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Sports industry application of grey evaluation model

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ABSTRACT

Sports industry is not only a comprehensive economic industry, but also an industry with strong economic relevance, the industry needs to provide necessary material conditions and social environment for the sports industry on the existing socio-economic basis. Related factors with the development of sports industry include: the own factors of sports industry, employing factors, GNP growth of the three major industries and GNP growth. In order to study the development situation and development prospects of the sports industry, it is essential to carry through the linkage analysis of this industry and related industries. On the basis of related data in 2006-2008 between the sports industry and other industry, this paper established the gray comprehensive evaluation model, carried through analysis on the correlation between the industries and provided a theoretical basis for China's sports industry and national production.

KEYWORDS

Gray Theory;
Sports industry;
Correlation degree;
Evaluation model.

INTRODUCTION

Sports industry is different from sports cause. The main task of sports cause is to meet the spiritual needs of society, focusing on the social benefits. But the sports industry focuses on economic benefits. So the sports industry contains more commercial nature. Sports industry includes: sports ontology industry, sports periphery industry, sports intermediary industry and sports industry consumers, among them sports ontology industry is hardcore of the entire sports industry including sports competition and public health; Sports peripheral industry includes sports goods business, sports equipment business, sports clothiers, sports tourism providers, sports betting providers and sports builders; sports intermediary industry includes sports advertisers, sponsors and sports insurance; sports consumers is the deciding power of the development of sports industry and the driving force of sports industry as a sunrise industry. The most developed country of sports industry in the world is the United States. According to the survey data of the prospective network "Market Outlook Report and leading business analysis of China Sports Industry in 2013-2017 ", in the 1980s, the output of U.S. sports industry ranked No. 22 in the major industry output. In the mid-1990s, the output value of U.S. sports industry has exceeded $ 300 billion. In today's rela-

tively developed sports industry countries like North America, Western Europe, Japan and other countries, the annual output value have entered the column of its domestic ten pillar industries. China's sports industry market started late, and it has the relatively complete industrial shape and system until the mid-1990s, making China's sports advertising, sports construction, sports lottery, sports tourism, sporting goods industry and other specific industries fully developed.

On the basis of related degree between the sports industry and other industry, this paper established the gray comprehensive evaluation model, quantitatively studied the correlation between The gross added value of sports industry and the gross employee growth, the gross added value of GNP, the gross added value of the primary industry, the gross added value of the secondary industry, the gross added value of industry, the gross added value of construction industry and the gross added value of the tertiary industry, revealed the inherent law and external rules for the development of sports industry and provided a theoretical basis for the development of China sports industry.

STUDY OBJECT AND METHOD

Study object

This paper takes the data of the gross added value of GNP, the gross added value of the primary industry, the gross added value of the secondary industry, the gross added value of industry, the gross added value of construction industry, the gross added value of the tertiary industry, the gross employee growth and the gross added value of sports industry in 2006-2008 as the study objects. Data is derived from the National Bureau of Statistics (http://www.stats.gov.cn/tjsj/ndsj/2012/indexce.htm).

TABLE 1 : 3 years' data list of the sports industry and related industries

Year	2006	2007	2008
The gross added value of sports industry	982.89	1265.30	1554.97
The gross added value of sports organization management activities	74.80	89.36	117.56
The gross added value of sports venues management activities	18.24	23.04	3
The gross added value of sports fitness leisure activities	46.98	58.79	74.49
The gross added value of sports intermediary activities	2.02	3.00	4.46
The gross added value of sports training activities	4.64	7.91	13.48
The gross added value of sports lottery	21.47	29.63	35.27
The gross added value of sports goods manufactures	705.12	898.10	1088.31
The gross added value of sports goods sales	76.45	110.77	141.79
The gross added value of sports venues buildings	33.17	44.63	49.61
The gross employee growth	256.30	283.74	317.09
The employee growth of sports organization management activities	18.71	18.98	20.87
The employee growth of sports venues management activities	2.58	2.41	2.62
The employee growth of sports fitness leisure activities	11.78	13.32	15.03
The employee growth of sports intermediary activities	0.87	0.96	1.35
The employee growth of sports training activities	1.91	2.21	3.56
The employee growth of sports lottery	11.11	13.37	17.64
The employee growth of sports goods manufactures	195.44	214.00	234.13
The employee growth of sports goods sales	11.13	15.20	18.54
The employee growth of sports venues buildings	2.77	3.29	3.35
The gross added value of GNP	31377.06	49495.88	48235.12
The gross added value of the primary industry	162	4587.00	5075.00
The gross added value of the secondary industry	16121.45	22111.82	23172.08
The gross added value of industry	14080.16	19223.94	19725.36
The gross added value of construction industry	2041.29	2887.88	3446.72
The gross added value of the tertiary industry	13635.61	22797.06	19988.04

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GREY COMPREHENSIVE EVALUATION MODEL

The correlation analysis method in gray system theory is a new quantization method to measure the association degree between factors, is a geometrical relationship comparison of the system statistical data column. This paper uses gray correlation analysis method to establish the gray comprehensive evaluation model with the least squares criterion.

Attribute matrix

Assuming the gray system has m evaluation objects, and each object has n evaluation factors. Each attribute value of evaluation objects under the each corresponding evaluation factor constitutes the property matrix as shown in equation (1):

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} = \left(x_{ij}\right)_{m\times n} \quad (1)$$

In the Formula (1) x_{ij} represents the attribute value of the i –th evaluation object under the j -th evaluation factor. In this paper the sports industry and its related factors have 26 evaluation objects, that is, there are 26 items of industry classification and employee classification. The evaluation factors are only different data of 2006, 2007 and 2008, so that in the paper we take $n=3, m=26$. The element is the data value of corresponding item, so $X = \left(x_{ij}\right)_{26\times 3}$.

Normalized matrix

The normalized matrix can be also understood as the matrix data normalization. The data processing is generally divided into "the greater the excellent type", "the smaller the excellent type" and "appropriate type" three kinds, the calculation method is respectively shown as formula (2), (3) and (4):

$$x_{ij}^{*} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (2)$$

$$x_{ij}^{*} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (3)$$

$$x_{ij}^{*} = 1 - \frac{\left|x_{ij} - \gamma_i\right|}{\max\left|x_{ij} - \gamma_i\right|} \quad (4)$$

The x_{ij}^{*} in Formula (2), (3) and (4) means the matrix elements after the normalization and $0 \le x_{ij}^{*} \le 1$; the γ_i in the formula (4) represents the standard value of the –th object. In order to get the maximum and minimum values for each object, define two vectors, respectively the priority vector of the system and the system sub-vector, and the expression is shown in the formula (5):

$$\begin{cases} \vec{G} = (g_1, g_2, \cdots, g_m) = (x_{11}^{*} \vee x_{12}^{*} \vee \ldots \vee x_{1n}^{*}, x_{21}^{*} \vee x_{22}^{*} \vee \ldots \vee x_{2n}^{*}, \ldots, x_{m1}^{*} \vee x_{m2}^{*} \vee \ldots \vee x_{mn}^{*}) \\ \vec{B} = (b_1, b_2, \cdots, b_m) = (x_{11}^{*} \vee x_{12}^{*} \vee \ldots \vee x_{1n}^{*}, x_{21}^{*} \vee x_{22}^{*} \vee \ldots \vee x_{2n}^{*}, \ldots, x_{m1}^{*} \vee x_{m2}^{*} \vee \ldots \vee x_{mn}^{*}) \end{cases} \quad (5)$$

In Formula (5), $\wedge, \vee$ respectively means taking the small and large operators, $g_i = \max\left\{x_{i1}^{*}, x_{i2}^{*}, \cdots, x_{im}^{*}\right\}$ $b_i = \min\left\{x_{i1}^{*}, x_{i2}^{*}, \cdots, x_{im}^{*}\right\}$; the data standardization method this paper selected is "appropriate type" approach, the standard value takes the average value of the object factors.

Correlation degree analysis

The weight vector of evaluation factors is obtained after normalizing the factor data, the expression is shown in formula (6) as follows:

$$\vec{W} = (\omega_1, \omega_2, \cdots, \omega_n), \sum_{i=1}^{n} \omega_i = 1 \quad (6)$$

In this article, $n = 3$.

The measurement of the association degree of series is presented by the correlation coefficients, the correlation coefficient between vector $\vec{X}_j$ of the j –th scheme and priority vector $\vec{G}$ is shown as formula (7) below:

$$\xi_i\left(\vec{X}_j, \vec{G}\right) = \frac{\min\limits_j \min\limits_i \left|x_{ij}^{*} - g_i\right| + r \max\limits_j \max\limits_i \left|x_{ij}^{*} - g_i\right|}{\left|x_{ij}^{*} - g_i\right| + r \max\limits_j \max\limits_i \left|x_{ij}^{*} - g_i\right|} \quad (7)$$

In Formula (7), $\xi_i\left(\vec{X}_j, \vec{G}\right)$ means correlation coefficient, r means the resolution coefficient and $r \in [0,1]$; the correlation coefficient between vector $\vec{x}_j$ of the j –th scheme and sub-vector $\vec{B}$ is shown as formula (8) below:

$$\xi_i\left(\vec{X}_j, \vec{B}\right) = \frac{\min\limits_j \min\limits_i \left|x_{ij}^{*} - b_i\right| + r \max\limits_j \max\limits_i \left|x_{ij}^{*} - b_i\right|}{\left|x_{ij}^{*} - b_i\right| + r \max\limits_j \max\limits_i \left|x_{ij}^{*} - b_i\right|} \quad (8)$$

The correlation degrees of $\vec{X}_j$ with priority vector $\vec{G}$ and that of with sub-vector are as formula (9) below:

$$\begin{cases} \nu(\vec{X}_j, \vec{G}) = \sum_{i=1}^{n} \omega_i \xi_i(\vec{X}_j, \vec{G}) \\ \nu(\vec{X}_j, \vec{B}) = \sum_{i=1}^{n} \omega_i \xi_i(\vec{X}_j, \vec{B}) \end{cases} \quad (9)$$

Model building

Suppose the vector $\vec{X}_j$ of the j -th solution belongs to priority vector $\vec{G}$, and then is to subordinate sub-vectors by, $\vec{B}$ by $(1-u_j)$, and the objective function of formula (10) is proposed:

$$f(\vec{u})_{\min} = \sum_{j=1}^{m} \left\{ \left[(1-u_j)^2 \nu(\vec{X}_j, \vec{G}) \right]^2 + \left[u_j^2 \nu(\vec{X}_j, \vec{B}) \right]^2 \right\} \quad (10)$$

The optimal solution vector of Formula (10) is shown as formula (11) below:

$$\vec{u} = (u_1, u_2, \cdots, u_m) \quad (11)$$

If we want to know the optimal solution u_j , it needs to meet $\frac{\partial f(\vec{u})}{\partial u_j} = 0$, and then the expression of u_j is shown in formula (12) as follows:

$$\frac{1}{u_j} = 1 + \left[\frac{\sum_{i=1}^{n} \omega_i \xi_i(\vec{X}_j, \vec{B})}{\sum_{i=1}^{n} \omega_i \xi_i(\vec{X}_j, \vec{G})} \right]^2 \quad (12)$$

RESULT ANALYSIS

The determination of normalized matrix

The normalized matrix can be obtained after processing the data in TABLE 1 according to formula (4). Since the matrix expression elements after normalization are too many, they are presented in tabular form as shown in TABLE 2.

The determination of weight vector matrix

The weight vector matrix can be obtained after processing the data in TABLE 1 according to formula (6). Since the matrix elements are too many, they are presented in tabular form as shown in TABLE 3.

TABLE 2 : The expression of normalized matrix

Item	Column 1	Column 2	Column 3
Line 1	0.01	0.99	0.00
Line 2	0.19	0.81	0.00
Line 3	0.12	0.88	0.00
Line 4	0.09	0.91	0.00
Line 5	0.12	0.88	0.00
Line 6	0.16	0.84	0.00
Line 7	0.00	0.89	0.11
Line 8	0.00	1.00	0.00
Line 9	0.00	0.97	0.03
Line 10	0.00	0.77	0.23
Line 11	0.06	0.94	0.00
Line 12	0.40	0.60	0.00
Line 13	0.66	0.00	0.34
Line 14	0.03	0.97	0.00
Line 15	0.34	0.66	0.00
Line 16	0.35	0.65	0.00
Line 17	0.19	0.81	0.00
Line 18	0.03	0.97	0.00
Line 19	0.00	0.94	0.06
Line 20	0.00	0.58	0.42
Line 21	0.00	0.45	0.55
Line 22	0.00	0.61	0.39
Line 23	0.00	0.62	0.38
Line 24	0.00	0.57	0.43
Line 25	0.00	0.87	0.13
Line 26	0.00	0.23	0.77

Determine of priority vector and sub-vector

According to formula (5) determine the priority vector $\vec{G}$ and the sub-vector $\vec{B}$, as shown in the formula (13) between:

$$\vec{G} = \begin{bmatrix} 0.99 \\ 0.81 \\ 0.88 \\ 0.91 \\ 0.88 \\ 0.84 \\ 0.89 \\ 1.00 \\ 0.97 \\ 0.77 \\ 0.94 \\ 0.60 \\ 0.66 \\ 0.97 \\ 0.66 \\ 0.65 \\ 0.81 \\ 0.97 \\ 0.94 \\ 0.58 \\ 0.55 \\ 0.61 \\ 0.62 \\ 0.57 \\ 0.87 \\ 0.77 \end{bmatrix}, \quad \vec{B} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad (13)$$

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TABLE 3 : The expression of weight vector matrix

Item	Column 1	Column 2	Column 3
Line 1	0.26	0.33	0.41
Line 2	0.27	0.32	0.42
Line 3	0.26	0.32	0.42
Line 4	0.26	0.33	0.41
Line 5	0.21	0.32	0.47
Line 6	0.18	0.30	0.52
Line 7	0.25	0.34	0.41
Line 8	0.26	0.33	0.40
Line 9	0.23	0.34	0.43
Line 10	0.26	0.35	0.39
Line 11	0.30	0.33	0.37
Line 12	0.32	0.32	0.36
Line 13	0.34	0.32	0.34
Line 14	0.29	0.33	0.37
Line 15	0.27	0.30	0.42
Line 16	0.25	0.29	0.46
Line 17	0.26	0.32	0.42
Line 18	0.30	0.33	0.36
Line 19	0.25	0.34	0.41
Line 20	0.29	0.35	0.36
Line 21	0.24	0.38	0.37
Line 22	0.14	0.41	0.45
Line 23	0.26	0.36	0.38
Line 24	0.27	0.36	0.37
Line 25	0.24	0.34	0.41
Line 26	0.24	0.40	0.35

Solving of correlation degree

Use the 26 uppercase letters to represent the classification in Table 1, such as: use A to represent the gross added value of sports industry, use B to represent the gross added value of sports organization management activities, use C to represent the gross added value of sports venues management activities, use D to represent the gross added value of sports fitness leisure activities, use Z to represent the gross added value of the tertiary industry, and so on, the association degree between the sports industry and related industries is shown in Figure 1.

Can be drawn from Figure 1 that the descending order of the association degree between gross output value of other industries and sports industry are: A<—Y<—S<—R<—N<—K<—I<—H<—G<—F<—E<—D<—C<—Q<—B<—J<—M<—P<—O<—W<—V<—L<—T<—X<—U<—Z. Among them the correlation coefficient above 0.95 are the gross added value of sports organization management activities, the gross added value of sports venues management activities, the gross added value of sports fitness leisure activities, the gross added value of sports intermediary activities, the gross added value of sports training activities, the gross added value of sports lottery, the gross added value of sports goods manufactures, the gross added value of sports goods sales, the gross added value of sports venues buildings, the gross employee

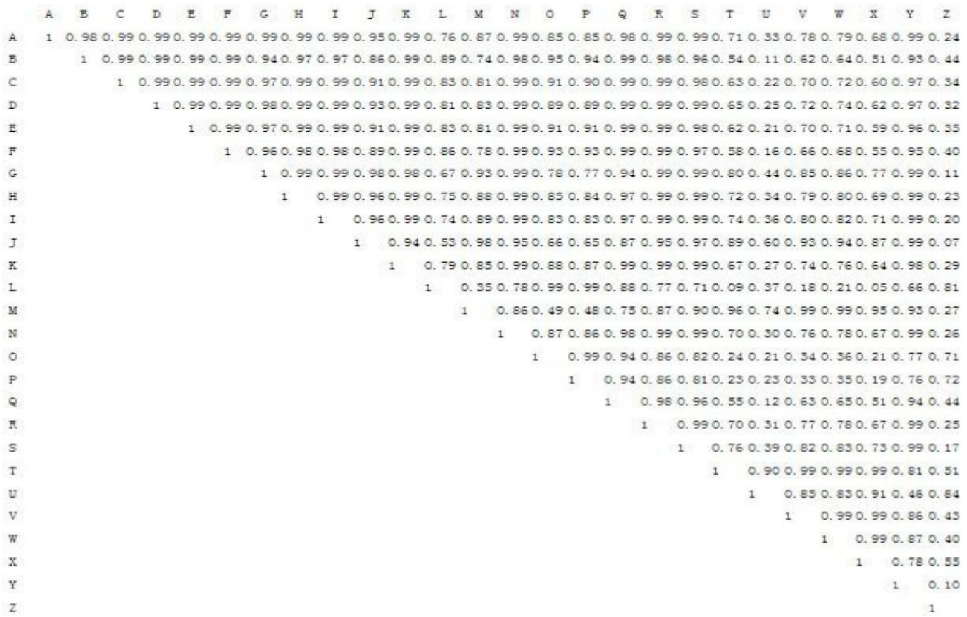

Figure 1 : The association degree between sports industry and related industries

growth, the gross employee growth, the employee growth of sports lottery, the employee growth of sports goods manufactures, the employee growth of sports goods sales and the employee growth of sports goods sales. The correlation coefficient in the 0.85-0.87 includes the employee growth of sports intermediary activities, the employee growth of sports training activities and the employee growth of sports venues management activities. The correlation coefficient in the 0.68-0.79 includes the gross added value of the primary industry, the gross added value of the secondary industry, the gross added value of industry, the employee growth of sports venues buildings and the employee growth of sports organization management activities. The correlation coefficient below 0.4 is the gross added value of the tertiary industry and the gross added value.

CONCLUSIONS

The establishment of comprehensive evaluation model well generate a more accurate reference vector; the industry that has a strong correlation with gross added value of sports industry is Y, S, R, N, K, I, H, G, F, E, D, C, Q, B, J; the industry that has a weak correlation with gross added value of sports industry is U, Z; This article obtained the association degree value between the related industries, which can well clear and definite the association extent between various industries.

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