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Chinese industry chain healthy development strategy research based on grey relational analysis

Shaobing Yu

Institute of Physical Education, Chuzhou University, Chuzhou, Anhui, China

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ABSTRACT

Sports industry nearly 60 years' rapid development has begun to take shape in worldwide. Sports industry brings into enormous economic benefits, especially for lots of developed countries in Europe and America, sports industry has already become core industry that occupies big advantage and belongs to economic system in national economy. By comparing, Chinese sports industry started later, though sports industry proportion of economy is constantly increasing, it still falls behind developed countries. Make use of sports industry relative statistical data from 2006 to 2008, starting from perspective of economy, it makes research on sports industry chain and its economic development relations, and researches sports relative industry and national economy's correlations. Take economic development as reference; adopt mathematic method pursuing sports industries mutual relations. By establishing sports industry and economic grey mathematical model, it solves correlation degree, and carries out research on sports and its relative industries correlations and its correlations with economy, it concludes that Chinese sports industry chain sports leading industry items can better promote economic development and drive other sports industries development.

Key words: sports economy, economic development, grey correlation, sports industry chain

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INTRODUCTION

Sports industry as sunrise industry, its development prospect is considerable, under new period; Chinese economy should proceed with industrial structure adjustment and promote economic healthy development. No doubt, sports development surely propels to economic development, and economic growth surely will also have huge effects on sports industry development. Approved by National Bureau of Statistics, State General Administration of Sports organized national sports and relative industries data special investigation in July, 2008 [1-5]. From September, 2008 to June, 2009, the special investigation world carried out in 16 provinces (cities), and obtained Chinese sports industry added values and employees' core data from 2006 to 2008, which built data basis for comprehensive, correctly grasping Chinese sports industry development basic information [6-8]. The special investigation is overall description on Chinese sports industry development overall status, is authoritative. Correctly solve the problem has important practical significances in planning scientific reasonable sports industrial policies, designing reasonable layers sports industry structure and rapidly propelling to sports industry development [9-11].

In sports industry and economic correlations, scholars have made a great deal researches. Among them, Yang Qian (2011) researched sports industry and economic relations by grey relative analysis method, she pointed out that sports industry sub-factor fitness entertainment had highest correlation degree with economy, and national economy played strong leading role in sports industry development. Tong Ying-Juan (2012) applied growth factors analysis method to deeply research on sports industry development external factors and economic factors; she got layout pattern and layout economic means based on eastern region sports industry. Hu Cheng-Hong etc. based on grey mathematical theory, established evaluation model for sports industry structure, and carried out sports industry structural research with Sichuan province as an example; they thought it should lead relative industrial development

on the basis of sports industry. Yu Shou-Wen investigated developed countries sports industry structural form and economic structural effects by collecting information, he thought that sports industry was economic growth newly-developed part, it could drive sports industry chain and economic rapidly development by mutual correlations.Zhu Jie applied factor analysis, on the basis of Chinese eastern each province practical situations, she did research on sports industry development influence factors and put forward sports industry development promoting methods and suggestions. Zhou Yi etc. (2012) in the article "Sports industry correlations dynamical features research", according to sports industry input and output, they analyzed sports industry and relative industries correlations. Liu Han-Sheng (2011) by analyzing national sports and relative industries' data, he applied grey mathematical theory researching on relative industries internal connections, which provided references for sports industry sustainable development.

The paper on the basis of previous researches, by referencing, it applies grey correlation mathematical model to make further research on sports industry and economy relations. Calculate correlation degree, by comparing correlation degrees, it finds out promoting sports and relative industries as well as economic levels of intimacy. It provides quantitative sports industry data for sports industry structural layout and healthy development.

SPORTS AND RELATIVE INDUSTRY INDICATOR

Relations between sports industry and economy are intricate, mutually effected, their each kind of economic indicator and sports industry inner relations, structure, as well as features conform to grey mathematical model. Due to sports industry and economy detailed parameters correlation form is not exactly, it belongs to grey system. Grey system is the system that its information is imperfect and incomplete, only knows partial and not know the entity. This paper starts from grey system original feature grey, researches on information greatly lacking of clear correlations system. Grey system can better fit and find out things grey relations, establish sports and relative industries as well as economic correlations, and hereby solve sports industry and economic correlations.

Indicator selection

There are many sports industry development status indicator factors, according to sports and relative industries investigation; it has data as following Table 1:

Table 1: Main indicators data overview

Type	Year 2006		Year 2007		Year 2008	
	GDP added value	Employees	GDP added value	Employees	GDP added value	Employees
	(Unit:billion Yuan)	(Unit: ten thousand people)	(Unit:billion Yuan)	(Unit: ten thousand people)	(Unit:billion Yuan)	(Unit: ten thousand people)
Organizational management	74.80	18.71	89.36	18.98	117.56	20.87
Stadium management	18.24	2.58	23.04	2.41	30	2.62
Recreation and body building	46.98	11.78	58.79	13.32	74.49	15.03
Sports intermediary	2.02	0.87	3.00	0.96	4.46	1.35
Sports training	4.46	1.91	7.91	2.21	13.48	3.56
Sports lottery	21.47	11.11	29.63	13.37	35.27	17.64
Goods manufacturing	705.12	195.44	898.10	214.00	1088.31	234.13
Goods sale	76.45	11.13	110.77	15.20	141.79	18.54
Stadium construction	33.17	2.77	44.63	3.29	49.61	3.35
Total	982.89	256.30	1265.23	283.74	1554.97	317.09

During 2006 to 2008, sports and relative industries each indicator is in rising trend, economic efficiency growth is especially obvious, meanwhile it drives employment for more people, sports industry employees show linear growth trend, which indicates sports industry still have great development space, and can rapidly promote employment and drive economic development. Meanwhile sports industry strong growth shows future sports industry and relative industries will further develop. According to above Table data sports GDP added values and employees' quantities changes in three years, it draws Figure 1 as it shows.

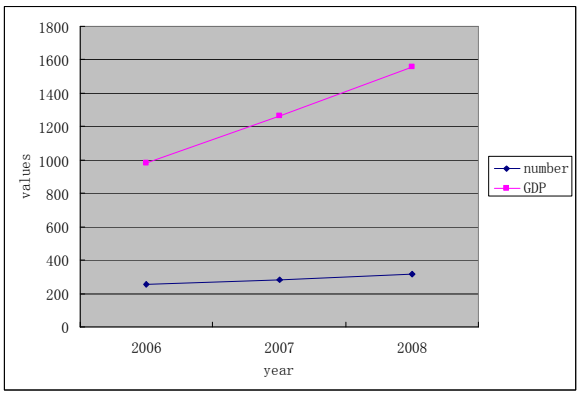

Figure1: Employees' quantity change in three years

Take 2008 data as an example, it can get that maximum proportion in sport GDP added value is sports manufacturing (includes sports goods, clothes, shoes and caps), the next is its closely connected sports sales. Larger proportions can deduce Chinese sports manufacturing is well-developed with regard to other sports industries, it can larger promote GDP growth, but whether manufacturing can become sports industry leading industry or not that still needs to further analyze its correlation degree with economy. It generates huge efficiency, meanwhile manufacturing and sales employees' quantities also lie in the top of each relative industries. The quantity of employees reflect the industry development level, its next year annual growing number of employees indicates manufacturing rapidly development. Relative industries' employees' quantities, sports and relative industries GDP added values in 2008 such bar chart is as Figure 2 show.

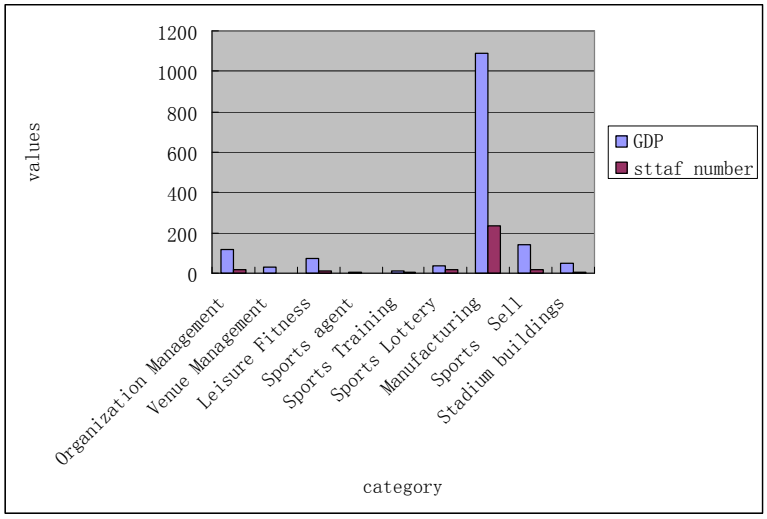

Figure 2: Relative industries change values bar chart

Correlation analysis and solution

Relational degree analysis method is put forward by grey system theory. Comparing with mathematical statistics, linear regression and other mathematical methods, grey mathematics has obvious advantages in handling with poor data information, fewer samples system. Grey correlation mathematical calculation, by handling and diminishing data randomness on original data, it carries out initialize transformation on sequence rule unobvious a group of data sequence, makes it regular. Correlation degree geometric significance is similarity degree after factor converted into function images. Its calculated amounts are less and not prone to appear correlation degree quantization result and qualitative analysis inconsistent status.

Reference indicator original data sequence selection

According to 2006 to 2008 national sports and relative industries statistical data, it takes annual GDP added values, per capita GDP, sports employees respectively as reference sequences, rest sequences as comparison sequences, and establishes original data table as following Table 2.

Table 2: Sequence original data table

Type	2006	2007	2008
	GDP	GDP	GDP
Sports organizational management(x_1)	74.8	89.36	117.56
Sports stadium management(x_2)	18.24	23.04	30
Recreation and body building(x_3)	46.98	58.79	74.49
Sports intermediary(x_4)	2.02	3	4.46
Sports training(x_5)	4.64	7.91	13.48
Sports lottery(x_6)	21.47	29.63	35.27
Sports manufacturing(x_7)	705.12	898.1	1088.31
Sports sales(x_8)	76.45	110.77	141.79
Sports stadium construction(x_9)	33.17	44.63	49.61
GDP added value(y_1)	982.89	1265.23	1554.97
Per capita GDP(y_2)	2042	2280	3313
Number of sports employees(y_3)	256.30	283.74	317.09

Correlation degree solution

Define A as original data comparison matrix. In matrix A, row represents sequence $x_i(i=1,2,\cdots 9)$, column represents year. Adopt grey mathematical model solving correlation degree, convert sports industry and economic development correlation into mathematical problems, in Table 2 sports industry data expressed by matrix A, it gets:

$$\mathrm{A}=\begin{pmatrix} 74.8 & 89.36 & 117.56 \\ 18.24 & 23.04 & 30 \\ 46.98 & 58.79 & 74.49 \\ 2.02 & 3 & 4.46 \\ 4.64 & 7.91 & 13.48 \\ 21.47 & 29.63 & 35.27 \\ 705.12 & 898.1 & 1088.31 \\ 76.45 & 110.77 & 141.79 \\ 33.17 & 44.63 & 49.61 \end{pmatrix}$$

Define B as original data comparison matrix. In matrix B, row represents sequence y_1、y_2、y_3, column represents year. In Table 2, economic development factors data is expressed by matrix B as:

$$\mathrm{B}=\begin{pmatrix} 982.89 & 1265.23 & 1554.97 \\ 2042 & 2280 & 3313 \\ 256.30 & 283.74 & 317.09 \end{pmatrix}$$

At first carry out data transformation

Because collected original data with different dimensions that have no comparability, to ensure modeling result accuracy, it should proceed with data transformation. Method is as following:

Define 1 Ordered sequence: $x=(x(1),x(2),\cdots x(n))$

And then call map

$f: x \to y$

$$f(x(k)) = y(k), k = 1,2,\cdots n$$

It is information sequence x to dimensionless sequence y data transformation relationship, its data transformation has: initialization transformation, mean transformation, percentage transformation, multiple transformation, normalization transformation, maximum range transformation, interval values transformation and so on.

$$f(x(k)) = \frac{x(k)}{x(1)} = y(k), k = 1,2,\cdots n and x(1) \neq 0$$

That is f initialization transformation. Make initialization transformation on matrix A, adopt matrix form transformation.

Define transformation matrix C: Let matrix that converts initial sequence matrix A into dimensionless initial value matrix D is called transformation matrix. Mathematical expression is: $\mathrm{C} \bullet \mathrm{A} = \mathrm{D}$

Matrix C general expression is: $\mathrm{C} = \begin{pmatrix} 1/a_{11} & 0 & \cdots & 0 \\ 0 & 1/a_{21} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1/a_{n1} \end{pmatrix}$

So make initialization transformation on A、B by transformation matrix C, it can get matrix:

$$\mathrm{D} = \mathrm{C} \bullet \mathrm{A} = \begin{pmatrix} 1 & 1.19 & 1.57 \\ 1 & 1.26 & 1.64 \\ 1 & 1.25 & 1.59 \\ 1 & 1.49 & 2.21 \\ 1 & 1.70 & 2.91 \\ 1 & 1.38 & 1.64 \\ 1 & 1.27 & 1.54 \\ 1 & 1.45 & 1.85 \\ 1 & 1.35 & 1.50 \end{pmatrix}$$

$$\mathrm{E} = \mathrm{C} \bullet \mathrm{B} = \begin{pmatrix} 1 & 1.29 & 1.58 \\ 1 & 1.12 & 1.62 \\ 1 & 1.11 & 1.24 \end{pmatrix}$$

Matrix D is comparison sequence matrix after grey theoretical data initialization that is after eliminating dimensions, E is reference matrix after grey theoretical original data initialization, in matrix, row represents D one reference sequence. Column represents values from 2006 to 2008.

Draw Figure 3 with data after initialization; observe sports industry and relative industries comparison sequences and reference sequences geometric figure, initially judge their correlations, and correlation degree sizes.

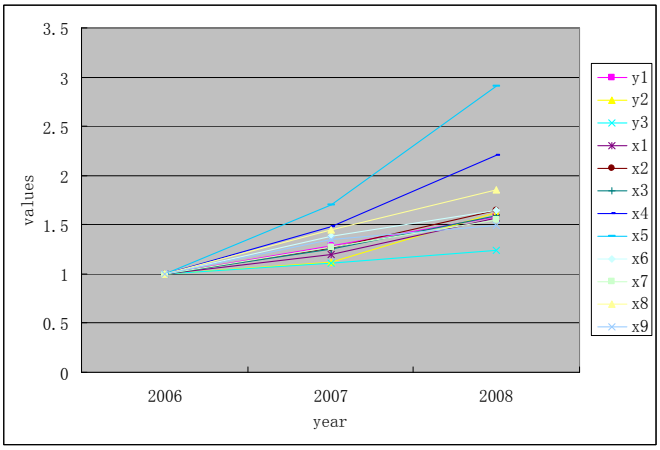

Figure 3: Factor trend correlation figure

By above qualitative analysis curve Figure 3, it is clear that sports industry GDP added values and sports relative industries GDP as well as other sequences trends approximate to consistency, there is similarity in figure, but each similar degree is different, which can roughly judge factors interaction sizes, but cannot make quantitative judgment on mutual correlation degrees sizes.

(2) Correlation coefficient solution

Select reference sequence. Reference sequence in the paper is y_1、y_2、y_3 factor. Other sequences are comparison sequence. Reference sequence:

$$x_0 = \{x_0(k) | k = 1,2,\cdots n\} = (x_0(1), x_0(2)\cdots x_0(n))$$

Among them, k is number of economic development factors, assume it has m pieces of comparison sequence:

$$x_i = \{x_i(k) | k = 1,2,\cdots n\} = (x_i(1), x_i(2)\cdots x_i(n)), i = 1,2,\cdots m$$

Then it calls

$$\xi_i(k) = \frac{\min\limits_s \min\limits_t |x_0(t) - x_s(t)| + \rho \max\limits_s \max\limits_t |x_0(t) - x_s(t)|}{|x_0(k) - x_i(k)| + \rho \max\limits_s \max\limits_t |x_0(t) - x_s(t)|} \tag{1}$$

It is comparison sequence x_i to reference sequence economic development sub factors x_0 at t moment correlation coefficient, from which $\rho \in [0,1]$ is resolution coefficient. In above formula, $\min\limits_s \min\limits_t |x_0(t) - x_s(t)|$、$\max\limits_s \max\limits_t |x_0(t) - x_s(t)|$ are respectively two-level minimum difference and two-level maximum difference.

Generally speaking, the bigger resolution ratio is, then the bigger resolution coefficient ρ would be; the smaller resolution ratio is, and then the smaller ρ would be, here the calculation takes $\rho = 0.5$.

Correlation degree solution, correlation coefficient is a kind of indicator describing reference sequence and comparison sequence correlation degree at some time, due to each point has a correlation coefficient, it is not convenient to compare, so give correlation degree definition:

$$r_i = \frac{1}{n}\sum_{k=1}^{n} \xi_i(k) \tag{2}$$

It is sequence x_i to reference sequence x_0 correlation degree. Correlation degree is concentrating each time correlation coefficient into an average value, which is also do collective handling with excess scattering information. Utilize correlation degree the concept, it can analyze and research sports industry and economic development correlation.

The solution, input initialized Table 3 data into formula(1)、(2), it can get each sequence correlation degree by

calculating, similarly input Table 4 data for calculating.

Calculated MATLAB program is as following:

```
clc, clear
load x.txt
for i=1:9
x(i, :)=x(i, :)/x(i, 1);
end
for i=6: 7
x(i, :)=x(i, 1)./x(i, :);
end
data=x;
n=size(data, 1);
ck=data(1, :);m1=size(ck, 1);
bj=data(2:n, :);m2=size(bj, 1);
for i=1:m1
for j=1:m2
t(j, :)=bj(j, :)-ck(i, :);
end
jc1=min(min(abs(t')));jc2=max(max(abs(t')));
rho=0.5;
ksi=(jc1+rho*jc2)./(abs(t)+rho*jc2);
rt=sum(ksi')/size(ksi, 2);
r(i, :)=rt;
end
r
[rs, rind]=sort(r, 'descend')
```

(3)Correlation degree result
According to above grey mathematical correlation degree computational method, the paper respectively takes sports GDP added value, per capita GDP, number of industry staff as reference sequences, and calculates nine comparison sequences correlation degrees, different reference sequences corresponding correlation degrees expressed with table, its result as following Table 3:

Table 3: Correlation degree value

Correlation degree	y_1	y_2	y_3
x_1	0.949	0.955	0.850
x_2	0.975	0.982	0.868
x_3	0.798	0.792	0.706
x_4	0.672	0.669	0.621
x_5	0.982	0.974	0.808
x_6	0.956	0.962	0.868
x_7	0.879	0.873	0.753
x_8	0.954	0.961	0.853
x_9	0.959	0.965	0.959

RESULT ANALYSIS

(1) In sports relative industries, it is sports training industry that has maximum correlation degree with sports GDP added values, correlation degree $r = 0.982$, increase sports training industry input can promote sports industry rapid development; it is sports stadium management industry that has highest correlation degree with per capita GDP, correlation degree $r = 0.982$, strengthen sports stadiums management plays important roles in improving per capita

GDP; it is sports stadium building industry that has highest correlation degree with employees, correlation degree $r = 0.959$, increase sports stadiums construction can improve employment rate.

(2) Sports lottery industry correlation degrees overall is the minimum one, which indicates lottery is out of step with Chinese current sports industry development, which needs to be further developed.

(3) Sports industry chain composition should use sports industry mode led by sports training, stadium management and sports stadium building developing sports industry, use leading industries driving relative industries development, and forms into closely connected, primary and secondary ordered sports industry chain.

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