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The comprehensive evaluation model research on the impact of table tennis competition system changes on the results based on Matlab

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ABSTRACT

The score changing situation within a Table tennis game is more complex. In order to more accurately describe the problem, this paper uses the classical probabilistic model to establish a function relationship of single round win probability and single game win probability, adopts the method of curve fitting images of hyperbolic tangent to simplify expressions, and thus leads to two evaluation models, namely contingency index and intense index. Study found that the contingency of using 11 points 5 winnings 3 wins competition system is almost 20 percent higher than 21 points 5 winnings 3 wins competition system. For the indicators of comprehensive evaluation model, it uses the optimal index evaluation model of weight-variable function, defines a weight-variable function to distinguish the weight of contingency factors and intense degree when p is not the same and draws four competition system evaluation schemes by calculating the distance between each evaluated object and the ideal solution and the negative ideal solution. © 2013 Trade Science Inc. - INDIA

KEYWORDS

Matlab simulation;
Evaluation model;
Table tennis;
TOPSIS.

INTRODUCTION

Many researchers in our country focus on the impact of new serve rules on table tennis players. Such as Zhang Xiao-peng conducted multi-angle video shooting on the existing serve approach of Chinese table tennis lead players, found out the incompatible links with the new serve rules, recommended improvements suggestions, conducted video study on the improvement suggestions, the findings got the confirmation of ITTF. There are some researchers analyzed the changes of new serve rules on table tennis, and made some training ideas and methods under the new rules. In addition, more literature discussed on the possible impact of new rules for athletes and put forward the corresponding countermeasures. Wu Huan-qun and Zhang Xiao-peng made a more systematic summary on the impact of the big ball, 11-point competition system and no blocking serve table tennis technology. We found the impact of competition system change on the game, there are few experts have launched a more detailed study from a mathematical point of view.

This paper establishes the comprehensive evaluation model of tennis 11-point and 21-point competition

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system based on Matlab, conducts research on the contingency and race intense of match results for different competition system, analyzes the relative rationality of the competition system through mathematical model, and provides theoretical guidance for the training, competition and development of table tennis.

SYMBOLS ASSUMPTION

i (i=11,21)	:	indicates tennis' competition system (the latter model has expanded on the value of i).
h (h=2,3,4)	:	indicates competition system, typically (2h-1) innings and h wins.
(i,h) (i=11, 21), (h=2, 3, 4)	:	indicates competition system is the i points system, using (2h-1) innings and h wins.
μ1	:	indicates the technical level of player a.
An (n≥i)	:	indicates the event that "in a i points system after n rounds a inning ends and a wins."
σ1	:	indicates play stability of athlete a.
X1	:	represents spot athletic ability of athlete a.
p	:	stands for of winning percentage player a in a single round match.
g(x)	:	Indicates the used curve fitting function.
fi(p)	:	represents the winning rate in a single game of athlete a in an i ponits competition system.
$g(p,\alpha_i)$	:	Indicates curve fitting function of fi (p).
$\varphi_i(2h-1, h, p)$	:	Indicates the single game winning percentage of athlete a in i points and (2h-1) innings competition system.
$g(p,\beta_h^{(i)})$	:	Indicates a curve fitting of function $\varphi_i(2h-1, h)$.
$OC(i, h)$	:	Indicates the contingency indicators of.
$\Omega_h^{(i)}(p)$	:	Indicates the intense indicators of i points and (2h-1) innings competition system.
$E(i, h, p)$	:	Indicates a commercial interests function.
$\lambda(p)$	:	Indicates weight-variable function.

All other symbols are described in the paper.

MODEL ASSUMPTIONS

(1) Assuming the results of the game are only related to the skills of both sides in the game, does not consider all kinds of interference of the opponent, do not take into account other factors inside and outside the field (including referees, tables and the audience, etc.). (2) Assuming athletes' winning rate in each round game is certain, i.e. it is regardless of the score in every game. (3) Assuming that all of the game can be completed within the specified time, that there is no possible that existing lottery or other non-scoring factors determine the competition results. (4) Assuming in all game system, the factors affecting the same player's competition level in a single round are consistent. (5) Assuming there are no ties. (6) Assuming consider only singles match (does not affect the essence of the problem). (7) For simplicity, assume that both players of the game is a and b. (8) Assume that the main factors affecting the commercial interests are the contingency and intense of competition system. (9) Assuming evaluation index to evaluate four kinds of competition systems are mainly contingency factors and intensity degree and competition system that solutions adopted.

THE ESTABLISHMENT OF EVALUATION INDEX MODEL

Contingency index model

Through the analysis of Figure 1, we learned that the tilt angle of the curve can reflect the contingency indicators of the competition system, since there is a negative correlation between α and OC, we define the following functions:

$$OC(i,h) = \frac{10}{1+\left(\alpha_h^{(i)}\right)^2} - 0.1 \quad (1)$$

By equation (1) we can conclude the contingency indicators of each scenario (see TABLE 1):

TABLE 1 : The contingency indexes of 4 kinds of competition system

Competition System	Contingency index
11 points 5 games 3 wins	0.4492
21 points 3 games 2 wins	0.4145
11 points 7 games 4 wins	0.4138
21 points 5 games 3 wins	0.3787

That contingency index obtained in this model is essentially an approximate probability of one competition system, i.e. in this game system we do not consider the impact of individual differences in athletes on contingency index. Although there are some errors, but the approximation results are good; in the latter commercial interests model contingency indicator in a competition system will be seen as a constant value.

Intense index model

Below we give the function expression of intense indicators:

Intense index function $\Omega_h^{(i)}(p)=1-4(\varphi_i(2h-1,h,p)-0.5)^2$,then:

$$\Omega_h^{(i)}(p)=\begin{cases} 0 & ,\ (0<p<0.3, 0.7<p<1) \\ 1-4\left(\dfrac{2}{1+\exp(-2\alpha_h^{(i)}(p-0.5))}-1\right)^2 & ,\ (0.7<p<1) \end{cases} \qquad \textbf{(2)}$$

Wherein through the squares algorithm we can still take the value of p in the interval (0,1); we can see from the expression that the range of $\Omega_h^{(i)}(p)$ is also in the interval (0,1); we can say that when $\Omega_h^{(i)}(p)$ is 0, the game has no intensity at all, and when $\Omega_h^{(i)}(p)$ is 1, the game has reached a white-hot stage.

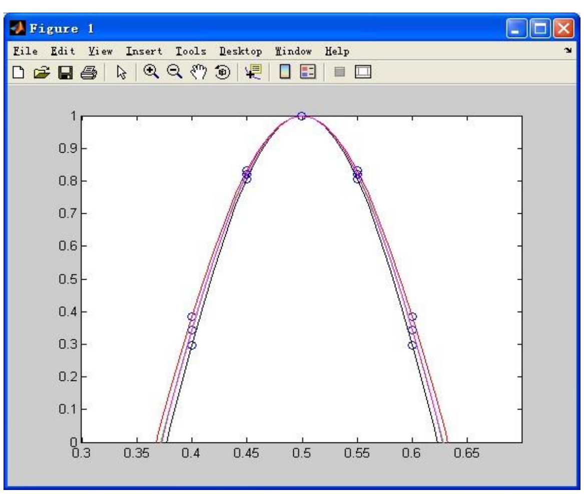

Figure 1 : Intense index curve of four schemes

11 points 5 games 3 wins
21 points 3 games 2 wins
11 points 7 games 4 wins
21 points 5 games 3 wins

We give the intense index curves of four schemes through MATLAB in Figure 1

We can give the corresponding analysis by the function image; the intensity of 11-point competition is above the 21-point competition. For the given four schemes, if we order them by the intense degree, there are 11 points 7 games 4 wins > 11 points 5 games 3 wins > 21 points 5 games 3 wins > 21 points 3 games 2 wins. Because the intense degree of each competition system suffers the influence of p, it is a given value different from contingency factor.

THE EVALUATION MODEL OF COMPETITION SYSTEM SCHEME

Evaluation model based on TOPSIS grey correlation degree

Here we do not consider the weight changes; suppose the weight of intense index is 0.6 and the weight of contingency index is 0.4. In the previous model, we have already mentioned that the intense index is the function of p, but here we use p = 0.4 to approximately represent the average intense of a competition system (temporarily ignore the differences of players); we can draw the following evaluation form (see TABLE 2):

TABLE 2 : Comprehensive evaluation table of four schemes

Scheme	Contingency index	Intense degree
11 points 5 games 3 wins	0.4492	0.3548
21 points 3 games 2 wins	0.4145	0.2991
11 points 7 games 4 wins	0.4138	0.3975
21 points 5 games 3 wins	0.3787	0.3447

Substitute the conferred weight into the table and obtain the weighted decision-making norm matrix Z:

$$Z=\begin{pmatrix} 0.1797 & 0.2129 \\ 0.1658 & 0.1795 \\ 0.1655 & 0.2385 \\ 0.1515 & 0.2068 \end{pmatrix}$$

We select the target sequence c = (0.1515, 0.2385) and respectively seek the grey correlation value of four schemes and parent sequence, for r1 = 0.0174, r2 = 0.0198, r3 = 0.0.0217.r4 = 0.0208.

Through the above analysis, 21 points 5 games 3 wins and 11 points 7 games 4 wins are more reasonable competition systems.

The optimal index evaluation model based on weight-variable function

Before modeling, we first give the following definitions: the given four schemes are denoted by j = 1,2,3,4, so there exists a correspondence relationship of (i, h) '! j, we record it as:

$$(11,3) \to 1;\ (21,2) \to 2;\ (11,4) \to 3;\ (21,3) \to 4; \qquad (3)$$

By the formula (1), (2) we can see that contingency factor is a fixed value for the j-th competition system, not suffers the impact of level differences of athletes. And the intensity degree of the competition is significantly affected by the impact of level differences of athletes (i.e., the impact of p). So we need to define a weight-variable function to distinguish the weight of contingency factors and intense degree when p is not the same. Here we give the evaluation function, weight-variable function and the optimal evaluation value.

Here based on symmetry analysis, we assume that 0 <p <0.5, and in the subsequent analysis of the model we have adopted this symmetry assumptions.

$M^{(j)}(p)$ is defined as the evaluation function of the j–th scheme, $\lambda(p, \alpha)$ is the corresponding weight-variable function, $W(j)$ is the optimal evaluation value f the j–th scheme.

Then:

$$M^{(j)}(p) = (1-\lambda(p,8))\Omega_h^{(i)}(p) + \lambda(p,8)\varphi_i(2h-1, h, p) \qquad (4)$$

$$W(j) = Max\{M^{(j)}(p)\} \qquad (5)$$

$$\lambda(p,\alpha) = \begin{cases} 1 & (0 < p < 0.3) \\ \dfrac{2}{1+e^{2\alpha(p-0.3)}} & (0.3 < p \le 0.5) \end{cases} \qquad (6)$$

Here we make a new definition to the contingency indicator that one weaker contestant (as reflected in the p value in the interval of (0, 0.5)) is the probability of still winning the game. So the resulting contingency indicator in this case is a function of p, rather than by the constant value in the foregoing model. We compare the W (j) of different solutions to conduct comprehensive assessment on the scheme.

OPTIMIZATION MODEL OF COMMERCIAL INTERESTS

Before the establishment of the model, we must first be clear that here we here consider only commercial interests, contingency indicators, intense degree and the competition system. Here we give the definition of variables (according to the above definition of the model we can see here the range of p is in (0, 0.5)), the function and the final expression.

Definition of E (i, h, p) for commercial interest function, x_j for 0-1 variables, S(j) for the commercial optimal value when taking the j-th competition system the nonlinear programming model is given below:

The objective function $S(j) = Max\, E(i, h, p)$

$$x_j = \begin{cases} 1, & taking\ j-th\ competition\ system \\ 0, & not\ taking\ j-th\ competition\ system \end{cases}$$

$$s.t.\ \begin{cases} E(i,h,p) = \lambda(p,10)\tilde{\Theta}C(i,h) + (1-\lambda(p,10))\tilde{\Omega}(p); \\ \tilde{\Omega}(p) = \sum_{j=1}^{4} x_j \Omega_h^{(i)}(p); \\ \tilde{\Theta}C(i,h) = \sum_{j=1}^{4} x_j \left(\dfrac{10}{1+\left(\alpha_h^{(i)}\right)^2} - 0.1 \right); \\ \sum_{j=1}^{4} x_j = 1; \\ x_j = 0 or 1; \end{cases}$$

Wherein $\lambda(p,\alpha) = \begin{cases} 1 & (0 < p < 0.3) \\ \dfrac{2}{1+e^{2\alpha(p-0.3)}} & (0.3 < p \le 0.5) \end{cases}$; Wherein (i, h) and j has the correspondence relation of equation (18).

To make matters even with more details, players' level will be divided into two categories, the first category that the two players' level is consistent, namely 0.4 <p <0.5; second category is one player's level is one-level higher than the other player, i.e. 0.3 <p <0.4 (here considering symmetry); (here we do not consider 0 <p <0.3, the previous model shows that the winning probability of weak player is almost zero, so here we do not consider this extreme question).

Here what we need to note is that the resulting commercial interests function represents a coefficient proportional to the commercial revenue, which may be referred to as business efficiency coefficient. We conduct the analysis on the relationship between the schemes' commercial interests coefficient and p in both cases through MATLAB programs. We first analyze Figure 2 of case one.

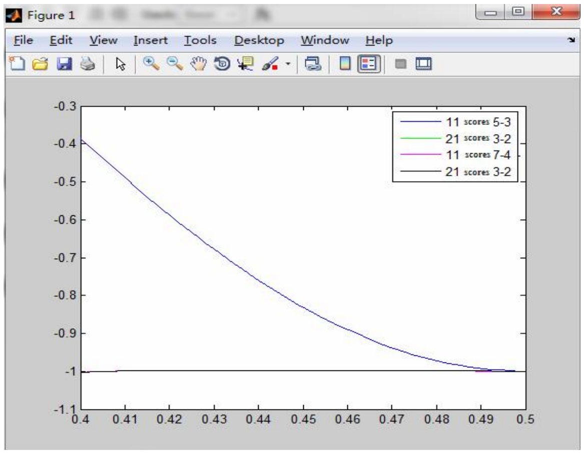

Figure 2 : The corresponding commercial interests figure of case one

According to the actual case, p is not a continuous variable. Here for convenience of calculation, we take him as a continuous variable, which can only takes some uncertain discrete values. We divided the p into several levels through classification, although we cannot determine the specific values of p, but can determine its specific range. In the appropriate range of p, we have to analyze adopt which kind of competition system can have promotion role to improve the business interests coefficient. Here to solve the maximum value of commercial benefit is moot, so we only analyze from the perspective of countermeasures.

Case 1: When 0.4 <p <0.5, the three resulting curves of four scenarios are almost completely overlap, except for the 11 points 5 innings 3 wins competition system. This is due to that the 11 points 5 innings 3 wins system scheme has very big contingency, reflects in the figure is that the smooth of curve is low. For this similar actual strength game, the organizers should try to avoid taking the race way of 11 points 5 innings 3 wins system. For the other three schemes, its contingency factors affect less on both sides of this case, and of the commercial effectiveness factor using the remaining three schemes is very stable. Under the circumstances of uncertain player's specific p-value in this interval, using one of these three programs is beneficial to commercial interests.

Here we analyze case two, i.e. Figure 3.

Case 2: When 0.3 <p <0.4 it represent that the level of both players is different with a grade, the most suitable scheme in the four schemes is 21 points 3 games 2 wins system, the least suitable scheme is 11 points 5 games 3 wins system. From the image, when the level of one player is closer to 0.3, the obtained business benefits value using 21 points 3 innings 2 wins system, 11 points 7 innings 4 wins system and 21 points 5 innings 3 wins system can reach 2.3 or so. From the trend in the figure we can see when using these three kinds of programs, with the increase of p, business efficiency coefficient is gradually reduced. From one image of the case one, the decline rate of the interests' value is getting slower and eventually approaches a steady-state value.

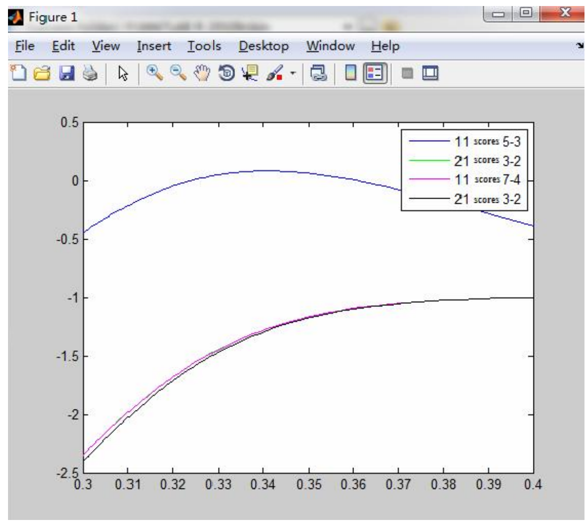

Figure 3 : The corresponding commercial interests figure of case two

From the above analysis in both cases we can see that the competition system of 11 points 5 games 3 wins 11 of 5 is not suitable for use in either case. For one kind of competition system, if its contingency index is larger, it is more unfavorable to the development of commercial interests.

CONCLUSIONS

This paper gives four kinds of competition system schemes, for either of these schemes, there is no absolute good or bad, only a relatively suitable and not suitable. Through research we can find that, in general, the contingency of 11-point system game is much larger than 21-point system game. The contingency of 11 points 5 innings 3 wins competition system is higher almost 20% than 21 points 5 innings 3 wins competition system. The increase of contingency improved the ornamental value of the ping-pong game, so that events can have richer suspense, but excessive contingency makes the game loss the competitive significance. This paper argues that the contingency using the 11 points 5 innings 3 wins is too big, in important international competitions we should avoid using this scheme; The contingency using uses 11 points 7 innings 4 wins and 21 points 5 innings 3 wins is roughly match, and they are more reasonable competition systems.

In the current case that table tennis players and spectators generally consider that the contingencies of 11-point system is too large and affects the fairness of the game, you can consider using the competition system between 11-point and 21-point, such as the 17-point, 13-point; in order to well promote the table tennis, we should increase the ornamental value of the competition, while maintain the goals of fair competition.

REFERENCES

[1] Bing Zhang; Dynamics mathematical model and prediction of long jump athletes in olympics. International Journal of Applied Mathematics and Statistics, **44(14)**, 422-430 **(2013)**.

[2] Cai Cui; Application of mathematical model for simulation of 100-meter race. International Journal of Applied Mathematics and Statistics, **42(12)**, 309-316 **(2013)**.

[3] Haibin Wang, Shuye Yang; An analysis of hurdle performance prediction based on mechanical analysis and gray prediction model. International Journal of Applied Mathematics and Statistics, **39(9)**, 243-250 **(2013)**.

[4] Hongbing Zhu, Jiantong Liu; Gray forecast of GM (1, 1) model and its application in forecast of sports performance. Journal of Beijing Teachers College of Physical Education, **15(1)**, 118-121 **(2003)**.

[5] Hongwei Yang; Evaluation model of physical fitness of young tennis athletes based on AHP-TOPSIS comprehensive evaluation. International Journal of Applied Mathematics and Statistics, **39(9)**, 188-195 **(2013)**.

[6] Jianguo Yuan; Research for fitness and technique of teenager basketball players in qinghai. China Sport Science and Technology, **4**, 50-55 **(1995)**.

[7] Yi Liu; The establishment of hierarchical model for basketball defensive quality. International Journal of Applied Mathematics and Statistics, **44(14)**, 245-252 **(2013)**.

[8] Yong Fan; Statistical analysis based on gray system theory basketball team scores its technical indicators associated. International Journal of Applied Mathematics and Statistics, **44(14)**, 185-192 **(2013)**.

[9] Zuojun Tan; Fuzzy data envelopment analysis and neural network evaluation mathematical applications model which based on martial arts competition. International Journal of Applied Mathematics and Statistics, **44(14)**, 37-44 **(2013)**.