	0.903	0.942	0.874	0.915	0.886
Nature Plants	0.972	0.956	0.893	0.912	0.954	0.971	0.943
Molecular Plant	0.608	0.664	0.521	0.532	0.728	0.675	0.621
Journal of Integrative Plant Biology	0.723	0.702	0.559	0.624	0.638	0.702	0.658
National Science Review	0.783	0.672	0.714	0.795	0.831	0.804	0.767

In recent years, due to the deepening of the digital transformation of periodicals, a variety of new communication carriers continue to appear, which breaks the space restriction of knowledge transmission and drives the development of periodicals. The input and output of domestic life science journals are basically at the average level, so the efficiency of knowledge exchange is not high, and relevant improvement is needed.

3.2 Malmquist index analysis

In this paper, DEAP2.1 software is used to measure Malmquist index and its decomposition, and dynamic analysis is made on the changes of knowledge exchange efficiency. The average value of total factor productivity (tfpch) of 18 life science journals is greater than 1, and the average annual growth rate is 3.8%. The average annual growth of technical progress (techch) was 5.5%, and the average annual decline of comprehensive technical efficiency (effch) was 1.6%, indicating that the total factor productivity of periodical knowledge exchange was most affected by technological progress, and the decline of comprehensive technical efficiency was mainly caused by the decline of pure technical efficiency (pech) and scale efficiency (sech). It shows that journals need to increase knowledge accumulation and improve relevant technology actively. It can be seen that life journals should increase the scale of investment and improve the ability and scope of periodical knowledge dissemination.

4. Analysis of influencing factors

4.1 Selection of influencing factors

Earlier in this paper, the SBM model and Malmquist index model have been used to measure the efficiency of knowledge exchange of life science journals, and the static and dynamic analysis of the efficiency of knowledge exchange of life science journals has been carried out respectively from the micro level. From the macro level, this paper analyzes the influencing factors of periodical knowledge exchange efficiency. Based on the study of previous literatures, most scholars select indexes such as academic quality, internationalization degree, launch time, publishing cycle, network communication and new media integration according to the characteristics of evaluated journals in terms of factors influencing the efficiency of periodical knowledge exchange.

The advent of the digital age has greatly changed the way of information transmission and acquisition. With the continuous increase of network users, traditional media began to integrate with various new media. As the carrier of academic information dissemination, the integration of academic journals with microblog, wechat, Twitter, Facebook and other new media makes the way of academic information dissemination take on a new look.

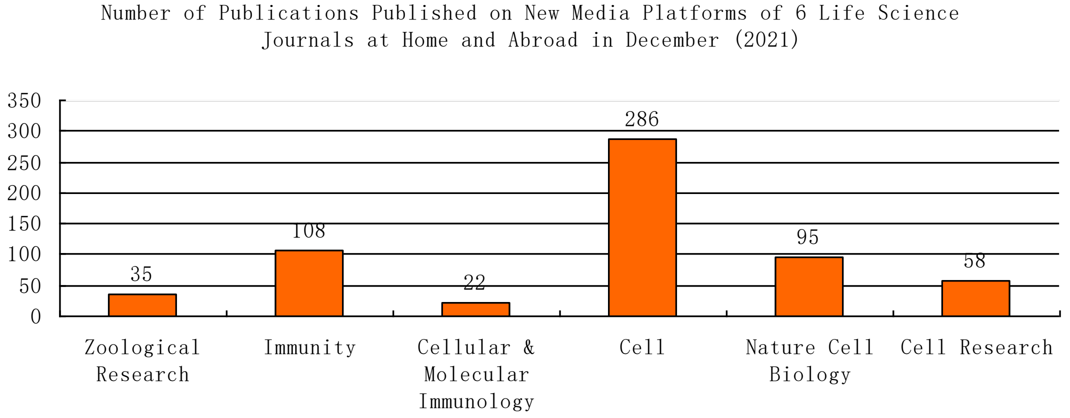

Figure 1. Number of Publications Published on New Media Platforms of 6 Life Science Journals at Home and Abroad in December (2021).

Considering the internal and external factors of life science journals, aging speed (X1), academic quality (X2), publication cycle (X3), publication time (X4) and new media integration (X5) are finally selected as factors influencing the efficiency of knowledge exchange of journals.

4.2 Data Analysis

In this paper, the knowledge exchange efficiency value of life science journals was taken as the dependent variable, the relevant influencing factors were introduced as the independent variables, and the Hausman test was conducted by Stata16 software. After measurement, Tobit model with fixed effect is finally selected, and the regression results are shown in Table 4.

Table 4. Tobit regression results

Y	Regression Coefficient	Standard Error	t Value	*P* Value
X1	-0.005	0.005	-0.824	0.432
X2	0.1752*	0.092	-2.185	0.031
X3	0.018**	0	-3.624	0.000
X4	-0.021**	0.005	-4.931	0.000
X5	0.015**	0	-4.215	0.000

Note: * means $P < 0.05$, ** means $P < 0.01$.

The regression coefficient of periodical aging speed (X1) is -0.005, which does not pass the significance test and has no significant impact on the efficiency of knowledge exchange. It shows that increasing or reducing the cited half-life is not very helpful to improve the efficiency of knowledge exchange of periodicals. More importantly, periodicals need to constantly explore suitable development strategies, improve the influence of periodicals and improve the efficiency of knowledge exchange in multiple ways.

Journal academic quality (X2) was significant at the 5% level, with a regression coefficient of 0.1752. It shows that the higher the academic quality of the accepted papers, the greater the efficiency of knowledge exchange. Therefore, periodicals should pay attention to the quality of articles and make reasonable use of their own characteristics and advantages to attract more excellent manuscripts.

The publication cycle (X3) of the journal is significant at the 1% level, with a regression coefficient of 0.018. This indicates that although the extension of the publication cycle of periodicals will compress the number of articles and have a certain impact on the scale of input, in the process of review with a longer period, periodicals can more strictly control the quality of manuscript sources and continuously improve the quality and influence of periodicals, which just make up for the defects caused by the reduction of the number of articles.

The publication time (X4) of the journal was significant at the 1% level, and the regression coefficient was -0.021. This indicates that although the knowledge reserve of periodicals with a long history is relatively large, the knowledge has not reached "qualitative change" through "quantitative change", which cannot represent the level of knowledge quality. Moreover, by absorbing a large amount of experience, the degree of brand building and the breadth and depth of knowledge dissemination of periodicals with a short history are no less than those with a long history. Therefore, journals should control the quality and value of knowledge in the process of knowledge transmission, firmly control the quality of manuscripts, give full play to their own advantages, and run a good journal.

Journal new media integration (X5) is significant at the 1% level, with a regression coefficient of 0.015. In the information age, academic journals actively construct new media matrix to maximize the dissemination and interaction of information with the help of the Internet. In the process of transformation, periodicals should carry out information dissemination selectively and emphatically according to the communication characteristics of each platform, which is conducive to the efficiency of knowledge exchange of periodicals.

5. Conclusions and Suggestions

This paper takes 18 life science journals from 2016 to 2021 as the research object, uses SBM model and Malmquist index model to conduct static and dynamic analysis on the efficiency of knowledge exchange of journals, and analyzes the influencing factors of knowledge exchange efficiency combined with Tobit model. The study found that the overall knowledge exchange efficiency of life science journals was low, and there were still deficiencies in pure technical efficiency and scale efficiency. The academic quality of journals, publication cycle of journals, launch time of journals and new media integration of journals passed the significance test, which had a significant impact on the efficiency of knowledge exchange. The aging speed of journals has no significant effect on the efficiency of knowledge exchange.

Based on the above conclusions, some suggestions are put forward to improve the efficiency of knowledge exchange in life science journals: First, life science journals should pay attention to the improvement of the input scale. On the premise of ensuring the quality of the sources, they should properly expand the input in the amount of knowledge [14]. For example, by opening the mode of "network debut", they can shorten the publication cycle of the papers and expand the transmission through the network, so as to effectively make up for the shortage of the input scale of the journals. It is helpful to improve the efficiency of periodical knowledge exchange to control the number of citations of periodical papers properly. The second is to constantly improve the technology of knowledge exchange and dissemination, reform the management system, give full play to their own advantages, find out the positioning of the periodical, launch the high-quality feature columns, optimize the overall allocation of resources, and actively explore the new road of periodical construction and development under the new situation [15]. Pay attention to the quality of manuscripts, improve the review system, and constantly improve the review level. Clear the purpose of running the journal, improve the quality of binding, build a brand journal, and absorb more high-quality manuscripts. So as to make up for the loss of input, expand output, improve the efficiency of knowledge exchange [16]. The third is to attach importance to the functions of journals in academic exchange, knowledge sharing and think tank construction. In the context of the integration with new media, it is particularly important for academic journals to optimize the topic selection of platform communication content, enhance the connection between tweets, and strengthen the effective interaction with the general audience and peers in order to achieve the goals of good operation, expanding the scope of audience and enhancing the readability of communication content.

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