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SBM-DEA model research and analysis based on an improved sports industry listed company operational efficiency evaluation

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ABSTRACT

Sports industry listed company development status has closely relations with widespread status of sports popularization, the paper makes research on Shanghai, Shenzhen exchanges' five sports industry listed companies and Hong Kong exchanges' six sports industry listed companies' financial data, summarizes five input indicator variables and five output indicator variables, and then by factor analysis, it summarizes input variables into input ability M1and operation capacity M2, as well as summarizes output variables into development potential N1 and profitability N2. In order to easier to research on problems, the paper adopts a kind of SMB-DEA model that based on improved sports industry listed company operational efficiency evaluation to make analysis; in the paper it firstly analyzes DEA model drawbacks in handling with undesirable output problems and establishes a kind of improved DEA mathematical planning model, after that it states Tone established SMB-DEA model's mathematical principle, finally after summarizing improved DEA model and SMB-DEA model's merits, it establishes a kind of improved SMB-DEA model. By researching on mathematical model and data features, it gets eleven sports industry listed companies input output variables technical efficiency status and pure technical efficiency status, and interprets each company operational status with numerical status, finally it applies improved SMB-DEA model getting each sports industry listed company scale efficiency evaluation value and efficiency value, relatively objective provides feasible reference suggestions for each company development.

KEYWORDS

SMB-DEA model;
Optimization model;
Technical efficiency;
Scale efficiency;
Sports industry.

INTRODUCTION

Science and technology is constantly developing, material civilization is constantly improving, people's living quality is moving steadily towards higher standard, as human race fitness warranted sports industry is also drastic developing, sports and leisure have become important parts of people's daily life. Sports industry refers to the total sum of sports material products and intellectual products, as well as all industries that provide sports service, as one department of national economy it has commonalities as other industries that is striving for market efficiency and economic efficiency, meanwhile it has features different from other industries

departments, its products important functions lie in improving residents physical qualities, developing social production, inspiring national ethos, realizing individual all-round development and the progress of social civilization[1].

For sports industry listed company researches, lots of people have made efforts, from which: Zhang Hong-Wei(2012) took 2006to 2010 as researching period, selected Yongping manufacturing listed company that main business was sports clothes, adopted DEA view analysis, considered and discussed domestic sports goods manufacturing and foreign similar enterprises operational efficiency changes, the research found that foreign major industry Adidas technical efficiency always taken the leading position, domestic sports goods manufacturing listed company operational efficiency kept certain paces with foreign companies, the differences were mainly caused by pure technical efficiency value, domestic partial enterprises operational efficiency were higher, and financial crisis had no great influences on domestic sports goods manufacturing listed companies[2]; Tang Hong etc.(2013) took Hong Kong, Shenzhen, Shanghai stock markets eleven sports industry listed companies financial data in 2010 as research objects, applied factor analysis finding out common factors that effected on input and output, and then input common factors into data envelopment analysis model, researched on sports industry listed companies operational efficiency, and made evaluation on each listed company operation status, as well as make feasible suggestions[3]; Wu Yan-Nian etc.(2010) collected four sports goods listed companies recent three years financial data, and by constructing Chinese sports goods listed companies enterprises competitive capacity evaluation indicator system, applying principal component analysis, they worked out every listed company financial indicators evaluation function scores, and hereby made comprehensive evaluation and analysis of listed companies financial status, so that found out each listed companies competitive capacity gap and enterprise itself advantages, it concluded that Chinese sports goods industry was a new type sunrise industry, overall profitability, operation capacity and growth were relatively ideal, and made relative measures and suggestions[4]; Lu Yu-Sen etc.(2013) took Hong Kong, Shenzhen, Shanghai stock markets seven sports industry listed companies financial data as analysis objects, applied DEA model researching their operational efficiency and returns to scale, and implemented input redundancy and output insufficient analyses of input and output elements, it provided different input, output combination schemes relative efficiencies, and got that Li-Ning and Anta sports scale efficiency did not change, under different input, output schemes, the two companies operational efficiency were always valid, Tibet tourism and Toread returns to scale were also in relative superior state, but input elements use rate not yet arrived at a relative stable state and other industries operation status, by measuring sports industry listed company operational efficiency, it was beneficial to make clear risk origins and its degrees sizes, so that provided references for investors avoiding risks and administrators monitoring markets[5].

For DEA model, SMB-DEA model and improved SMB-DEA model, lots of people have made researches, from which: Li Jing (2008) applied SBM model evaluating environment efficiency, and carried out environment efficiency empirical analysis of 43 enterprises[6]; Song Ma-Lin etc. (2010) utilized an improved environment efficiency evaluation ISMB-DEA model to make ISMB analysis of years domestic productivity, and carried out empirical analysis of data from 1995 to 2008[7]; Huang Yong etc.(2010) used DEA model's CCR model, CCGSS model as well as DEA confrontation and intersection model evaluating 13 port industry listed companies data in 2008, and made improvement suggestions on evaluation result[8].

DEA evaluating idea is a kind of constraint that requires input tries to arrive at no redundancy, output tries to arrive at no deficits, and then establish objective function, utilizes multiple input indicators and multiple output indicators to evaluate decision unit relative efficiency, DEA evaluation model application range is very widely, and its analysis of economic efficiency and operational efficiency are more common, to better analyze sports industry listed companies operation status, the paper researches improved DEA model, SMB-DEA model and improved SMB-DEA model, by research methods in the paper, in the hope of getting reasonable analysis of eleven sports industry listed company operation status in 2010, and provides objective improvement

suggestions on them.

RESEARCH OBJECTS

Data sources

The paper data is from CSMAR database, and consults listed companies reports and statement notes in 2010 through CITIC building security company website.

Research objects

The paper selects Shanghai stock exchange, Hong Kong stock exchange and Shenzhen exchange sports industry listed companies financial data as research objects, to eliminate abnormal operation phenomenon of operation performance largely rising caused by reorganization, get rid of data incompletely disclosing, suffered ST enterprises, major business loss, acquired by other enterprises or happened replacements of assets caused major business fundamental changed enterprises, it selects Shanghai, Shenzhen exchange's Chinese sports industry, Tibet tourism, Xinlong industry, Toread, Qingdao Doublestar total five companies, and selects Hong Kong exchange's Li Ning, Anta sports, Xtep international, China Dongxiang, Peak sport, and 361°total six companies.

Regard above eleven listed companies five indicators in 2010 as input variables, the input variables are respectively: total assets I_1, working funds I_2, money funds I_3, gross liability I_4 and circulating shares amount I_5, from which total assets reflect enterprises' producing activities; working funds reflect enterprises input elements most active element; money funds mainly include enterprise cash on hand, bank loan and other money funds, listed companies money funds amount has relations with enterprises' debt paying ability and ability to pay, is external reflection of enterprise financial status; gross liability reflects enterprises' bearing and debt paying fund; circulating shares amount reflects economic scale.

Regards above eleven listed companies five indicators in 2010 as output variables, output variables are respectively: circulating shares earnings per share Q_1, net profit Q_2, current ratio Q_3, quick ratio Q_4 and return on invested capital Q_5, from which circulating shares earnings per share reflects stock investment values, comprehensive reflects company's earnings-generating capacity; net profit reflects listed company profitability; current ratio reflects listed company current period paying off short-term debt ability; quick ratio reflects listed company capital flowing sizes, which has closely connections with enterprises' producing capacity and debt paying risks ; return on invested capital reflects listed company overall efficiency and output scale factor.

For above 11 sports industry listed company annual reports' financial reports, taking ten indicators corresponding data as research objects, handle with original data, it can get two input variables that are respectively input ability and operation capacity, and gets two output variables that are respectively development potential and profitability.

MATHEMATICAL MODEL PRINCIPLE

DEA(data envelopment analysis) represents data envelopment analysis, the method is mathematics, operational research, management science and mathematical economics intersectional one new type analysis method, Is a kind of quantitative analysis method according to multiple input indicators and multiple output indicators, applying linear planning carrying out efficiency evaluation on same type decision units with comparability. DEA evaluation idea is let input produces minimum redundancy as much as possible, and output tries to achieve no deficit, the method utilizes multiple input indicators and multiple output indicators for evaluating decision units' relative efficiency. DEA can regard decision units as a black box, by considering input and output, it can judge these DMU_S efficient, and in real production process, when expected output produced out, it tends to accompany with unexpected by-product generation, these by-products are called undesirable output, these undesirable outputs may cause certain effects on production efficiency, if people only pursuit output without deficit, and then it will cause undesirable outputs increasing, therefore people should pursuit positive outputs increasing, meanwhile reduce undesirable outputs, so that it can realize best economic efficiency, and typical DEA model cannot answer to

undesirable output problems, which needs to explore more advanced model.

For the attempts of DEA model introducing undesirable output, lots of people have made efforts, from which carrying out data transformation on undesirable output, and designing undesirable output solutions roughly have following three types:

Curve measurement evaluation method, the method is a kind of non-linear function solution, though Fare and others proposed linear function transformation method, it is still complex when solving, and in case input has no redundancy, its undesirable output will not linear increasing with input increasing, therefore curve measurement evaluation non-linear function linear solution is not the best method for selecting neither in calculation complex nor in practical demands.

Data transformation function solution, the method is taking negative value on undesirable output and adding a proper positive number that causes all data can above zero, but the added positive number will change with data collectors personal subjective wishes, which lacks of objectivity, and the method achieved efficiency evaluation value and interrupt processing achieved value have consistency;

Distance function approach, the method subjectively sets function convergence direction that causes it cannot objectively evaluate undesirable output efficiency problem.

Improved DEA model

The paper adopts a kind of DEA improved algorithm, its expression is as formula (1) show:

$$\max \quad \pi_0 = \sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ + \sum_{t=1}^{k} s_t^-$$

$$\text{s.t.} \begin{cases} \sum_{j=1}^{n} \lambda_j x_{mj} + s_i^- = X_0, m = 1,2,\cdots,m \\ \sum_{j=1}^{n} \lambda_j y_{rj} - s_i^+ = Y_0, r = 1,2,\cdots,r \\ \sum_{j=1}^{n} \lambda_j z_{sj} + s_t^- = Z_0, s = 1,2,\cdots,s \\ \sum_{j=1}^{n} \lambda_j = 1; \lambda_j \geq 0, j = 1,2,\cdots,n \end{cases} \quad (1)$$

Based on that, set three parameters $\alpha_i, \beta_r, \gamma_t$, their representative definitions are as formula (2) show:

$$\begin{cases} \alpha_i = \dfrac{x_{i0} - s_i^-}{x_{i0}}, \beta_r = \dfrac{y_{r0}}{y_{r0} + s_r^+}, \gamma_t = \dfrac{z_{t0} - s_t^-}{z_{t0}} \\ i = 1,2,\cdots,m; r = 1,2,\cdots,s; t = 1,2,\cdots,k \end{cases} \quad (2)$$

As formula (1) and formula(2) show, it can get economic efficiency value τ_0 computational formula, as formula (3) show:

$$\tau_0 = \frac{1}{m+s+k}\left(\sum_{i=1}^{m} \alpha_i + \sum_{r=1}^{s} \beta_r + \sum_{t=1}^{k} \gamma_t\right) \quad (3)$$

SBM-DEA model

When handling with undesirable output SBM model, it needs to assume that production system has n pieces of decision units, and its each decision unit has three input output vectors that are input, desirable output and undesirable output, three vectors are expressed as $x \in R^m$, $y^g \in R^{s1}$ and $y^b \in R^{s2}$, and defines matrix $\mathbf{X}, \mathbf{Y^g}, \mathbf{Y^b}$ as formula (4) show:

$$\begin{aligned} X &= [x_1, x_2, \cdots, x_n] \in R^{m \times n} \\ Y^g &= [y_1^g, y_2^g, \cdots, y_n^g] \in R^{s1 \times n} \\ Y^b &= [y_1^b, y_2^b, \cdots, y_n^b] \in R^{s2 \times n} \\ X &> 0, Y^g > 0 \end{aligned} \quad (4)$$

In case returns to scale are unchanged, production possibility set P definition is as formula (5) show:

$$P = \left\{ (x, y^g, y^b) \middle| x \geq X^\lambda, y^g \leq Y^{g\lambda}, y^b \geq Y^{b\lambda}, \lambda \geq 0 \right\} \quad (5)$$

Based on improved DEA model idea, Tone started from objective function, constructed SBM-DEA model, and directly introduced slack variable into objective function, which not only solved input output slackness problems but also solved decision units efficiency evaluation problems to a certain degree, SBM-DEA model is a kind of non-radial non-angular evaluation method, its objective function is as formula (6) expressing:

$$\min \quad \rho = \frac{1}{1 + \dfrac{1}{s_1 + s_2}\left(\sum_{r=1}^{s_1} \dfrac{s_r^g}{y_{r0}^g} + \sum_{r=1}^{s_2} \dfrac{s_r^b}{y_{r0}^b}\right)} \left(1 - \frac{1}{m}\sum_{i=1}^{m} \frac{s_i^-}{x_{i0}}\right) \quad (6)$$

FULL PAPER

By formula(6), it is clear that Tone took redundancy proportions in input as numerator, deficit proportions in output as denominator, in this way it can let input reduce as much as possible and let output expand as much as possible when making linear planning.

Objective function formula (6) constraint condition is as formula (7) show:

$$\text{s.t.}\ \begin{cases} \mathbf{x_0 = X^{\lambda} + s^-, y_0^g = Y^{g\lambda} - s^g, y_0^b = Y^{b\lambda} + s^b} \\ \mathbf{s^- \geq 0, s^g \geq 0, s^b \geq 0, \lambda \geq 0} \end{cases} \quad (7)$$

In formula(7) s represents input output slack variable, λ represents weight vector, objective function formula(6) is seriously diminishing regarding s^-, s^g, s^b, and objective function values overall range is [0,1].

Improved SBM-DEA model

In order to simplify objective function, extremism solution easily realizing, the paper establishes a kind of improved SBM-DEA model, the model objective function only considers positive output maximization, and no need considering undesirable output problems, and reflects undesirable output minimize condition in constraint conditions. To explain mathematical model expressive definitions, it has symbols descriptions as following:

x represents input indicator; y represents output indicator; z represents undesirable output indicator;

ω_{id} represents the d decision unit the i input indicator weight;

μ_{rd} represents the decision unit the output indicator weight;

δ_{jd} represents the d decision unit the j undesirable output's weight.

If assume that in production process, returns to scale don't change, it has as formula (8) showed planning model:

$$\max\ \frac{\mathbf{uY_0}}{\mathbf{vX_0 - dZ_0}}$$
$$\text{s.t.}\ \begin{cases} \mathbf{v_{id}x_j - d_{jd}z_j \geq u_{rd}y_j} \\ \mathbf{v_{id}X_0 - d_{jd}Z_0 = 1} \\ \mathbf{d_{jd} \geq u_{rd}} \\ \mathbf{v, u, d \geq 0} \end{cases} \quad (8)$$

Formula (8) showed planning model is time-share planning, if it goes through a C^2 transformation, then it can convert formula (8) into an equivalent linear planning form, so formula (8) can have as formula (9) showed equivalent panning form:

$$\max\ \mathbf{\mu Y_0}$$
$$\text{s.t.}\ \begin{cases} \mathbf{\omega_{id}x_j \geq \delta_{jd}z_j + \mu_{rd}y_j} \\ \mathbf{\omega_{id}X_0 - \delta_{jd}Z_0 = 1} \\ \mathbf{\delta_{jd} \geq \mu_{rd}} \\ \mathbf{\omega, \delta, \mu \geq 0} \end{cases} \quad (9)$$

TABLE 1 : After original data handling, achieved eleven listed companies input variables and output variables

Name	Input variable(Input)		Output variable (Output)	
	M1	M2	N1	N2
A. Chinese sports industry	0.711	0.864	0.627	0.649
B. Tibet tourism	0.601	0.645	0.634	0.601
C. Qingdao Doublestar	0.689	1.000	0.624	0.888
D. Toread	0.608	0.601	0.692	0.901
E. Xinlong industry	0.615	0.665	0.636	0.681
F. Li Ning	0.791	0.671	0.601	1.000
G. Anta sports	0.939	0.778	0.719	0.918
H. Xtep international	0.765	0.656	0.760	0.836
I. China Dongxiang	1.000	0.611	1.000	0.758
J. Peak sport	0.745	0.631	0.829	0.829
K. 361°	0.838	0.790	0.736	0.836

Note: M1 represents input ability; M2 represents operation capacity; N1 represents development potential; N2 represents profitability

In formula (9), constraint condition $\omega_{id} X_0 - \delta_{jd} Z_0 = 1$ is handling to undesirable output, its solution methods have two types, one is minimum input method, the other is data transformation function method optimization handling method, its dual planning form is as formula (10) show:

$$\text{s.t.}\begin{cases}\sum_{j=1}^{n}\lambda_j x_{mj} + S^- = \theta X_0, m = 1,2,\cdots,m\\ \sum_{j=1}^{n}\lambda_j y_{rj} + \varphi - S_y^+ = Y_0, r = 1,2,\cdots,r\\ \sum_{j=1}^{n}\lambda_j z_{sj} - \varphi - S_z^- = \theta Z_1, s = 1,2,\cdots,s\\ \lambda_j \geq 0, j = 1,2,\cdots,n\end{cases} \quad (10)$$

For DEA efficiency, it has following showed theorem

Theorem If formula (8) any optimal solution $\lambda^0 = \left(\lambda_1^0, \lambda_2^0, \cdots, \lambda_n^0\right)^T, S^-, S_y^+, S_z^+, \varphi$ when it has $\theta_j = 1, S^- = 0, S_y^+ = 0, \varphi = 0$, and then it calls DMU_j is DEA efficient.

If $\varphi > 0$ and $\theta_j = 1, S^- = 0, S_y^+ = 0, S_z^+ = 0$, then it calls DMU_j Is weakly efficient.

Theorem prove is as following showÿ

Prove formula (8) production possibility set is as formula (11) show:

$$\mathbf{T} = \left\{(\mathbf{X},\mathbf{Y},\mathbf{Z}) \middle| \begin{array}{l}\sum_{j=1}^{n}\lambda_j \mathbf{X_j} \leq \mathbf{X},\\ \sum_{j=1}^{n}\lambda_j \mathbf{Y_j} - \varphi \geq \mathbf{Y}, \sum_{j=1}^{n}\lambda_j \mathbf{Z_j} + \varphi \geq \mathbf{Z}\end{array}\right\} \quad (11)$$

If $\theta = 1$, then constraint condition changes into $\sum_{j=1}^{n}\lambda_j Z_j \leq X, \sum_{j=1}^{n}\lambda_j Z_j + \varphi \leq Z$, in production leading edge, so DMU_j is weak DEA is efficient. If $\varphi = 0$, then it exists constraint condition $\delta = \mu$, now it can take optimal solution in the internal of production possibility set, so it is DEA efficient, the theorem is proved.

RESEARCH RESULT AND ANALYSIS

Original data handling result is as TABLE 1 show.

By TABLE 1, it gets sports industry listed company technical efficiencies as TABLE 2 show.

From TABLE 2, it is clear that input with no redundancy listed companies are D. Toread, I China Dongxiang and J Peak sport, and other eight companies sports industry listed companies all exist input redundancy to different degrees.

A Chinese sports industry, from the perspective of input, it exists redundancy, which shows input factors allocation is not reasonable, if increasing input use rate, it requires to reduce M1 0.159, reduce M2 0.319, and then it can realize output N2 increasing 0.170 let it increases from original 0.649 to 0.819;

B Tibet tourism, from the perspective of input, it exists redundancy, which shows input factors allocation is not reasonable, if increasing input use rate, it requires to reduce M1 0.045, reduce M2 0.099, and then it can realize output N2 increasing 0.225 let it increases from original 0.601 to 0.826;

C Qingdao Doublestar, from the perspective of input, it exists redundancy, which shows input factors allocation is not reasonable, if increasing input use rate, it requires to reduce M1 0.094, reduce M2 0.412, and then it can realize output N1 increasing 0.055 let it increases from original 0.624 to 0.679;

E Xinlong industry, from the perspective of input, it exists redundancy, which shows input factors allocation is not reasonable, if increasing input use rate, it requires to reduce M1 0.055, reduce M2 0.113, and then it can realize output N2 increasing 0.151 let it increases from original 0.681 to 0.832;

F Li Ning, from the perspective of input, it exists redundancy, which shows input factors allocation is not reasonable, if increasing input use rate, it requires to reduce M1 0.118, reduce M2 0.008, and then it can realize output N1 increasing 0.165 let it increases from original 0.601 to 0.766;

G Anta sports, from the perspective of input, it exists redundancy, which shows input factors allocation is not reasonable, if increasing input use rate, it requires to reduce M1 0.304, reduce M2 0.164, and then it can realize original output;

H Xtep international, from the perspective of input, it exists redundancy, which shows input factors allocation is not reasonable, if increasing input use rate,

FULL PAPER

TABLE 2 : Sports industry eleven listed companies input output variables technical efficiency values table

Name	θ	M1			M2		
		Original value	Improved value	Target value	Original value	Improved value	Target value
A	0.778	0.711	0.159	0.552	0.864	0.319	0.545
B	0.926	0.601	0.045	0.556	0.645	0.099	0.546
C	0.866	0.689	0.094	0.595	1.000	0.412	0.588
D	1.000	0.608	0.000	0.608	0.601	0.000	0.601
E	0.911	0.615	0.055	0.56	0.665	0.113	0.552
F	0.988	0.791	0.118	0.673	0.671	0.008	0.663
G	0.791	0.939	0.304	0.635	0.778	0.164	0.614
H	0.904	0.765	0.073	0.692	0.656	0.063	0.593
I	1.000	1.000	0.000	1.000	0.611	0.000	0.611
J	1.000	0.745	0.000	0.745	0.631	0.000	0.631
K	0.778	0.838	0.186	0.652	0.790	0.177	0.613
Name	θ	**N1**			**N2**		
		Original value	Improved value	Target value	Original value	Improved value	Target value
A	0.778	0.627	0.000	0.627	0.649	0.170	0.819
B	0.926	0.634	0.000	0.634	0.601	0.225	0.826
C	0.866	0.624	0.055	0.679	0.888	0.000	0.888
D	1.000	0.692	0.000	0.692	0.901	0.000	0.901
E	0.911	0.636	0.000	0.636	0.681	0.151	0.832
F	0.988	0.601	0.165	0.766	1.000	0.000	1.000
G	0.791	0.719	0.000	0.719	0.918	0.000	0.918
H	0.904	0.760	0.000	0.760	0.836	0.000	0.836
I	1.000	1.000	0.000	1.000	0.758	0.000	0.758
J	1.000	0.829	0.000	0.829	0.829	0.000	0.829
K	0.778	0.736	0.000	0.736	0.836	0.054	0.890

Note: M1 represents input ability; M2 represents operation capacity; N1 represents development potential; N2 represents profitability

it requires to reduce M1 0.073, reduce M2 0.063, and then it can realize original output;

K 361°, from the perspective of input, it exists redundancy, which shows input factors allocation is not reasonable, if increasing input use rate, it requires to reduce M1 0.186, reduce M2 0.177, and then it can realize original output.

Above 8 companies input redundancy sports industry listed companies, Tibet tourism, Xinlong industry, Li Ning and Xtep international technical efficiency value arrives at above 90%, which respectively has 7.3%,9.0%,1.1% and 9.5% improvement room, other four companies technical efficiency are less than 90%, from which Chinese sports industry and 361°rank in the last two, the two companies M1 and M2 input factors all exist redundancy, N2 shows output insufficient, if it can make adjustment according to the two companies' resources administration and allocation mode, then it can let the two listed companies generate huge potentials.

Sports industry listed company pure technical efficiency

From TABLE 3, it is clear that no occurrence of techniques inefficient sports industry listed companies are B. Tibet tourism, D.Toread, F. Li Ning, I China Dongxiang and J Peak sports, and other six sports industry listed companies all exist technique inefficient

TABLE 3 : Sports industry eleven listed companies input output variables pure technical efficiency values table

Name	θ	M1			M2		
		Original value	Improved value	Target value	Original value	Improved value	Target value
A	0.846	0.711	0.109	0.602	0.864	0.226	0.638
B	1.000	0.601	0.000	0.601	0.645	0.000	0.645
C	0.880	0.689	0.083	0.606	1.000	0.398	0.602
D	1.000	0.608	0.000	0.608	0.601	0.000	0.601
E	0.980	0.615	0.014	0.601	0.665	0.032	0.633
F	1.000	0.791	0.000	0.791	0.671	0.000	0.671
G	0.845	0.939	0.144	0.795	0.778	0.137	0.641
H	0.920	0.765	0.072	0.693	0.656	0.053	0.603
I	1.000	1.000	0.000	1.000	0.611	0.000	0.611
J	1.000	0.745	0.000	0.745	0.631	0.000	0.631
K	0.777	0.838	0.186	0.652	0.790	0.179	0.611
Name	θ	N1			N2		
		Original value	Improved value	Target value	Original value	Improved value	Target value
A	0.846	0.627	0.015	0.642	0.649	0.000	0.649
B	1.000	0.634	0.000	0.634	0.601	0.000	0.601
C	0.880	0.624	0.066	0.690	0.888	0.000	0.888
D	1.000	0.692	0.000	0.692	0.901	0.000	0.901
E	0.980	0.636	0.013	0.649	0.681	0.000	0.681
F	1.000	0.601	0.000	0.601	1.000	0.000	1.000
G	0.845	0.719	0.000	0.719	0.918	0.000	0.918
H	0.920	0.760	0.000	0.760	0.836	0.035	0.871
I	1.000	1.000	0.000	1.000	0.758	0.000	0.758
J	1.000	0.829	0.000	0.829	0.829	0.000	0.829
K	0.777	0.736	0.000	0.736	0.836	0.046	0.882

Note: M1 represents input ability; M2 represents operation capacity; N1 represents development potential; N2 represents profitability

phenomenon.

Chinese sports industry, Qingdao Doublestar, Xinlong industry, Anta sports, Xtep international and 361°still have improvement rooms in input ability production factors, from which 361°improvement room is the maximum, improved value arrives at 0.186.

Chinese sports industry, Qingdao Doublestar, Xinlong industry, Anta sports, Xtep international and 361°still have improvement rooms in operation capacity production factors, from which Chinese sports industry, Qingdao Doublestar improved value respectively arrive at 0.226 and 0.398, therefore it proves that their operational capacity promoting have greater contribution to the whole companies production efficiency.

In above A-K eleven sports industry listed companies, eight companies operation capacity output factors arrive at best one, and the other three companies respectively Chinese sports industry, Qingdao Doublestar and Xinlong industry, the three companies have to be improved in operation capacity output factors aspect.

In profit aspect, only Xtep international and 361°are required to be further improved in development strategy, other nine companies have already arrived at best output state.

Sports industry listed company scale efficiency

Sports industry listed company scale efficiency in DEA model, generally use λ_i reflecting listed company

FULL PAPER

TABLE 4 : Sports industry listed company scale efficiency table

Name	Evaluation value		Scale	
	SMB-DEA	Improved SMB-DEA	Scale efficiency	Returns to scale
A. Chinese sports industry	0.765	0.874	0.875	↑
B. Tibet tourism	0.938	1.000	0.938	↑
C. Qingdao Doublestar	0.871	0.904	0.963	↑
D. Toread	1.000	1.000	1.000	——
E. Xinlong industry	0.919	0.994	0.925	↑
F. Li Ning	0.987	1.000	0.987	↓
G. Anta sports	0.780	0.859	0.908	↓
H. Xtep international	0.902	0.925	0.975	↑
I. China Dongxiang	1.000	1.000	1.000	——
J. Peak sport	1.000	1.000	1.000	——
K. 361°	0.765	0.787	0.972	?

Note: ↑ represents scale efficiency progressive increase; —— represents scale efficiency not change; ↓ represents scale efficiency progressive decrease

production scale changes caused output changes rule, if set returns to scale m expression as formula (12) show, then when $m<1$ represents listed companies production input is in returns to scale progressively increasing phase, when $m=1$ represents listed companies input returns to scale not change, which shows now listed companies input and output allocation are the best, when $m>1$ represents listed companies production input is in returns to scale progressively decreasing phase.

$$\mathbf{m}=\sum_{\mathbf{i}=1}^{\mathbf{n}}\boldsymbol{\lambda}_{\mathbf{i}}^{*} \quad \textbf{(12)}$$

In formula (12), $\lambda_i^*(i=1,2,\cdots,n)$ represents linear planning optimal solution.

TABLE 4 shows that A, B, C, E, H five sports industry listed companies are in scale efficiency progressively increasing phase, F, G, K three sports industry listed companies are in scale efficiency progressively decreasing phase, D, I, J three sports industry listed companies are in scale efficiency allocation optimal state.

Five sports industry listed companies that are in scale efficiency progressively increasing phase should get better efficiency by expanding production scale; the three sports industry listed companies that are in scale efficiency progressively decreasing phase should realize listed companies operational efficiency improvement by reducing production process existing uneconomic problems; and the three companies that are in scale efficiency of production leading edge, which also means D, I, J three companies are stable operating companies, they need to keep such production way.

CONCLUSIONS

The paper analyzes and researches eleven sports industry listed companies financial reports and note information, on the basis of data handling analysis, it gets eleven companies input indicators in 2010: input ability and operation capacity, output indicators; development potential and profitability: Analyzes improved DEA model and SMB-DEA model, on the basis of researching, it establishes improved SMB-DEA model, and applies the two models getting eleven sports industry listed companies evaluation values and improved values; by analyzing eleven ports industry listed companies scale efficiency, objectively gets that improvement strategies under scale efficiency three phases, which provides scientific evidence for companies rectification.

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