

## An Optimization Study for Asian Sports Industrial Structure and Development

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**Abstract** — There are numerous problems in the development of Asian sports structure. We investigate first how data analysis is implemented on Asian sports product manufacturing development to assess Asian countries' changes in sports industrial development. Then we analyze and study the effect of China and South Korea's sports economic development in national development. By Grey's relational degrees mathematical model, we assess how sports industry and economy is computed and relations among South Korean sports industrial structure are illustrated. It is shown in the China and South Korea comparative study that China has solid foundation in sports product manufacturing and sales industry, and Chinese industrial structure adjustment should focus on the development of sports service industry and sports equipment.

**Keywords** - sports industry; structural optimization; China and South Korea's sports

### I. INTRODUCTION

Having the pulling effect and radiation intensity of sports industry on national economy verified by the world, economic value generated due to sports industry has become an important part in developed countries. Sports industrial structure is closely linked to its development, and industrial structure optimization is crucial to facilitate sports industrial development.

Asian sports developed later by comparing to Europe and America, and its sports industry developed slower due to the influence of competition with Europe and America's high quality sports enterprises. Asia based on developing countries, where science and technology power and economic level was lower and manufacturing industry was less developed so that the development of sports industry was seriously restricted. Coming into the 21st century, Asian sports undertakings have made significant progress, however, there are still numerous problems in sports industrial development [1-5]. Imbalance development occurred in Asian countries' sports industry. Japan's sports industry is among the largest in the world. In 1960s, South Korea's rapidly economic development built foundation for the development of sports industry, which rapidly developed in 1980s and becomes one of the South Korea's pillar industries now [6-9]. Rather perfect sports industrial structure conformed to policies in South Korea. The analysis of Asian Games' medal number suggested that China was absolutely No.1 in Asia as a powerful Asian sports country, next was Japan and South Korea, however, Japan and South Korea's sports industry and sports culture and education were ahead of Asia and even

partially the world, especially based on Japan. As a main developing country, India rather fell behind China, Japan and South Korea in competitive sports strength and sports industrial development [10-12].

The entire Asian sports industrial structure and most countries' industrial structures tend not to be reasonable. How to construct sports industry to conform to Asians development reality, all countries' national culture and economic development is the key to Asian sports undertakings development. Relying on analysis of South Korea and China's sports and Asian sports power, reasonable suggestions are presented on sports industrial structure development and regional optimization.

### II. DEVELOPMENT OF ASIAN SPORTS PRODUCT INDUSTRY

Asian sports product consumption is one of the symbols of Asian sports industrial growth, which can better reflect development state of Asian countries sports. Sports product being highly consumed and increased per year demonstrates that Asian sports is also rapidly growing under the impact of world sports, better promoting Asian sports industrial development. It is a good promotion to Asian sports industrial development.

Asian sports manufacturing industry is mainly invested by world famous sports brand enterprises, it initially begins with South Korea, Taiwan, later transfers to China, and then shifts to Southeast Asian countries that owing to enterprises investment shift caused by labor force cost, while great changes are brought to Asian sports industrial structure. Situation of enterprise earnings can refer to following figure 1.

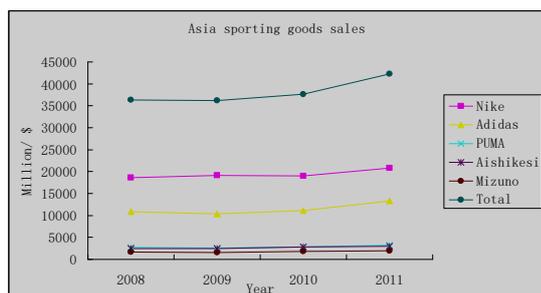


Figure 1. Changes of annual growth of the earnings of sports brand in Asia

Enterprise alternative investment exerts great impacts on all countries' sports industry, especially China that sports product manufacturing contract awarding has twice topped in Asia. Take Nike's data in 2013 as an example. In global sports product manufacturing, Asia mainly bases on the advantage of intensive cheap labor forces, however, it is changing. In sports product manufacturing, export shares of high-tech products are increasing in Asia. Almost Asian plants produce all global market sports equipment. And at the same time, Asia has become a

main consumption region of sports product that is an emerging global sales market. And Asian sports industry rapidly develops that builds foundation for the rise of Asian sports.

### III. CHINA AND SOUTH KOREA'S SPORTS INDUSTRIAL COMPARISON

#### A. Gross sports economic output value comparison

Both South Korea and China are Asian countries with deep historical origins and similar humanistic culture. They also have lots of similarities in sports event, South Korea's sports industry started earlier, which has developed into a perfect sports industrial structure at present. The study of South Korean sports industrial development will good enlighten Chinese sports industrial development. Sports industrial output is an important reflection of sports industrial competence measurement. Here is the proportion and growth speed comparison of China and South Korea's sports industrial output in native GDP.

TABLE 1. CHINA AND SOUTH KOREA'S SPORTS ECONOMIC COMPARATIVE ANALYSIS

Sports economic comparison	2007	2008	2009	2010
Total amount of China sports economy	1265.23	1554.97	1854.96	2183.72
Total amount of South Korea's sports economy	1529.52	1843.89	2341.1	2887.98
Total amount of sports economy/GDP proportion growth( China)	-	0.07	0.10	0.13
Total amount of sports economy /GDP proportion growth( South Korea)	-	0.08	0.03	0.05

Total amount of sports economy is increasing in both China and South Korea, however, China is lower than South Korea in total amount of sports economy and its growth of total amount of sports competitiveness is also slower (Figure 2). It shows that South Korean sports industry is superior to China both in scale and development speed, and China sports have huge development potentials, while China exceeds South Korea by far in the growth of proportion of total amount of sports competitiveness in GDP in the manner more rapidly sports industrial development in Chinese economic development. Initial dilemma has been brought to development due to imperfect industrial structure slower (Figure 3).

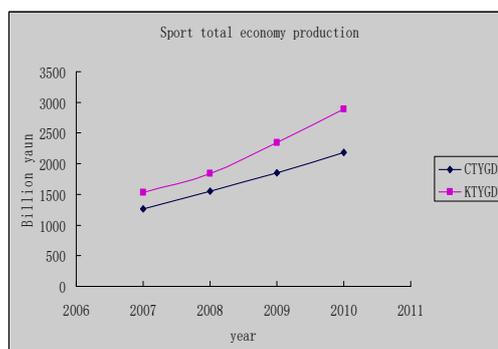


Figure 2. Gross sports economic output value comparison

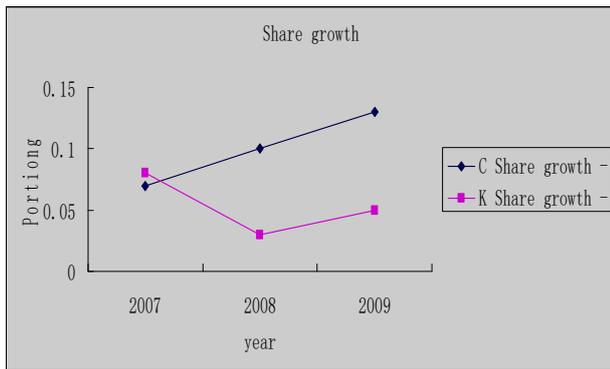


Figure 3. Proportion growth comparison

**B. China and South Korea's industrial structure grey relational degree analysis**

Relations between sports industry and economy are intricate and interactive, all kinds of economic indicators and sports industry's internal relations, structures and features conform to grey mathematics model. Sports industry and economy's specific parameters' correlation forms are uncertain that belong to grey system. Grey system is the term of system from which the information is incomplete, partial is known and partial is unknown. The paper starts from grey system original feature grey, researches on system with lots of information while lacks of definite correlation. Grey system can better fit and find out things' grey relations. Establish correlation between sub factors from sports industry and economy so as to solve the correlation between sports industry and economy. Calculate relational degree between sub factors of sports industry and economy. China and South Korea's sports industrial annual value added is as shown in following Table 2.

**C. Data is from national sports bureau and South Korea's official website**

The geometrical significances of correlation degree lie in the similarities level after factors turning into functional image. Its calculated quantity is little and the inconsistency between correlation degree's quantization result and qualitative analysis is not liable to appear. As a changing system, actually correlation analysis is quantized comparison analysis of dynamic process development trend slower (Figure 4).

TABLE 2. CHINA AND SOUTH KOREA'S SPORTS INDUSTRY COMPARISON( A HUNDRED MILLION)

China	2007	2008	2009	2010
Sports product manufacturing $x_1$	898.1	1088.31	1254.63	1508.32
Sports product sales $x_2$	110.77	141.83	233.73	237.16
Sports product service $x_3$	99.51	127.7	145.3	172.6
Sports product facility $x_4$	156.85	197.13	231.3	265.64
Sports overall value added $y$	1265.23	1554.97	1854.96	2183.72
South Korea	2007	2008	2009	2010
Sports product manufacturing $x_1$	123.96	160.01	322.09	392.31
Sports product sales $x_2$	94.93	106.4	341.11	417.5
Sports product service $x_3$	709.93	910.19	996.45	1267.3
Sports product facility $x_4$	600.7	667.29	681.45	775.87
Sports overall value added $y$	1529.52	1843.89	2341.1	2887.98

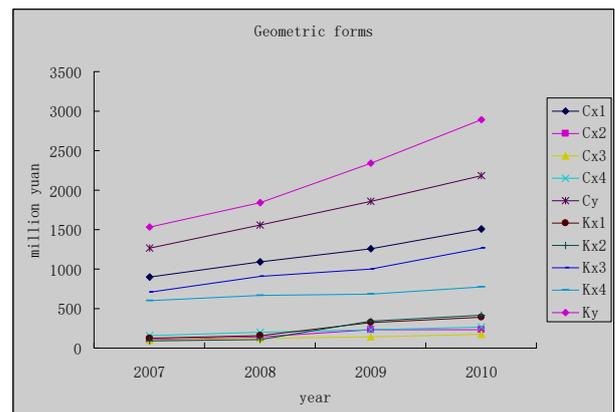


Figure 4. Sports industry and total sports economic value added trend chart

**D. Correlation solution**

To make correlation analysis of above sports industry, reference sequence and comparison sequence should be determined, given sports industry as comparison sequence, sports industrial total value added as reference sequence to solve correlation between comparison sequence and reference sequence.

(1) At first, carry out data transformation

Since data with different dimensions have no comparability, to ensure modeling result accuracy, it should proceed with data transformation to eliminate factors dimensions. Method is as following:

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

And then call map  $f : x \rightarrow y$  ;  
 $f(x(k)) = y(k), k = 1, 2, \dots, n$

It is data transformation expression between information sequence  $x$  to no dimensional sequence  $y$ , its data transformation has: initialization transformation, mean transformation, percentage transformation, multiple transformation, normalization transformation, maximum range transformation, interval values transformation and

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

so on.

That is  $f$  initialization transformation. Make initialization transformation on original data, adopt matrix form transformation.

Define transformation matrix  $C$ : Let matrix that converts initial sequence matrix  $A$  into non-dimensional initial value matrix  $D$  is called transformation matrix. Mathematical expression is:  $C \bullet A = D$

Matrix  $C$  General formula

$$C = \begin{pmatrix} 1/a_{11} & 0 & \dots & 0 \\ 0 & 1/a_{21} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1/a_{m1} \end{pmatrix}$$

Then, carry out initialization transformation on  $A$ ,  $B$  (refer to reference matrix and comparison matrix respectively) by transformation matrix  $C$  and get matrix:  $D = C \bullet A$ ;  $E = C \bullet B$

Matrix  $D$  is contrast sequence matrix after getting rid of dimension as carrying out normalization of grey theoretical data,  $E$  is reference matrix after normalized original data of grey theory that represents one reference sequence of  $D$  in matrix.

(2) Correlation coefficient solution method

Select reference sequence. Reference sequence in the paper refers to factor  $y_1, y_2, y_3$ . Other sequences are comparison sequence.

Reference sequence  $x_0 = \{x_0(k) | k = 1, 2, \dots, n\} = (x_0(1), x_0(2), \dots, x_0(n))$

Among them  $k$  represents athletes, given that it has  $m$  pieces of comparison sequence:

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

Then it

$$\xi_i(k) = \frac{\min_t |x_0(t) - x_s(t)| + \rho \max_t |x_0(t) - x_s(t)|}{|x_0(k) - x_i(k)| + \rho \max_t |x_0(t) - x_s(t)|}$$

calls

It is correlation coefficient of comparison sequence  $x_i$  to reference sequence  $x_0$  at  $k$  moment, from which  $\rho \in [0, 1]$  is resolution coefficient. In above formula,

$\min_s \min_t |x_0(t) - x_s(t)|$ ,  $\max_s \max_t |x_0(t) - x_s(t)|$  are respectively two-level minimum difference and two-level maximum difference.

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

Correlation degree solution, Correlation coefficient is a correlation degree of reference sequence and comparison sequence at different time, due to each point has a correlation coefficient, information is too decentralized to make rapidly comparison. Thus, given correlation degree

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

definition:

It is sequence  $x_i$  to reference sequence  $x_0$  correlation degree. Correlation degree is average value of correlation coefficient of comparison sequence at different time. Utilize correlation degree the concept, it can analyze and study.

(3) Correlation degree result

According to above grey mathematics correlation degree computational method, different reference sequences corresponding correlation degrees are expressed in the form of table, the result is as following:

TABLE 3. CORRELATION DEGREE VALUE

$y$	$x_1$	$x_2$	$x_4$	$x_3$
China	0.932	0.736	0.581	0.765
South Korea	0.697	0.593	0.872	0.769

It is obviously reflected in computed result that China and South Korea's sports industry has obvious differences in the whole sports development. South Korea sports industry started earlier and was rather perfected. It is obviously not reasonable to establish Chinese sports industrial structure on the standard of South Korea, the greatest difference is China has strong sports manufacturing ability with solid industrial base, however its sports high-end market turns to weak and sports service industry is backward by comparing to South Korea. It is necessary to carry out optimization adjustment on the proportion of industrial structure.

IV. CONCLUSION

From the advantage analysis of China and South Korea's sports industry correlation degree computational result, it is found that the proportion of basic manufacturing industry in Chinese sports industry should be properly reduced to appropriate level. And it should focus on the development of sports service industry and improve the development of sports facility. China's sports

industrial structure can be optimized by referencing South Korea's sports industrial experiences. Develop sports service high-end industry, innovate high-end sports equipment with science and technology and improve national sports consciousness and enhance domestic sports development.

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