Research on Predatory Journal Identification Using Altmetrics Indicators

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Abstract

Objective To investigate the effectiveness of applying Altmetrics indicators to the identification of predatory journals and to provide a new perspective for predatory journal identification. Methods Based on the Logit regression model, three predatory journal discriminant models were constructed respectively: one containing only average citation count, one containing only Altmetrics presence rate indicator, and one simultaneously integrating both indicators. The fitting performance of the three models was compared through ROC curves. Finally, journal data from invitation-to-submit emails were used to validate the model effectiveness. Results The predatory journal discriminant model simultaneously integrating average citation count and Altmetrics presence rate indicator achieved optimal performance, with both indicators showing significant negative correlation with journal predatory nature. Validation using data from 14 journals from invitation-to-submit emails found that over 85% were identified as predatory journals, demonstrating the rationality of the model. Conclusion Altmetrics indicators demonstrate good effectiveness in the identification of predatory journals and provide a new and beneficial supplement for predatory journal identification.

Full Text

A Study of Predatory Journal Identification Using Altmetrics Indicators

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Abstract: [Purpose] This study explores the effectiveness of applying Altmetrics indicators to the identification of predatory journals, aiming to provide a new perspective for predatory journal detection. [Methods] Based on the Logit

regression model, three discriminant models for predatory journals were constructed: one using only average citation counts, one using only Altmetrics presence rates, and one integrating both indicators. The ROC curve was employed to compare the fitting effects of these three models. Finally, journal data from invitation emails were used to validate the model performance. [Findings] The model integrating both average citation counts and Altmetrics presence rates demonstrated the optimal performance, with both indicators showing significant negative correlations with journal predatory behavior. Validation using data from 14 journals that sent solicitation emails revealed that over 85% were identified as predatory, confirming the model's rationality. [Conclusions] The application of Altmetrics indicators shows promising results in identifying predatory journals and provides a valuable new supplement to existing detection methods.

Keywords: Predatory journals; Altmetrics; Citation frequency; Logit model; Identification studies

Open Access (OA) is an academic journal publishing model proposed to promote the sharing of academic information resources and facilitate scholarly communication. As the primary product of open access, OA journals provide free access to published articles for public readers, enabling more efficient and convenient dissemination of academic achievements. OA publishers charge authors article processing fees (APCs) to maintain operations and profitability. However, some unscrupulous publishers have exploited this model by publishing paid literature in large volumes without proper review to maximize profits. Jeffrey Beall, a librarian at the University of Colorado, termed such journals that exploit the open access model through fabrication and false promises while irresponsibly collecting APCs for profit as "predatory journals." Predatory journals have since entered scholars' 视野 and attracted widespread attention and discussion.

Predatory journals exploit the characteristics of open access to conceal their deceptive nature and seek private gains, causing certain disruptions and damage to the open access movement. In recent years, predatory journals have shown rapid growth, seriously harming the academic ecosystem. Data published by *Nature* in March 2022 indicated that the number of predatory journals has exceeded 15,500 and continues to grow rapidly. However, current academic research on predatory journal identification remains relatively weak. Existing identification methods primarily rely on list-based approaches, such as Beall's "potential, possible, or probable predatory scholarly open-access publishers" list and the Kscien Predatory List Committee's Kscien's List. These list-based methods have obvious limitations: first, they are difficult to generate and update, making it challenging to timely include newly emerged predatory journals; second, they cannot cover all predatory journals, resulting in certain false-negative rates. Therefore, as the number of articles published in predatory journals increases annually, how to identify and judge predatory journals has become an urgent concern. In recent years, Altmetrics has gained widespread attention as a new indicator for measuring academic impact, providing a novel perspective for jour-

nal evaluation. This study aims to utilize Altmetrics indicators to judge journal predatory behavior, hoping to establish a more effective identification method.

1.1 Research on Characteristics and Identification Methods of Predatory Journals

Given the significant global impact and harm caused by predatory journals, scholars have studied their distinguishing characteristics from various dimensions. The 2022 InterAcademy Partnership (IAP) report *Combatting Predatory Academic Journals and Conferences* employed mapping methods to specifically differentiate characteristics of various journals, with typical predatory journal features including nonexistent or incorrect peer review, imitation of other journals or websites, absent or fake editorial boards, and alternative or fake impact factors. Shamseer et al. identified 13 characteristics of English-language predatory scientific journals, including website spelling and grammatical errors, promises of rapid publication, and absence of retraction policies. Frandsen found that authors publishing more frequently in predatory journals also had higher average publication counts (and medians) across Scopus, showing a certain positive correlation. Based on multi-dimensional research, predatory journals exhibit vulnerabilities and problems in various aspects including fees, promotion, review processes, and policies, which have become their relatively obvious characteristics.

As predatory journal characteristics continue to be discovered and summarized, researchers have proposed numerous perspectives on identification indicators and methods in recent years. Regarding the high publication fees of predatory journals, Xia studied their charging practices and found that APCs cannot serve as the sole criterion for distinguishing predatory journals. Wang Lingfeng et al. proposed the Journal Price Index (JPI) to evaluate the reasonable level of academic journal publication fees, providing a simple and effective objective method for precisely defining predatory journals from the perspective of page charges. Ruiter-Lopez et al. examined editorial boards of predatory journals using quantitative methods and found that most board members were high-level scholars with a median publication count of 43, citation count of 664, and h-index of 14, indicating that checking editorial board membership is difficult for identifying predatory behavior. Regarding journal websites and terminology, Chen L-X et al. used machine learning methods to extract website text content and keywords from mainstream predatory and legitimate journal websites, proposing a predatory journal classification system based on a new model. Chen et al. also found that measuring word frequency differences between journals using differential scoring could improve classification efficiency of bag-of-words models and TF-IDF algorithms to help identify predatory journal characteristic words. However, journal websites and vocabulary usage can be adjusted and modified, making the boundary between predatory and low-quality journals still relatively ambiguous. Yeo-The et al. argued that the most important criterion for distinguishing predatory from legitimate academic journals is the

rigor of peer review, and that authors' motivations or intentions are also crucial. Kong Yehan et al. conducted comparative analysis from six dimensions including academic publishing legitimacy, commercial fraud behavior, and academic misconduct, establishing 18 secondary indicators to classify identified "warning journals" into different levels. Although analyzing these motivational and behavioral factors yields deeper conclusions, subjective factors are difficult to collect and judge, which may affect identification accuracy. Therefore, many scholars also study predatory journals from citation perspectives. Frandsen tracked citations to 124 predatory journals in Scopus from 2013-2016, finding they were cited 1,295 times (approximately 10.5 times per journal) and concluded that citations to predatory journals in non-predatory literature were limited. Bo-Christer Björk et al. randomly selected 250 articles published in predatory journals from Google Scholar and studied their citation data over five years, finding each article was cited an average of 2.6 times, with 56% of articles receiving no citations at all.

1.2 The Value and Applications of Altmetrics Indicators

Although traditional citation indicators are frequently used to measure academic impact, they suffer from issues such as time lag, negative citations, and self-citations, and cannot comprehensively reflect academic influence. With the continuous development of social online media platforms, scientific communication has become increasingly networked and academic activities more open. More and more researchers use online academic networks and social media platforms to acquire, disseminate, and exchange academic resources. In 2010, J. Priem first proposed the concept of Altmetrics on Twitter to evaluate the impact of academic papers on social networks by tracking their dissemination and communication online to measure their societal impact.

As an emerging indicator of research impact, Altmetrics has attracted extensive scholarly attention since its inception. Existing literature shows that Altmetrics application research primarily focuses on comprehensive evaluation of paper or journal impact. For example, at the paper level, Wang Yanbo et al. proposed combining Altmetrics indicators (measuring societal impact) with traditional citation indicators (measuring academic impact) to construct a more comprehensive and holistic evaluation system for academic paper impact. At the journal level, Wang Kaili et al. integrated citation analysis and Altmetrics methods to construct a journal impact evaluation system and applied it to analyze international library and information science journals. Yu Zhenglu et al. used Altmetrics mention counts to statistically analyze the international societal impact of Chinese English-language scientific journals. These studies demonstrate that the effectiveness of Altmetrics indicators for comprehensive evaluation of paper or journal impact has been preliminarily validated.

1.3 Using Altmetrics Indicators for Predatory Journal Identification

Although research on using Altmetrics indicators to identify predatory journals is limited, preliminary studies suggest its potential. The authors' previous research analyzed the performance of predatory versus non-predatory journals in library and information science on Altmetrics, finding that predatory journals had much lower Altmetrics presence rates than non-predatory journals. However, due to limited predatory journal data, the study could not conclusively determine that Altmetrics could effectively identify predatory journals, and its utility awaits validation through large-sample systematic research. Building on this foundation, this study selects the biomedical field where predatory journals are widely distributed, introduces Altmetrics indicators on top of traditional citation-based identification methods, and employs Logit regression models to construct discriminant models for predatory journals, providing new indicators and methods for their identification.

2.1 Research Hypotheses

Based on the literature review and analysis of journal predatory behavior and Altmetrics and citation indicators, this study constructs two hypotheses and uses the Logit regression model with journal citation and Altmetrics indicator values as independent variables and journal predatory behavior as the dependent variable to test these hypotheses.

Hypothesis 1: Citation indicators are negatively correlated with journal predatory behavior, meaning that when average citation metrics are higher, the probability of a journal being identified as predatory decreases.

Hypothesis 2: Altmetrics indicators are also negatively correlated with journal predatory behavior, meaning that when Altmetrics indicators are higher, the probability of a journal being identified as predatory decreases.

2.2 Research Methods

The Logit model, also known as the "logistic regression model" or "classification model," is a type of discrete choice model used to predict the probability of event occurrence. It primarily includes binary Logit regression models and multinomial Logit regression models. Binary Logit regression models have dichotomous dependent variables, typically defining event occurrence as "1" and non-occurrence as "0." Multinomial Logit regression models are suitable for dependent variables with multiple categories. Logit models are widely applied in sociology, biostatistics, econometrics, and other fields. In library and information science, Ren Haizhi et al. used multinomial Logit regression models to empirically analyze factors influencing the dissemination power of book publishing companies' official WeChat accounts. This study focuses on predatory journal identification, and the binary Logit model can effectively characterize the two categories of "predatory journals" and "non-predatory journals." Since this study hypothesizes negative correlations between citation indicators and

Altmetrics indicators and predatory behavior, the binary Logit model is selected for journal type identification analysis.

In linear regression, the dependent variable y has a range of $(-\infty, +\infty)$, while event occurrence probability ranges from [0,1]. Therefore, a Logit transformation of the linear regression model is required. First, we introduce the odds ratio (Odds), which represents the ratio of the probability of event occurrence to non-occurrence. The calculation method for Odds is shown in Equation (1), where Odds has a range of $[0, +\infty)$:

$$\text{Odds} = \frac{p}{1-p}$$

where p represents the probability of event occurrence.

Taking the natural logarithm of Odds yields the Logit, which maps p from [0,1] to $(-\infty, +\infty)$, enabling multivariate linear regression modeling. The process from probability p to Odds to Logit is called the Logit transformation, as shown in Equation (2):

$$\text{logit}(p) = \ln(\text{Odds}) = \ln\left(\frac{p}{1-p}\right) = \alpha_0 + \sum \alpha_j x_j$$

where p represents the probability of a particular value of the dependent variable, x_j represents independent variables, α_j represents coefficients of independent variables, α_0 represents the intercept term, and the error term is omitted for simplicity.

2.3.1 Definition and Data Sources of Dependent Variable

This study employs a dichotomous discrete variable of journal type as the dependent variable, defining predatory journals = 1 and non-predatory journals = 0. Shen and Björk found that the number of articles in predatory journals increased rapidly year by year, from over 53,000 in 2010 to more than 420,000 in 2014, with approximately 8,000 active predatory journals, the vast majority of which were in biomedicine and related fields. Therefore, this study randomly selected 100 predatory journals and 100 non-predatory journals from the biomedical field as research samples. Predatory journal data were sourced from Kscien's List, while non-predatory journal data were obtained from the DOAJ directory. DOAJ is a directory of peer-reviewed open access journals created and maintained by Lund University Libraries in Sweden, with strict journal inclusion standards and evaluation processes. Since both Kscien's List and DOAJ consist of open access journals, the two types of journal samples selected in this study are comparable.

2.3.2 Definition and Data Sources of Independent Variables

Citation counts reflect the academic impact of articles or journals to some extent, serving as important indicators for evaluating paper quality and value, and forming the core metric for calculating journal impact factors. To eliminate the influence of journal article quantity differences on citation counts, this study uses the average number of citations per journal as the citation metric, denoted by variable x_1. Data on the number of articles published by journals from 2012-2022 were collected by crawling journal websites, and citation counts for the same period were obtained using Web of Science. The specific calculation formula is shown in Equation (3):

$$\text{Average Citations per Journal} = \frac{\text{Total Citations of Journal Articles}}{\text{Number of Articles Published by Journal}}$$

Altmetrics serves as a new indicator for measuring the societal impact of academic achievements, expanding traditional citation-based impact evaluation and more comprehensively reflecting the influence of academic achievements in digital networks. Since the concept of Altmetrics was proposed, various measurement tools have emerged, such as Altmetric.com, PlumX, and Crossref Event Data (CED). Among these, Altmetric.com covers a wide range of information sources, including over 5,000 mainstream media outlets and 15,000 academic and non-academic blogs worldwide, and offers free access to researchers. Consequently, most Altmetrics-related research in recent years has adopted Altmetric.com. This study used Altmetric.com's Altmetric Explorer tool, with journal ISSN as the search condition, to obtain Altmetrics data for journals from 2012-2022. To eliminate the influence of journal scale differences, this study defines the Altmetrics presence rate indicator, denoted by variable x_2, with the specific calculation formula shown in Equation (4):

$$\text{Altmetrics Presence Rate} = \frac{\text{Number of Articles with Altmetrics Scores}}{\text{Number of Articles Published by Journal}}$$

3 Empirical Analysis

3.1 Descriptive Statistics

Descriptive statistics for the Altmetrics presence rates and average citation counts of the 200 sampled predatory and non-predatory journals (Table 1) reveal that the average Altmetrics presence rate for predatory journals is only 0.0088. Among these 100 journals, 81 have an Altmetrics presence rate of 0, indicating that 81% of predatory journal articles receive no Altmetrics scores. This demonstrates that predatory journal articles receive little attention and discussion on social media. The mean average citation count for these predatory journals is 0.7210, meaning each article is cited approximately 0.7210 times on average.

In contrast, non-predatory journals have an average Altmetrics presence rate of 0.338, significantly higher than the 0.0088 for predatory journals. This indicates that non-predatory journals have much greater influence on social networks than predatory journals. For non-predatory journals, only 23 journals have an Altmetrics presence rate of 0, and the highest Altmetrics presence rate reaches 0.9916, showing that compared to predatory journals, non-predatory journals receive much more attention and have greater influence on social networks. Regarding citations, the mean average citation count for non-predatory journals is 5.1763, higher than that for predatory journals. This indirectly reflects that the quality of predatory journal articles is difficult to guarantee, may not provide constructive viewpoints, and are less frequently cited, while non-predatory journal articles may be of higher quality and provide more substantial help to researchers, resulting in more citations.

3.2 Empirical Analysis Results Based on Logit Model

The above analysis shows significant differences in average citation counts and Altmetrics presence rates between predatory and non-predatory journals. Can these be used as indicators to determine journal predatory behavior? Using Stata 14.0 software, the following three Logit regression models were established and compared. First, a predatory journal identification model was constructed based on citation indicators alone (Model 1). Then, a discriminant model using only Altmetrics presence rates was examined (Model 2). Finally, a predatory journal identification model incorporating both average citation counts and Altmetrics presence rates was built (Model 3), and the three models and their effects were compared and analyzed.

3.2.1 Analysis Results of Citation-Only Discriminant Model (Model 1) Logit model regression analysis of journal average citation counts using Stata 14.0 software yielded the results shown in Table 2 . The Logit model fitting result expression is:

$$\text{logit}(p) = \ln\left(\frac{p}{1-p}\right) = 0.864 - 0.438 \times \text{AverageCitations}$$

The coefficient for the average citations variable is -0.438 $<$ 0 (sig $<$ 0.05), indicating that average citation count is significantly negatively correlated with whether a journal is predatory, supporting Hypothesis 1. When average citation counts are low, the probability of a journal being predatory increases.

After calculating model parameters, it is necessary to evaluate whether the calculated expected probabilities and actual probabilities fit effectively. If actual observations show high consistency with model predictions, the model is considered to fit the data; otherwise, the model is rejected and variables must be reset. This study uses the Hosmer-Lemeshow test to evaluate the goodness-of-fit of the binary Logit regression model.

The Hosmer-Lemeshow test measures the 吻合程度 between fitted and observed values. If Sig < 0.05, the model's predicted values differ significantly from observed values, indicating poor model performance. Conversely, if Sig > 0.05, the model's estimates fit the data at an acceptable level, indicating good model performance. The Hosmer-Lemeshow test for the citation-only discriminant model yields Sig $= 0.000 < 0.05$, indicating that the Logit discriminant model based solely on average citation counts has poor fit. Therefore, we attempt to introduce Altmetrics indicators for discrimination.

3.2.2 Analysis Results of Altmetrics-Only Discriminant Model (Model 2) First, a Logit discriminant model was established using only journal Altmetrics presence rates, yielding the Logit model fitting results shown in Table 3 . The coefficient for Altmetrics presence rate is -14.871 < 0 (sig < 0.05), indicating that journal Altmetrics presence rate is significantly negatively correlated with whether a journal is predatory, supporting Hypothesis 2. The higher the journal's Altmetrics presence rate, the lower the probability of it being predatory. Since Altmetrics presence rate reflects a journal's societal impact, this result is reasonable. The Hosmer-Lemeshow test continues to be used to evaluate model fit, yielding Sig $= 0.997 > 0.05$ for the Altmetrics-based discriminant model, indicating good model fit.

3.2.3 Analysis Results of Discriminant Model with Both Indicators (Model 3) In addition to constructing a Logit discriminant model using Altmetrics presence rate alone, a Logit regression model incorporating both average citation counts and Altmetrics presence rate variables was established. The Logit model fitting result expression is:

$$\text{logit}(p) = \ln\left(\frac{p}{1-p}\right) = 1.220 - 0.204 \times \text{AverageCitations} - 12.015 \times \text{AltmetricsPresenceRate}$$

The regression results are shown in Table 4 . The significance levels for average citations and Altmetrics presence rate indicators are 0.033 and 0.002 respectively, both less than 0.05, indicating significant fit. Both average citation counts and Altmetrics presence rate have negative effects on whether a journal is predatory, supporting Hypotheses 1 and 2. When both average citation counts and Altmetrics presence rates are low, the probability of a journal being predatory is higher. These results are consistent with those from Models 1 and 2.

The Hosmer-Lemeshow test for model goodness-of-fit yields Sig $= 0.3568 > 0.05$. In the Hosmer-Lemeshow test, Sig > 0.05 indicates good fit, and Sig > 0.1 indicates even better fit, demonstrating that the discriminant model incorporating Altmetrics presence rate has good fit.

3.2.4 Comparative Analysis Results of Three Models ROC curve analysis was used to examine model prediction accuracy, with the area under the ROC curve (AUC) considered to indicate sufficient discriminatory power when greater than 0.75. Based on curve position, the ROC curve divides the graph into two parts, with the area under the curve called AUC (Area Under Curve), representing prediction accuracy. Higher AUC values (larger area under the curve) indicate higher prediction accuracy. Curves closer to the upper-left corner (smaller X, larger Y) indicate higher prediction accuracy. This study uses ROC analysis for comparative analysis of the three models.

The ROC results (Table 5) show that Model 3's prediction performance is superior to Models 1 and 2, meaning Model 3 has higher prediction accuracy. In discriminant model construction, the model integrating both average citations and Altmetrics presence rate performs better than models using either indicator alone, and the Altmetrics-only model performs better than the citations-only model. This proves the rationality and correctness of introducing Altmetrics indicators for predatory journal discrimination proposed in this study.

4 Model Validation

To validate model effectiveness, data were collected from journals in invitation emails received within the past year. Sureda-Negre et al. analyzed journals from emails soliciting publications sent to three professors in education at a Spanish university over three months, finding that most journals (69.7%) appeared on predatory journal lists and concluding that journals sending solicitation emails to scholars are mostly of low quality. Therefore, using invitation email journals for discriminant model validation is considered reasonable. After excluding journals already appearing on Kscien's List, the journals shown in Table 6 were obtained.

Using the same data collection method, citation and Altmetrics data for these journals were collected and input into Model 3 for validation. The results are shown in Table 7 . Among the 14 validation journals, only one journal—*Health Informatics Journal*—had a predicted probability of being predatory of 0.003 < 0.5. Upon investigation, *Health Informatics Journal* is an SCI-indexed journal in JCR Q3, which matches our prediction of low predatory probability. The remaining 13 journals have predicted probabilities greater than 0.5, with 12 having probabilities greater than 0.7, indicating that although these journals have not yet appeared on Kscien's predatory journal list, they have high probabilities of being predatory. This aligns with Sureda-Negre et al.'s view that journals sending solicitation emails to scholars are of low quality, and demonstrates the rationality of the predatory journal discriminant model integrating both average citations and Altmetrics presence rate.

5 Discussion and Conclusion

This study constructed three predatory journal discriminant models based on Logit regression: one containing only average citation counts, one containing only Altmetrics presence rates, and one containing both indicators. Comparative analysis revealed that the models containing only Altmetrics presence rates and both indicators performed optimally. Although citation indicators are traditionally considered suitable for measuring journal academic impact, Oviedo-García's analysis of the predatory publisher MDPI showed that some predatory journals have high self-citation rates, leading to artificially high citation counts. This indicates that high citation counts in these journals may be manipulated, making pure citation-based identification inaccurate. In the Web 2.0 environment, Altmetrics indicators fully utilize academic social networks for bibliometric analysis. With more timely data updates, Altmetrics can avoid the lag in evaluating academic impact and supplementarily reflect the societal impact of academic achievements. The combined application of Altmetrics and citation indicators can more comprehensively evaluate academic impact. In this study, the discriminant model incorporating both average citations and Altmetrics indicators integrates the advantages of both types of indicators, thus achieving better results in judging journal predatory behavior.

Building on this foundation, data from journals in solicitation emails were collected and input into the discriminant model incorporating both average citations and Altmetrics presence rates for validation. The results showed that journals sending email invitations are highly likely to be predatory, demonstrating that Altmetrics indicators have good effectiveness in identifying predatory journals and can better judge journal quality, providing new indicators and methods for predatory journal identification.

Nevertheless, this study has certain limitations. First, due to data acquisition difficulties, we could only preliminarily validate the effectiveness of using journal citation and Altmetrics indicators for predatory journal identification. Second, the methods applied require further optimization. Future research will attempt improvements in two aspects: first, expanding indicator types to include more effective predatory journal identification indicators to enrich model output; second, increasing sample size and adopting more advanced methods such as random forest models in machine learning to improve identification effectiveness and model precision. Overall, this study offers certain 启发意义 for predatory journal identification, but further expansion in data and methods is needed.

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Note: Figure translations are in progress. See original paper for figures.