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Collaborative relationship research of the sports industry and other related industries based on the grey correlation analysis

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ABSTRACT

The sports industry is a wide range industry with strong relevance. Its research methods conclude analytic hierarchy process, fuzzy comprehensive analysis, Delphi method and other qualitative analysis method. There is a certain degree of subjectivity, and it cannot accurately explore the substantive law of the sports industry. In this paper, from the linkage angle between the industries to study the coordinated development of the sports industry and other related industries, and use the gray correlation effects analysis method to conduct global and systematic analysis on the GNP statistics data in 2000-2009, research the correlation between sports industry and other industries, provides data basis for the development of the sports industry, and provide a reference and analysis theory for the joint development of related careers.

KEYWORDS

Grey correlation;
The sports industry;
GNP;
Collaborative relationship.

INTRODUCTION

Sports economy departures from two angles: the production and management mix mass sports life and the associated economic behaviour organically together to develop as a special industry. The relative sports industry is a industry that provides a wide range of sports services for the whole community in the form of activities, is the general term of the sports service industry. Sports industry development is inseparable from the support of the national economy of other industries; the development of other industries will also be driven by the sports industry. Sports industry is known as the "sunrise industry", compared to other industries in the national economy, it has the potential for sustainable development and has linkage role to other industry, and it can drive the development of tourism, commerce, advertising, manufacturing, services, communication industry, information industry and the financial industry. From the number of employees in the international sports industry, in 1990, practitioners the British sports and sports industry reach nearly 50 million people, more than practitioners in agriculture; the number of employees in leisure services of Germany is more than 300 million people, an annual turnover up to 400 billion marks, sports play an important role in this wide range of industries; Los Angeles Olympic Games created employment opportunities for 2.5 million people for the city of Los Angeles; Seoul Olympics provided employment opportunities for 3.4 million people; Atlanta Olym-

pic Games brought 7.7 million jobs to the state; 2008 Beijing Olympic Games had an increase of nearly 100,000 jobs in Beijing. The development of China's national economy cannot be separated from the driver of sports industry, while various other industries should also provide support and space for the sports industry.

On the basis of previous studies, this paper uses the grey correlation analysis to research the collaborative relationship between the sports industry and other industries, reveals the inherent law of the sports industry development, in order to provide a theoretical basis for the development of sports industry in China.

RESEARCH OBJECT AND METHOD

Research object

This paper takes 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 the tertiary industry and the gross added value of sports industry from 2006 to 2009 in China as the research objects.

Data is derived from the National Bureau of Statistics (http://www.stats.gov.cn/tjsj/ndsj/2012/indexce.htm).

GNP added value of gross added value of gross value added gross value added of gross value added

Research method

1) Document literature method: the paper downloading through the full-text journal database of CNKI and Baidu library, has made adequate preparations for the theory correctness and accuracy of the calculation in this paper.
2) Grey correlation analysis method: Determine the reference sequence and comparative sequence and then calculate the correlation coefficient, elaborate the development direction of the sports industry by revealing the correlation degree of the data changes between the sports industry and other industries.

GREY CORRELATION ANALYSIS METHOD

Social systems, economic systems, agricultural systems, ecosystems and other abstract systems contain a variety of factors. Among these factors which are the main and which secondary, which impact bigger and which impact smaller, which needs to be suppressed and which need development, which is potential and which is obvious, these are all the contents of factors analysis. On the basis of the regression analysis using gray system theory, we adopt correlation analysis method for system analysis. As a developing and changing system, the correlation degree analysis is actually a quantitative analysis of development trend in the dy-

TABLE 1 : 4 years' data list of the sports industry and related industries

Year	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 the tertiary industry	The gross added value of sports industry
2006	31377.056979	1620	16121.447797	13635.609183	982.89
2007	49495.879904	4587	22111.816459	22797.063445	1265.23
2008	48235.121243	5075	23172.081958	19988.039285	1554.97
2009	26857.385495	1524	8635.3365727	16698.048922	2100

Note: The unit of the added of value output value is one hundred million yuan

namic process, is the quantitative comparative analysis of the development trend.

Correlation analysis method first needs data processing, processing method including: data columns representation of the original data and correlation coefficient calculation.

Representation of the data columns

Correlation analysis needs to specify the reference sequence; the reference sequence is usually referred to as x_0. The value of the first time is denoted as $x_0(1)$, the value of the second time is denoted as $x_0(2)$, the value of the k-th time is denoted as $x_0(k)$, and therefore the mathematical expression of the reference sequence is shown in formula (1):

$$x_0 = [x_0(1) \quad x_0(2) \quad \cdots \quad x_0(n)] \tag{1}$$

The comparative columns in correlation analysis are

usually referred to as $x_1, x_2, \cdots, x_k$, and its expression form is shown in formula (2) similar to the reference sequence x_0:

$$\begin{aligned} x_1 &= [x_1(1) \quad x_1(2) \quad \cdots \quad x_2(n)] \\ x_2 &= [x_2(1) \quad x_2(2) \quad \cdots \quad x_2(n)] \\ &\vdots \\ x_k &= [x_k(1) \quad x_k(2) \quad \cdots \quad x_k(n)] \end{aligned} \tag{2}$$

Suppose $X_i = \{x_i(k)\}, i \in \alpha_1, k \in \alpha_2$ the comparative sequence X_i indicates that the i-th participating units in the system S. Establish the evaluation matrix V and normalized evaluation augmented matrix X_0 combining with the reference sequence V_0, and the evaluation matrix and normalized evaluation augmented matrix are shown in formula (3):

$$V = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix}, X = \begin{bmatrix} v_{01} & v_{02} & \cdots & v_{0n} \\ v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} \tag{3}$$

In formula (3) $v_{ij} = x_i(j)$.

Correlation coefficient calculation method

The correlation coefficient is defined as the tightness of two comparative sequences at a particular moment, for example at time $\Delta_{0i}(min)$, $\xi(x_0(k), x_i(k)) = 1$ the correlation coefficient is the biggest, while at time $\Delta_{0i}(max)$, $\xi(x_0(k), x_i(k)) = 0$, the correlation coefficient is the smallest, and its change range is $0 < \xi(x_0(k), x_i(k)) \le 1$. For a reference data column x_0, there are several comparative columns, which can be denoted by the difference of each comparative curve and reference curve at each point (time) in the formula (4):

$$\xi_i(k) = \frac{\min\limits_i(\Delta_i(min)) + \zeta \max\limits_i(\Delta_i(max))}{|x_0(k) - x_i(k)| + \zeta \max\limits_i(\Delta_i(max))} \tag{4}$$

In the formula (4), $\xi_i(k)$ means the relative difference of the comparison curve x_i with reference curve x_0 at moment k, known as the correlation coefficient of x_i to x_0 at time k. ζ is the resolution coefficient between 0 and 1, in general, the greater the resolution coefficient, the greater the resolution; the smaller the resolution coefficient, the smaller the resolution, $\zeta = 0.5$ is taken in this article. Wherein the expression of $\min\limits_i(\Delta_i(min))$, $\max\limits_i(\Delta_i(max))$ is shown in the formula (5) below:

$$\begin{cases} \min\limits_i(\Delta_i(min)) = \min\limits_i\left(\min\limits_k|x_0(k) - x_i(k)|\right) \\ \max\limits_i(\Delta_i(max)) = \max\limits_i\left(\max\limits_k|x_0(k) - x_i(k)|\right) \end{cases} \tag{5}$$

Correlation degree vector calculation

The correlation degree is related with the reference sequence x_0, the comparative sequence x_i, the converting method of original data, the data column length N and resolution ζ, and the calculation method of correlation degree is shown in formula (6) below:

$$\xi(x_0, x_i) = \frac{1}{N}\sum_{k=1}^{N}\xi(x_0(k), x_i(k)) \tag{6}$$

In the formula (6) $\xi(x_0, x_i)$ denotes the correlation degree of the sub-sequence and the base sequence N denotes the step degree of the two comparative sequences. The matrix form of correlation degree is shown in formula (7):

$$R = \xi(x_0, x_i) = \begin{bmatrix} r_{11} & r_{11} & \cdots & r_{11} \\ r_{21} & r_{11} & \cdots & r_{11} \\ \cdots & \cdots & \cdots & \cdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} \tag{7}$$

The R in Formula (7) indicates the correlation degree matrix.

ANALYSIS OF RESULTS

Data analysis of GNP

The change trend of GNP data characteristics with year is shown in Figure 1:

The upper curve in Figure 1 shows the change trends of GNP, the middle curve in Figure 1 shows the trend graph of the added value, the curve below in Figure 1 shows the trend graph of growth rate. We can see from Figure 1 that GNP is raising, but the added value has a downward trend in 2007, the growth rate is the percentage of the added value compared to last year in the total value of last year, the change of the value is in the

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fluctuations. Before year 2007 it has an increasing trend but after 2007 it has significant decreasing trend. In the 10 years from 2000 to 2009, the absolute value of the gross national product has continuously increased, but the change rate of the increasing is in volatility with a downward trend after 2007.

TABLE 2 : List of GNP in 2000-2009

Year	GNP	The added value of GNP	Rate of increase
2000	99214.6	9537.5	10.6%
2001	109655.2	10440.6	10.5%
2002	120332.7	10677.5	9.7%
2003	135822.8	15490.1	12.9%
2004	159878.3	24055.5	17.7%
2005	184937.4	25059.1	15.7%
2006	216314.4	31377	17.0%
2007	265810.3	49495.9	22.9%
2008	314045.4	48235.1	18.1%
2009	340902.8	26857.4	8.6%

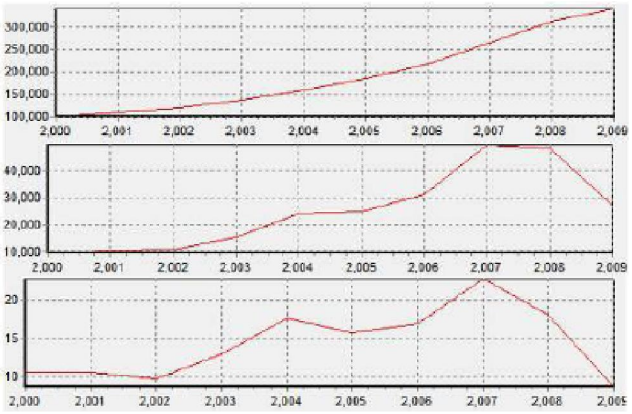

Figure 1 : The change trends of GNP over Year

TABLE 3 : The total output value list of primary industry in 2000-2009

Year	The total output value of primary industry	The added value of primary industry for the year	Rate of increase
2000	14944.7	174.7	1.2%
2001	15781.3	836.6	5.6%
2002	16537.0	755.7	4.8%
2003	17381.7	844.7	5.1%
2004	21412.7	4031	23.2%
2005	22420.0	1007.3	4.7%
2006	24040.0	1620	7.2%
2007	28627.0	4587	19.1%
2008	33702.0	5075	17.7%
2009	35226.0	1524	4.5%

The data analysis of primary industry output value

The change trend of the data characteristics of the primary industry output with the year is shown in Figure 2:

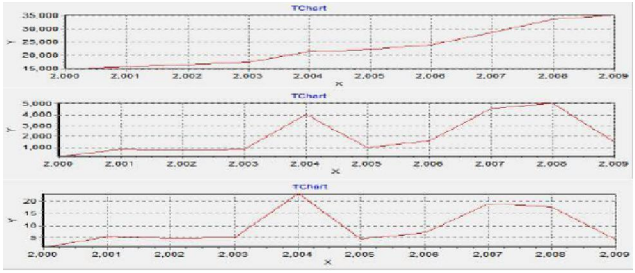

Figure 2 : The change trends of the primary industry over year

The upper curve in Figure 2 shows the change trends of the total value of primary industry, the middle curve in Figure 2 shows the trend graph of the added value, the curve below in Figure 2 shows the trend graph of growth rate. From Figure 2 we can see that the GNP of primary industry is continuously rising, relatively increase slowly in 2001-2003, and the increase in 2006-2008 is relatively large; the added value in 2004 and 2008 has the maximum absolute value, the growth rate is the percentage of the added value compared to last year in the total value of last year, the volatility of the value is big but it is basically consistent with the change trend of the added values.

TABLE 4 : The total output value list of the secondary industry in 2000-2009

Year	GNP	The added value of GNP	Rate of increase
2000	45555.9	4522.3	11.0%
2001	49512.3	3956.4	8.7%
2002	53896.8	4384.5	8.9%
2003	62436.3	8539.5	15.8%
2004	73904.3	11468	18.4%
2005	87598.1	13693.8	18.5%
2006	103719.5	16121.4	18.4%
2007	125831.4	22111.9	21.3%
2008	149003.4	23172	18.4%
2009	157638.8	8635.4	5.8%

The data analysis of the secondary industry total output value

The change trend of the data characteristics of the secondary industry output with the year is shown in Fig-

ure 3:

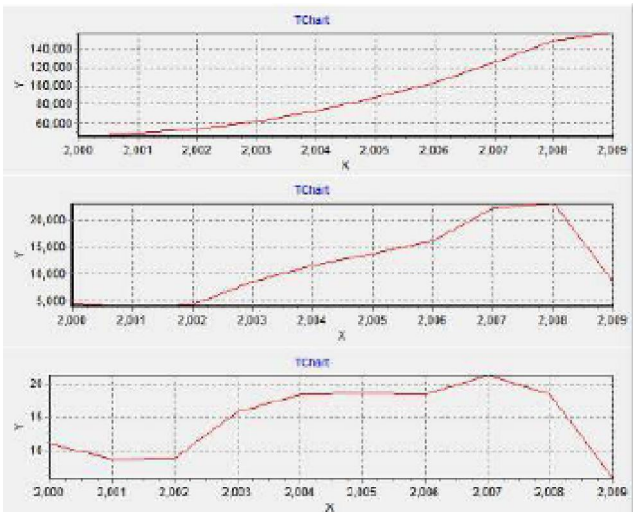

Figure 3 : The change trends secondary industry over year

The upper curve in Figure 3 shows the change trends of the total value of secondary industry, the middle curve in Figure 3 shows the trend graph of the added value, the curve below in Figure 3 shows the trend graph of growth rate. From Figure 3 we can see that the total value of the second industry is rising, the growth rate has gradually increased before 2008, the added value has a downward trend in 2008; the growth rate is the percentage of the added value compared to last year in the total value of last year, the change of the value in volatility is not big, basically in the increasing trend before year 2007, and in the downward trend after 2007.

TABLE 5 : The total value list of the tertiary industry in 2000-2009

Year	GNP	The added value of GNP	Rate of increase
2000	38714.0	4840.6	14.29%
2001	44361.6	5647.6	14.59%
2002	49898.9	5537.3	12.48%
2003	56004.7	6105.8	12.24%
2004	64561.3	8556.6	15.28%
2005	74919.3	10358	16.04%
2006	88554.9	13635.6	18.20%
2007	111351.9	22797	25.74%
2008	131340.0	19988.1	17.95%
2009	148038.0	16698	12.71%

The data analysis of the tertiary industry total value

The change trend of GNP data characteristics over year is shown in Figure 4:

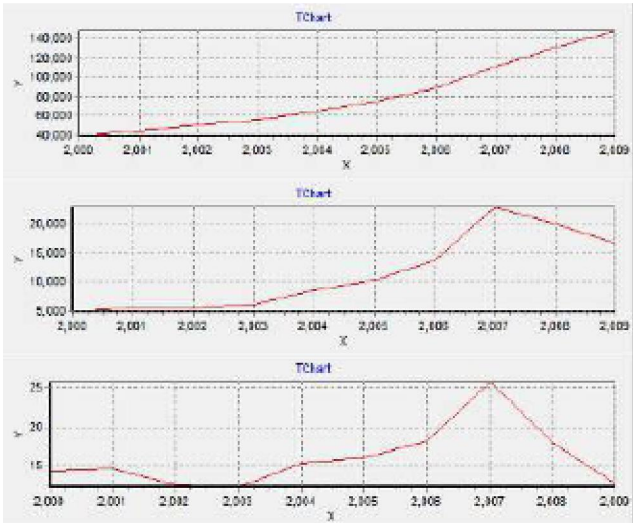

Figure 4 : The change trends of the tertiary industry total value over year

The upper curve in Figure 4 shows the change trends of the total value of primary industry, the middle curve in Figure 4 shows the trend graph of the added value, the curve below in Figure 4 shows the trend graph of growth rate. From Figure 4, we can see that the total value of primary industry is rising, the added value magnitude after 2006 has increased, the change trends of growth rate and added value is basically unanimous.

The correlation degree analysis of the sports industry and related industries

Through the data analysis in TABLE 1, 2, 3, 4, 5 and the formula of correlation analysis method, you can use the Matlab software to solve the correlation degree matrix of the sports-related industries.

When the resolution is 0.5, the correlation coefficient matrix is shown in formula (8):

$$E = e_{0i}(k) = \begin{bmatrix} 0.333 & 0.4009 & 0.5061 & 1.0000 \\ 0.7146 & 0.3333 & 0.3462 & 1.0000 \\ 0.9487 & 0.3670 & 0.3333 & 1.0000 \\ 0.4926 & 0.3504 & 0.3333 & 1.0000 \\ 0.333 & 0.4289 & 0.6199 & 1.0000 \end{bmatrix} \quad (8)$$

The correlation degree between the sports industry and the gross national product, the primary industry, the secondary industry and the tertiary industry is shown in equation (9):

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$$R = \xi(x_0, x_i) = \begin{bmatrix} 0.5645 \\ 0.4903 \\ 0.4278 \\ 0.8858 \end{bmatrix} \quad (9)$$

Seen from formula (9), the correlation degree between the sports industry and the tertiary industry is the biggest, followed by GNP, and the correlation degree with the secondary industry is the minimum.

CONCLUSIONS

The correlation degree analysis well reveals the relationship between the sports industry and other industries; sports industry itself is a kind of tertiary industry, and it shows the feasibility of the correlation degree analysis from the actual situation; the change rate of the GNP continuously reduce, but the added value of the sports industry continues to increase, which shows that the sports industry trends to become dominant in GNP.

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