

Evaluation of Economics Journals Based on Reduction Algorithm of Rough Set and Grey Correlation

Mei-Jia Huang¹, Yuan-Biao Zhang^{2,3}, Jie-Huan Luo¹ & He Nie¹

¹Electrical and Information School, Jinan University, Zhuhai 519070, China

²Packaging Engineering Institute, Jinan University, Zhuhai 519070, China

³Key Laboratory of Product Packaging and Logistics of Guangdong Higher Education Institutes, Jinan University, Zhuhai 519070, China

Correspondence to: Yuan-Biao Zhang, Packaging Engineering Institute, Jinan University, Zhuhai 519070, China.
E-mail: zybt@jnu.edu.cn

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Abstract

In order to evaluate economics journals objectively and avoid the problem arising from artificial subjective factors, this paper put forward an evaluation of economics journals model based on reduction algorithm of rough set and grey correlation. Firstly, it used reduction algorithm of rough set based on equivalence relation to determine the key indicators. Secondly, it determined the key indicators weights by using grey correlation degree method, then used dominance relation of rough set method to determine another group of weights of key indicators. Lastly, it combined TOPSIS with two groups of weights above to evaluate and rank economics journals and compared the results, proved the evaluation model of economics journals based on reduction algorithm of rough set and grey correlation could be applied in evaluation of economics journals with high practicality and reasonability.

Keywords: evaluation of economics journals, rough set, grey correlation, dominance-based rough set, TOPSIS

1. Introduction

The journal industry has made great progress in our country. The quality of journals becomes more important as they are increasing in the number. Therefore, it is of great significance to establish reasonable and objective indicator evaluation systems to evaluate journals level objectively. Many scholars have used different evaluation indicators and methods to set up kinds of journal evaluation systems and improved these systems as well. Zhang Hong et al. (2008) use the principal component analysis method to evaluate scientific journals. Li et al. (2007) put forward a comprehensive evaluation method based on variance right to determine the indicators weights and drew a conclusion that key indicators can replace all indicators to evaluate journals. Liu et al. (2006) analyse the relationship between academic indicators using normalization and conventional evaluation results for sci-tech journals. Wang et al. (2012) use key ratio method to determine key indicators in the evaluation of journals and used TOPSIS method to evaluate and rank journals.

Rough set theory is a math tool for dealing with imprecise, inconsistent and incomplete information and knowledge in quantitative analysis (Pawlak, 1982). Rough set theory is commonly used in data classification. Its basic idea is to utilize equivalence relation classes through attribution reduction and decision rule reduction, to achieve knowledge mining and reduction in the case of keeping the same ability for classification. Xiao et al. (2001) use rough set theory to analyse the evaluation result of research project supported by science foundation. Xiong Ping et al. (2003) put forward a new subjective weighting method based on rough sets. Rough set theory has been developed rapidly. It has a high application value in multiple attribute decision making and can be used in the academic evaluation system.

Grey correlation analysis is an important branch of the grey system theory (Deng, 2002). The basic idea of grey correlation analysis is to judge whether the contact is close according to the similar degree of sequence curve geometry shape. The more similar tow curves are, the greater the correlation between corresponding sequences are, and vice versa. So it can identify the influence degree of the object to be identified to the object of study by comparing the degree of the correlation. Compared to the system analysis methods such as principal component analysis and regression analysis, grey correlation analysis is independent of the sample capacity and the rules of

probability distribution and its computation cost is small.

On the basis of the researches of others, this paper puts forward an evaluation of economics journals model based on reduction algorithm of Rough Set and Grey Correlation. Firstly, using reduction algorithm of Rough Set to determine the key indicators, then determine the key indicators weights by using grey incidence degree analysis method, and then using dominance relation of rough set method to determine another group of weights of these key indicators (Lv et al., 2012). Lastly, we combines TOPSIS with two groups of weights determined above to evaluate and rank economics journals and compare the results (Qian et al., 2008), proves the evaluation model of economics journals based on reduction algorithm of rough set and grey correlation is more reasonable.

2. The Reduction Evaluation Model Based on Grey-Rough Set

This paper uses indicators reduction algorithm based on the equivalence relation of rough set theory to reduce seven common evaluation indicators of journals to get the key indicators. Then through studying the correlation of feature data of evaluation indicator and feature data of journals ranks to obtain the importance of each factor, and weight according to their importance. We combine the weight with TOPSIS method for comprehensive evaluation of journals. And compare results with another weighting method—dominance relation of rough set.

2.1 Rough Set Reduction

There are some definitions on rough set reduction as follows (Zhou, 2008):

Definition 1: Let N denotes a family of equivalence relations, if $IND(N) = IND(R - \{N\})$, we call N can be reduced in the equivalence relation family R , otherwise cannot. If any equivalence relation N of R cannot be reduced, we called R is independent, otherwise known as dependent.

Definition 2: Set $R = (r_{ij})_{m \times n}$, if M is independent, and $IND(M) = IND(S)$, then M is a reduction of equivalence relation family S .

Base on Rough set theory and reduction principles, we can obtain reduction algorithm of evaluation indicators, described as follows:

Step 1: for the evaluation indicators system $R = \{n_i\} (i = 1, \dots, k)$, obtaining $IND(R)$.

Step 2: for $i = 1, \dots, m$, obtaining $IND(R - \{n_i\}) (i = 1, \dots, k)$.

Step 3: if $IND(R - \{n_i\}) = IND(R)$, that is, n_i is miscellaneous indicators of indicator system R can be removed, if not, n_i is necessary indicators cannot be removed.

2.2 Grey Correlation Weights

The evaluation weight determination of comprehensive evaluation system is an important factor to affect the results of the evaluation, thus determining the evaluation weight objectively and reasonably is particularly important. Common methods of endow with weight are subjective weighting method, objective weighting method and a combination of subjective and objective weighting method. In this paper, we do a gray correlation weights analysis, through studying the correlation of feature data of evaluation indicator and feature data of journals ranks to obtain the importance of each factor, and weight according to their importance.

Some definitions about grey correlation as follows:

A system for behavior sequence:

$$\begin{cases} X_0 = (x_0(1), x_0(2), \dots, x_0(n)) \\ X_1 = (x_1(1), x_1(2), \dots, x_1(n)) \\ \dots \\ X_i = (x_i(1), x_i(2), \dots, x_i(n)) \\ \dots \\ X_m = (x_m(1), x_m(2), \dots, x_m(n)) \end{cases}$$

The correlation coefficient between X_i and X_0 is:

$$r_{ij} = \frac{\min_i \min_j |x_0(j) - x_i(j)| + \rho \max_i \max_j |x_0(j) - x_i(j)|}{|x_0(j) - x_i(j)| + \rho \max_i \max_j |x_0(j) - x_i(j)|}$$

Get the correlation coefficient matrix:

$$R = (r_{ij})_{m \times n}$$

The degree of correlation between X_i and X_0 is:

$$r_i = \frac{1}{n} \sum_{j=1}^n r_{ij}$$

Where, $\rho \in (0,1)$ is resolution ratio, generally $\rho = 0.5$ according to the principle of minimum information.

The calculation steps about determination of weight using grey correlation as follows:

Step 1: X_0 and X_i do the initial treatment,

$$X'_i = X_i / X_i(1) = (x'_i(1), x'_i(2), \dots, x'_i(n)), i = 0, 1, 2, \dots, m$$

Step 2: strives for the sequence of difference:

$$\Delta_i(j) = |x'_0(j) - x'_i(j)|$$

Where, $i = 1, 2, \dots, m$, $j = 1, 2, \dots, n$.

Step 3: strives for the correlation coefficient:

$$M = \max_i \max_j \Delta_i(j), m = \min_i \min_j \Delta_i(j)$$

Therefore, correlation coefficient is:

$$r_{ij} = \frac{m + \rho M}{\Delta_i(j) + \rho M}, \rho \in (0,1), i = 1, 2, \dots, m, j = 1, 2, \dots, n$$

Step 4: calculate correlation degree and weight,

$$r_i = \frac{1}{n} \sum_{j=1}^n r_{ij}$$

Finally, we normalize γ_{0i} , and order

$$\omega_i = \frac{r_i}{\sum_{i=1}^m r_i}, i = 1, 2, \dots, m$$

Where, denote ω_i as indicators weight.

Base on reduction of rough to get core indicators, we use grey correlation weights methods to calculate the correlation degree of journals and calculate the weight of core indicators.

3. Instance Analysis

This paper selects a part of journals and the data of seven common evaluation indicators of these journals from *CHINESE S&T JOURNAL REPORTS (Expanded Edition)*, as well as search the ranks of relevant journals in *A Report on Chinese Academic Journals Evaluation*. Then using indicators reduction algorithm based on the equivalence relation of rough set theory to reduce seven common evaluation indicators of journals to get the key indicators. And do a determination on the indicators weights by using grey incidence degree analysis method and dominance relation of rough set method. Lastly, it combines two groups of weights above with TOPSIS method for comprehensive evaluation of journals and compares the results.

3.1 Evaluation Indicators Reduction Based on Equivalence Relation of Rough Set

This paper selects 20 economics journals in four grades from *A Report on Chinese Academic Journals Evaluation* as research objects, as well as search the data of seven common evaluation indicators of these journals from *CHINESE S&T JOURNAL REPORTS (Expanded Edition)*.

Let $a_1, a_2, a_3, a_4, a_5, a_6, a_7$ denote total citation, impact factor, current-year index, cited rate, H index, average amount of citations and ratio of funded papers.

The journals selected are divided into 4 grades according their ranks in *A Report on Chinese Academic Journals Evaluation*. Let d denote grade. The range of values for d is 1 to 4, the higher the rank, the higher the value. The

data of evaluation indicators of the journals selected shown in Table 1. We abbreviate a part of journals names because of space limitations.

Table 1. The data of evaluation indicators of 20 journals selected

Journal Name	a_1	a_2	a_3	a_4	a_5	a_6	a_7	d
Econ Theory and Business Management	1739	1.717	0.324	0.99	9	19.39	0.75	4
Studies of International Finance	1869	2.08	0.338	0.96	10	15.36	0.475	4
China Rural Survey	1422	2.248	0.31	0.97	10	18.81	0.845	4
J of Business Economics	1365	1.099	0.171	0.97	8	24.52	0.868	4
Economist	1849	1.896	0.319	0.99	12	13.42	0.694	4
J of Shanghai Lixin Univ of Commerce	323	0.793	0.156	0.99	4	20.98	0.938	3
Technology Economics	1449	0.815	0.243	0.85	6	19.6	0.69	3
On Economic Problems	1963	0.782	0.176	0.97	7	7.03	0.49	3
Rural Economy	2461	0.997	0.136	0.97	7	6.75	0.703	3
South China J of Economics	1029	1.745	0.128	0.88	9	31.9	0.807	3
Market Modernization	9330	0.293	0.049	0.98	8	3.19	0.093	2
Economic Issues in China	369	0.922	0.153	0.93	5	15.43	0.653	2
J of Hebei Univ of Econ and Trade	477	0.808	0.211	0.95	4	8.85	0.325	2
Review of Economic Research	2231	0.796	0.065	0.99	8	3.32	0.187	2
J of Capital Univ of Econ and Business	494	0.509	0.11	1	4	15.49	0.569	2
Jiangsu Commercial Forum	1295	0.31	0.056	0.97	5	5.95	0.442	1
Logistics Sci-Tech	1607	0.507	0.098	0.95	6	5.9	0.36	1
Studies of Fin and Accounting in Educ	554	0.891	0.202	0.98	5	3.9	0.583	1
J of Xi'an Univ of Finance and Econ	512	0.615	0.125	0.9	4	8.31	0.514	1
J of Shijiazhuang University of Econ	486	0.337	0.056	0.99	4	11.33	0.525	1

Next, it adopts equalization method in dimensionless treatment to the data in Table 1. The processing results (portion) shown in Table 2.

Table 2. The processing results (portion) in equalization method to the data of evaluation indicators

Journal Name	a_1	a_2	a_3	a_4	a_5	a_6	a_7
Econ Theory and Business Management	1.0596	1.7034	1.8914	1.0323	1.3333	1.4948	1.3031
Studies of International Fin	1.1388	2.0635	1.9731	1.001	1.4815	1.1841	0.8253
China Rural Survey	0.8664	2.2302	1.8097	1.0115	1.4815	1.4501	1.4682
J of Business Economics	0.8317	1.0903	0.9982	1.0115	1.1852	1.8903	1.5081
Economist	1.1266	1.881	1.8622	1.0323	1.7778	1.0346	1.2058
J of Shanghai Lixin Univ of Commerce	0.1968	0.7867	0.9107	1.0323	0.5926	1.6174	1.6297
Technology Economics	0.8829	0.8085	1.4186	0.8863	0.8889	1.511	1.1989
On Economic Problems	1.1961	0.7758	1.0274	1.0115	1.037	0.542	0.8514
Rural Economy	1.4995	0.9891	0.7939	1.0115	1.037	0.5204	1.2214

Then it discretizes the data of evaluation indicators in Table 2 by equidistance division method. As the journals selected have 4 grades, the range between the minimum and maximum is divided into 4 intervals. The integers from 1 to 4 are assigned to 4 intervals from small to large. The discrete results (portion) shown in Table 3.

Table 3. The discrete result (portion) of evaluation indicators

Journal Name	a_1	a_2	a_3	a_4	a_5	a_6	a_7	d
Economic Theory and Business Management	1	3	4	4	3	3	4	4
Studies of International Finance	1	4	4	3	3	2	2	4
China Rural Survey	1	4	4	4	3	3	4	4
Journal of Business Economics	1	2	2	4	3	3	4	4
Economist	1	4	4	4	4	2	3	4
Journal of Shanghai Lixin University of Commerce	1	2	2	4	1	3	4	3
Technology Economics	1	2	3	1	1	3	3	3
On Economic Problems	1	2	2	4	2	1	2	3
Rural Economy	1	2	2	4	2	1	3	3

Impact factor, cited rate, H index, ratio of funded papers is selected as key evaluation indicators through reduction algorithm of Rough Set. Li et al. (2007) calculated the weighted value of each evaluation indicators with the mathematical integration method and selected current-year index, impact factor and ratio of funded papers as key indicators. The key evaluation indicators selected above include impact factor and ratio of funded papers, and H index and cited rate are considered seriously in many journal evaluation systems. So the key indicators selected through reduction algorithm of Rough Set are reasonable.

3.2 Weights Determination of Key Evaluation Indicators

3.2.1 Weights Determination of Key Evaluation Indicators Based on Grey Correlation Method

The data (portion) of 4 key indicators selected through reduction algorithm of Rough Set shown in Table 4. The weights of indicators are calculated by gray correlation advantage analysis.

Table 4. The data (portion) of 4 key evaluation indicators

Journal Name	a_2	a_4	a_5	a_7	d
Economic Theory and Business Management	1.717	0.99	9	0.75	4
Studies of International Finance	2.08	0.96	10	0.475	4
China Rural Survey	2.248	0.97	10	0.845	4
Journal of Business Economics	1.099	0.97	8	0.868	4
Economist	1.896	0.99	12	0.694	4
J of Shanghai Lixin University of Commerce	0.793	0.99	4	0.938	3
Technology Economics	0.815	0.85	6	0.69	3
On Economic Problems	0.782	0.97	7	0.49	3
Rural Economy	0.997	0.97	7	0.703	3

First, it calculates the initial images of each sequence. Let

$$A'_i = A_i / a_i(1) = (a'_i(1), a'_i(2), \dots, a'_i(5)), i = 0, 1, 2, \dots, 20$$

And the initial images of each sequence shown in Table 5.

Table 5. The initial images of each sequence

	a_2	a_4	a_5	a_7	d
1	1	1	1	1	1
1.2114	0.9697	1.1111	0.6333	1	1
1.3093	0.9798	1.1111	1.1267	1	1
0.6401	0.9798	0.8889	1.1573	1	1
1.1043	1	1.3333	0.9253	1	1
0.4619	1	0.4444	1.2507	0.75	0.75
0.4747	0.8586	0.6667	0.92	0.75	0.75
0.4554	0.9798	0.7778	0.6533	0.75	0.75
0.5807	0.9798	0.7778	0.9373	0.75	0.75
1.0163	0.8889	1	1.076	0.75	0.75
0.1706	0.9899	0.8889	0.124	0.5	0.5
0.537	0.9394	0.5556	0.8707	0.5	0.5

0.4706	0.9596	0.4444	0.4333	0.5
0.4636	1	0.8889	0.2493	0.5
0.2964	1.0101	0.4444	0.7587	0.5
0.1805	0.9798	0.5556	0.5893	0.25
0.2953	0.9596	0.6667	0.48	0.25
0.5189	0.9899	0.5556	0.7773	0.25
0.3582	0.9091	0.4444	0.6853	0.25
0.1963	1	0.4444	0.7	0.25

Secondly, calculate the sequence of differences. Using formula

$$\Delta_i(j) = |a'_i(j) - a'_i(5)|$$

Where, $i = 1, 2, \dots, 18$, $j = 1, 2, \dots, 5$. The sequences of differences are shown in Table 6.

Table 6. The sequences of differences

0.2114	0.0303	0.1111	0.3667	0
0.3093	0.0202	0.1111	0.1267	0
0.3599	0.0202	0.1111	0.1573	0
0.1043	0	0.3333	0.0747	0
0.2881	0.25	0.3056	0.5007	0
0.2753	0.1086	0.0833	0.17	0
0.2946	0.2298	0.0278	0.0967	0
0.1693	0.2298	0.0278	0.1873	0
0.2663	0.1389	0.25	0.326	0
0.3294	0.4899	0.3889	0.376	0
0.037	0.4394	0.0556	0.3707	0
0.0294	0.4596	0.0556	0.0667	0
0.0364	0.5	0.3889	0.2507	0
0.2036	0.5101	0.0556	0.2587	0
0.0695	0.7298	0.3056	0.3393	0
0.0453	0.7096	0.4167	0.23	0
0.2689	0.7399	0.3056	0.5273	0
0.1082	0.6591	0.1944	0.4353	0
0.0537	0.75	0.1944	0.45	0

Thirdly, calculate the correlation coefficients,

$$M = \max_i \max_j \Delta_i(j) = 0.75, \quad m = \min_i \min_j \Delta_i(j) = 0$$

Let identification coefficient $\rho = 0.5$, thus

$$r_{ij} = \frac{m + \rho M}{\Delta_i(j) + \rho M} = \frac{0.375}{\Delta_i(j) + 0.375}$$

And the correlation coefficients showed in Table 7.

Table 7. The gray correlation coefficient

	a_2	a_4	a_5	a_7	d
1	1	1	1	1	1
0.6395	0.9252	0.7714	0.5056	1	1
0.548	0.9489	0.7714	0.7475	1	1
0.5103	0.9489	0.7714	0.7044	1	1
0.7825	1	0.5294	0.834	1	1
0.5655	0.6	0.551	0.4282	1	1
0.5766	0.7755	0.8182	0.6881	1	1
0.5601	0.62	0.931	0.7951	1	1
0.6889	0.62	0.931	0.6669	1	1
0.5847	0.7297	0.6	0.535	1	1
0.5324	0.4336	0.4909	0.4993	1	1
0.9102	0.4605	0.871	0.5029	1	1
0.9273	0.4493	0.871	0.8491	1	1
0.9115	0.4286	0.4909	0.5994	1	1
0.6482	0.4237	0.871	0.5918	1	1
0.8437	0.3394	0.551	0.525	1	1
0.8923	0.3458	0.4737	0.6198	1	1
0.5824	0.3364	0.551	0.4156	1	1
0.7761	0.3626	0.6585	0.4628	1	1
0.8747	0.3333	0.6585	0.4545	1	1

Fourthly, calculate the grey correlation degrees. From

$$r_i = \frac{1}{n} \sum_{j=1}^n r_{ij} = \frac{1}{20} \sum_{j=1}^{20} r_{ij}$$

It gets the values of each grey correlation degree:

$$r_1 = 0.7177, \quad r_2 = 0.6041, \quad r_3 = 0.7081, \quad r_4 = 0.6212$$

Lastly, calculate the weights of each indicator:

$$\omega_1 = 0.2707, \quad \omega_2 = 0.2278, \quad \omega_3 = 0.2671, \quad \omega_4 = 0.2343$$

3.2.2 Weights Determination of Key Evaluation Indicators Based on Dominance-Based Rough Set

Dominance-based rough set is another objective weight method. Here we use dominance-based rough set method, which was introduced in The Weight determination Based on Dominance-based Rough Set in Fuzzy Comprehensive Evaluation, to calculate another group of weights of 4 key indicators. The weights were obtained as follows:

$$\omega'_1 = 0.1154, \quad \omega'_2 = 0.4846, \quad \omega'_3 = 0.1538, \quad \omega'_4 = 0.2462$$

3.3 The Comparative Results

This paper selects 40 economics journals from *A Report on Chinese Academic Journals Evaluation* as research objects, as well as searches the data of seven common evaluation indicators of these journals from *CHINESE S&T JOURNAL REPORTS (Expanded Edition)*. Combined with the previous two groups of weights determined by grey correlation method and dominance-based rough set method, the TOPSIS method is used to calculate the comprehensive scores of the 40 economics journals selected and sort these journals according to their scores. Then it gets the ranking by TOPSIS based on grey correlation(G for short) and the ranking by TOPSIS based on dominance-based rough set(D for short).It also searches the ranking of these journals in *A Report on Chinese Academic Journals Evaluation*(R for short).Three rankings above shown in Table 8. Here we abbreviate a part of journals names because of space limitations.

Table 8. The rankings for journals

Journal Name	R	G	D	Journal Name	R	G	D
Economic Research Journal	1	1	1	Intergrade	21	27	15
Accounting Research	2	2	2	Economic Survey	22	23	30
China Industrial Economics	3	3	3	Contemporary Econ & Management	23	20	20
J of Financial Research	4	5	5	Taxation Research	24	21	31
The Journal of World Economy	5	4	4	Reformation & Strategy	25	29	33
Journal of International Trade	6	7	7	Friends of Accounting	26	30	24
Tourism Tribune	7	8	6	Economic Issues in China	27	26	39
Chinese Rural Economy	8	13	8	Agricultural Economy	28	32	25
Journal of Finance and Economics	9	6	9	Public Finance Research	29	31	40
Finance & Trade Economics	10	10	13	Asia-pacific Econ Review	30	18	28
Contemporary Finance & Economics	11	9	10	Economy and Management	31	33	38
World Economy Study	12	12	17	Shanghai Finance	32	39	29
Auditing Research	13	11	12	J of Econ of Water Resources	33	25	32
Modern Economic Science	14	17	22	The World of Survey and Research	34	28	26
Inquiry into Economic Issues	15	24	11	South China Finance	35	40	36
Economic Review	16	14	14	Chin Univ Technology Transfer	36	38	21
Finance and Trade Research	17	22	27	Finance and Economy	37	36	34
Securities Market Herald	18	19	23	Jiangsu Commercial Forum	38	34	18
Macroeconomics	19	16	19	J of Xi'an Univ of Fin and Econ	39	37	37
On Economic Problems	20	15	16	Special Zone Economy	40	35	35

As seen in Table 8, the five top in G Ranking and D Ranking are the same and largely consistent with R Ranking. It is normal that three kinds of rankings above have differences because they use different evaluation methods. There is still a good agreement among them. Next, it compared G Ranking with D Ranking.

From the weights of comparison, it can be seen that in the weight determination based on dominance-based rough set, cited rate has a weight of 0.4846, ratio of funded papers has a weight of 0.2462, but the weights of H index and impact factor are only 0.1538 and 0.1154. H index and impact factor are two important evaluation indicators in journal evaluation and generally H index is more important than ratio of funded papers. Thus the weight determination based on dominance-based rough set here is inappropriate. By contrast, the weights determined by grey correlation are more reasonable. Impact factor has a highest weight of 0.2707 and H index had a higher weight than ratio of funded papers.

As the ranking in *A Report on Chinese Academic Journals Evaluation* is more authoritative and has a high reference value, here we use the square error sum to measure the proximity of G ranking to R ranking and the proximity of D ranking to R ranking. From Table 8 it can calculate that the square error sum between G Ranking and R Ranking is 680 and the square error sum between D Ranking and R Ranking is 1556. Thus G Ranking is closer to R Ranking.

Above all, in evaluation of economics journals, the evaluation of economics journals model based on reduction algorithm of Rough Set and Grey Correlation can select rational key indicators and get rational weights of these indicators. And the evaluate result is reasonable. Thus this evaluation model has a certain reasonability and practicality.

4. Conclusion

This paper proposed an evaluation of economics journals model based on reduction algorithm of Rough Set and Grey Correlation to evaluate economics journals. It used rough set reduction method to select the key evaluation indicators, which simplified the evaluation system. Compared with the dominance-based rough set, grey correlation method allocated the indicators weights more reasonably and succinctly here. Lastly we combined the TOPSIS with the weights determined by grey correlation and dominance-based rough set to evaluate and rank economics journals. The results showed that the evaluation of economics journals model based on reduction algorithm of Rough Set and Grey Correlation has a certain reasonability and practicality. The evaluation of economics journals model based on reduction algorithm of Rough Set and Grey Correlation has general applicability. Here we only apply this model in the evaluation of economics journals, it is practical to adjust this model to be applied in other field. Besides, Rough set, grey correlation and TOPSIS are commonly used in academic evaluation field.

The selection and weight for evaluation indicators and the evaluation rules in comprehensive evaluation system

have important influence on valuation result of the system. It is better to consider the reasonability of different components to establish scientific and objective evaluation system. The integration of these methods can be applied in other fields such as the environmental quality assessment (Wang et al., 2014), short-term wind speed forecasting (Yin et al., 2014) and so on.

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