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Research Article

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Game theory and SPSS variance analysis-based table tennis serve direction affects score research

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ABSTRACT

By researching on table tennis competition, it is found that paddlers inevitable would apply game theory thoughts in competition process. Utilizing mathematical model method in researching some data in competition, it gets paddlers left serve or right serve influences on score probability, then carries out normal distribution examination on the data, it gets that its P value is conform to variance analysis request, after that make single-factor variance analysis. By researching, it is clear that when making left serve, it can improve score probability, and their left and right serve times have no significant influence.

Key words: Table tennis, game theory, variance analysis, service ace

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INTRODUCTION

Game theory is a kind of interdependent, interactional decisive theory rational decision behavior. It is a kind of mathematical theory or research objects fighting competitive property, which covers an important branch in linear programming; game theory typical problem is researching its own party get most benefit results, including on some hostilities or competition conditions two or more participants make their own decisions. We define game as some interactional, interdependent decision behavior as well as their results combination [1, 2]. Game theory has been rapidly developed in recent years; it has already widely used in economics, law, literature, politics and other social science fields. According to differences results in games, divide it into zero and game, as well as game regular changes and game. It is mainly researching zero-sum game this time [3, 4].

Generally speaking, game is a mixed strategy that composed of following some parts balanced and comprehensive researches participants' game beneficial targets, whose main concern is that every aspect has normally functions of all participants' actions or strategies from game when valid participants finish the game. In that case, the policy expresses all needy people as select their strategy participants all participants selection decide every participant beneficial status policy. Game theory has been grown up since the end of 1950s, "The importance is to research early humans so that they get conclusions that a simple game learning model predicts single animal model reinforced learning." The result is not consistent to practical result, the design can solve some problems; However under the circumstance of game theory opposition optimal decision-making behavior theory, for the problem it can learn from the case that subject opponents are given and these solution schemes would all consistent with theoretical expectations [5, 6]. The attendant thinks that with regard to opponent who cannot deal with, the best strategy is meeting mixed strategy balance, because these subjects unknown information programs opponent behaviors would cause them to be experimental results that hard to explain. What need to mention is that participants can choose is "strategy", while game is "action" or not is called finite game, it meets conditions –first, participants numbers are finite; second, every participant selectable strategy number is also finite [7-10].

This research not only makes analysis of some applications of game theory, but also combines with variance analysis, firstly utilize normal distribution examination implementing value test on required data, and make its data

more authentic and reliable. Then use single-factor variance analysis to research on it gets paddlers left serve or right serve has large influence on its own score ratio, at the same time of variable controlling makes results more scientific.

GAME THEORY MODEL ESTABLISHMENT IN TABLE TENNIS COMPETITION

Game theory principle

In game matrix, inside I gain and loss is just on the contrary of insider II, we can use another matrix to express game result. However, it is different in non-zero-sum game. If player I chooses strategy $a_i \in S_1$, corresponding player I's gain is a_{ij}, while player II chooses strategy $\beta_j \in S_2$, player II's gain is not $-a_{ij}$ but b_{ij}, game situation is $(a_i, \beta_j) \in S$ that game result is (a_{ij}, b_{ij}). We usually call the game as $G = \{S_1, S_2, A, B\}$, from which $A = (a_{ij})$, is player I gain matrix, $B = (b_{ij})$ is player II gain matrix, therefore call it as two people finite non-zero-sum double matrix game model [6].

Practical decision problems whole process can be divided into some steps as following;

● Define problems $\rightarrow$ According to decision makers proposed problems, find out the crux of the matter and define problems essence.

● Set goals $\rightarrow$ if goals are not clear, then it might tend to cause wrong decision-making. Goal is achieved result that decision maker requires. In case of multiple goals, you should make priority consideration, sufficiently considering and also need to focus on advanced reliable goals, ensure that problems are solved.

● Planning $\rightarrow$-After goals set it should start collect relative information, make analysis of decision states, establish corresponding model and put forward every feasible plan that achieve decision goals.

● Plan evaluation $\rightarrow$Make evaluation on every possible plan effects, compare plans merits as well as gain and loss through scientific calculation with quantitative analysis method as much as possible.

● Select plan $\rightarrow$In order to select and make goals achieve optimization, decision maker should start from overall perspective, making comprehensive systematical analysis of every possible plan purpose, feasibility and timeliness.

● Feedback adjustment $\rightarrow$In decision implementation process, it may appear some undead statuses, therefore, decision maker in practice should timely collect feedback information in running, analyze whether there is a situation that made decision plan interferes with expected decision goals implementation.

Table 1: Partial paddlers' data

Competition	Server	Serve times		Score times		Score ratio	
		Left	Right	Left	Right	Left	Right
02 World Cup	Pohl	32	28	17	14	0.53125	0.5
	Primorac	8	54	4	27	0.5	0.5
02 World Cup	Pohl	25	27	15	11	0.6	0.407407
	Kong Ling-Hui	32	22	13	11	0.40625	0.5
03 World Table Tennis Championship	Schrage	59	10	35	8	0.59322	0.8
	Kong Ling-Hui	62	11	40	6	0.645161	0.545455
03 World Table Tennis Championship	Wang Li-Qin	32	22	20	12	0.625	0.545455
	Saive	50	4	25	1	0.5	0.25
04 Olympic Games	Wang Hao	34	7	24	4	0.705882	0.571429
	Wang Li-Qin	8	37	4	19	0.5	0.513514
04 Olympic Games	Liu Cheng-Min	34	23	18	13	0.529412	0.565217
	Wang Hao	37	23	14	13	0.378378	0.565217
04 World Cup	Ma Lin	47	14	25	7	0.531915	0.5
	Gelinka	45	18	27	9	0.6	0.5
04 World Cup	Jiang Peng-Long	17	40	10	25	0.588235	0.625
	Wang Li-Qin	23	33	14	20	0.608696	0.606061
05 World Table Tennis Championship	Maze	8	35	3	20	0.375	0.571429
	Wang Hao	15	29	7	12	0.466667	0.413793
05 World Table Tennis Championship	Wang Li-Qin	21	26	17	18	0.809524	0.692308
	Wu Shang-Yin	15	28	8	16	0.533333	0.571429
05 World Table Tennis Championship	Ma Lin	21	16	13	8	0.619048	0.5
	Maze	31	7	11	4	0.354839	0.571429
05 World Table Tennis Championship	Wang Li-Qin	27	27	14	11	0.518519	0.407407
	Ma Lin	45	12	22	5	0.488889	0.416667

In table tennis competition, every one point confrontation can be regarded as a double zero-sum game model, two

parties' every point gain and failure only has two possible results that in the meanwhile of getting score, the opponent would fail; A and B's gain and failure are just on the contrary; then we can establish single competition model which provides basis for establishing model. From the competition, it is clear for us about its drop point on receiver's left half court or court center line right half area status, then record left and right respective score ratios statuses. This paper extracts World Cup, World Table Tennis Championship and Olympic Games in 2002-2005 weighted paddlers' serve and score data can refer to Table 1. Figure 1 is paddlers two parties stand positions when receive the serve in practical competition.

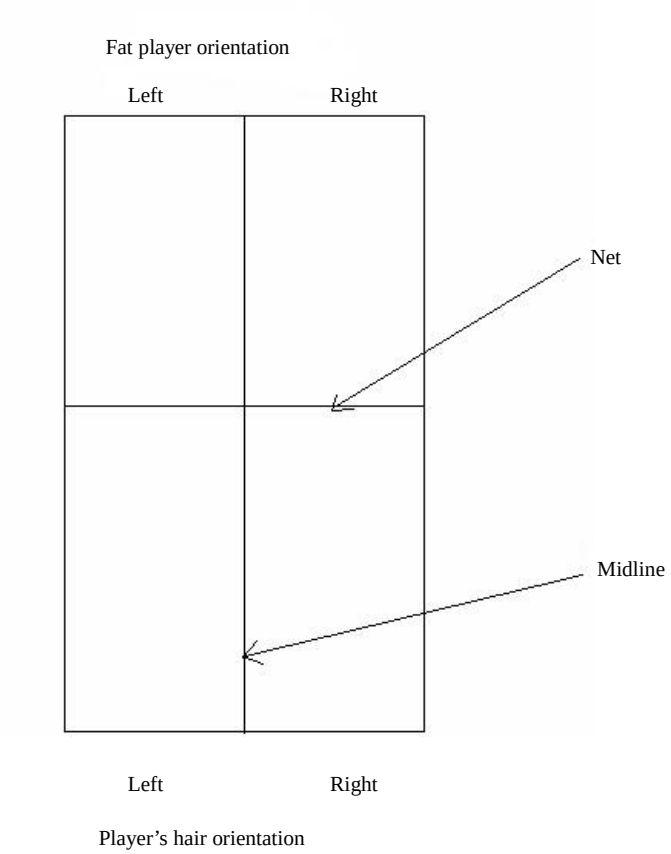

Figure 1: Paddlers standing positions in competition

Assume that random variable original accumulation distribution function is $F(x)$, when its real value is x, and its corresponding P value is $P(x)=1-F(x)$, for any meets $0 \le b \le 1$ condition value is b, and then it has:

$$
\begin{aligned}
&P_n[P(x) \le b] = P_n[1-F(x) \le b] \\
&= P_n[F(x) \ge 1-b] \\
&= P_n[X \ge F^{-1}(1-b)] \\
&= 1-F[F^{-1}(1-b)] \\
&= 1-(1-b) \\
&= b
\end{aligned}
$$

From above formula, it is clear that when original hypothesis is true, statistics D_n value should be very small; when original hypothesis is false, statistics D_n value may take big value and big samples, and use statistics $\sqrt{n}D_n$ to test. In order to test whether P value conforms to $[0,1]$ uniform distribution, accumulation distribution function in experiment distribution uniform distribution is $F(x)=x$ .For Table 1 24 data's data distribution, it uses $F_n(x)$ to express as following formula (1):

$$F_n(x)=\frac{1}{24}\sum_{i=1}^{24} I[0,x]\left(P^i\right) \quad \text{(From which } P^i \text{ is game } i \text{ value } P\text{)} \tag{1}$$

If $P^i \le x$, then get $I_{[0,x]}\left(P^i\right)=1$, or else it would get $I_{[0,x]}\left(P^i\right)=0$; on the condition of original hypothesis, test statistics $D_n=\sqrt{40}\sup_{x\in[0,1]}\left|F_n(x)-x\right|$. From Table 1 data, it can get $D_n=0.82$, its corresponding P value is 0.38, on such condition, we cannot refuse combined hypothesis, then we can think that paddlers in every serve competition would inevitable adopt mixed strategy balanced strategy combination method.

TABLE TENNIS COMPETITION SCORE FACTOR VARIANCE ANALYSIS

Single-factor variance analysis, it is also called one dimensional approach analysis method that used for analyzing dependent variable average value whether has significant difference or not when single control factor values adopt different levels; single-factor variance analysis principle is based on each observation whether comes from several normal samples that independent from each other, and under same conditions hypothesis, its control variable grouping methods in different levels .Single-factor variance analysis classifies all variances into systematical deviation part and random deviation parts which cannot be explained by the factor, if systematical deviation parts are obviously above random deviation parts, then it is thought that when control factor takes different levels, dependent variable average value actually exists significant differences.

Single-factor variance analysis principle application

At first, only consider one factor requiring different levels influences an indicator to pay attention to, every level carries out a series of tests; In changing an experiment while other factors influence coefficient remains unchanged, our targets is making deduction from testing results, a factor is required indicator that has significant influence, the indicator when testing whether exists different extents significant difference or not. A takeover coefficient is called random variable certain levels, A adopts different grades to judge whether has significant difference or not that equal to average defining some universal equity indicator. Set a level, in normal population level is unknown, here, it can be different, but possess same variance. Set A takes r levels $A_1, A_2 \ldots, A_r$, under level A_i, overall x_i conforms to normal distribution $N\left(\mu_i,\sigma^2\right)$, $i=1,\ldots r$, Here μ,σ^2 are unknown, μ_i can be different from each other, but assume that x_i has same variances. Also assume that under every level A_i, it makes n_i times independent testing, we extract samples with capacity n_i as x_{ij}, $j=1,\ldots n_i$ x_{ij}; It is in $N\left(\mu_i,\sigma^2\right)$, $i=1,\ldots r, j=1,\ldots . n_i$ (and nonintervention from each other).These data would be made into Table 2 as following.

Table 2: Single-factor test data table

A_2	x_{11}	x_{12}	•••	x_{1n_1}
A_2	x_{21}	x_{22}	•••	x_{2n_2}
•••	•••	•••	•••	•••
A_r	x_{r1}	x_{r2}	•••	x_{rn_r}

Call the i row as the i group data. Judge A r pieces of levels have significant influences on indicators or not that equal to make following hypothesis testing, H_0: $\mu_1=\mu_2=\ldots .=\mu_r$ not totally the same.

Due to x_{ij} values not only affected by different levels A_i influence, and related to random factors influences when A_i is fixed, so we dissolve it as $x_{ij}=\mu_i+\varepsilon_{ij}$, $i=1,\ldots .r, j=1,\ldots n_i$, from which $\varepsilon_{ij}\to N\left(0,\sigma^2\right)$, and independent from each other. Record formula (2):

$$\mu=\frac{1}{n}\sum_{i=1}^{r} n_i\mu_i, n=\sum_{i=1}^{r} n_i, a_i=\mu_i-\mu, i=1,\ldots .,r \tag{2}$$

μ Is total average value, a_i is level A_i effect on indicator, then model can be expressed as formula(3):

$$\begin{cases} x_{ij} = \mu + a_i + \varepsilon_{ij} \\ \sum_{i=1}^{r} a_i = 0 \\ \varepsilon_{ij} \to N(0, \sigma^2), i = 1,...r,\ j = 1,....n_i \end{cases} \tag{3}$$

Original hypothesis is H_0: $a_1 = a_2 = ... = a_r = 0$, variance analysis adopted significance level general rule is taking $a = 0.01$, refuse H_0, it is called factor A influence is very remarkable; but take $a = 0.05$, refuse H_0, it is called that factor A influence is remarkable; Take $a = 0.05$, do not refuse H_0, it is called that factor A has no significant influence. Apply SPSS into Table 1left and right two sides score ratios, it gets Figure 2, Figure 3 as following:

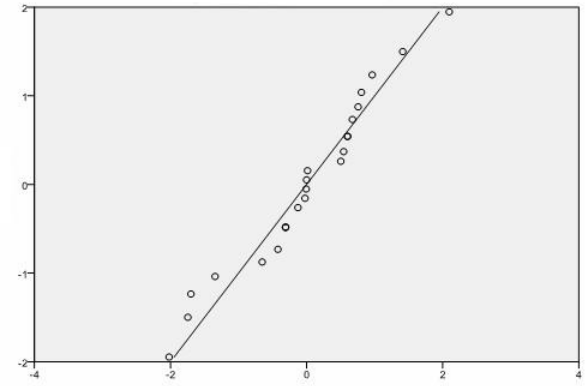

Figure 2: Left side score ratio normal Q-Q figure

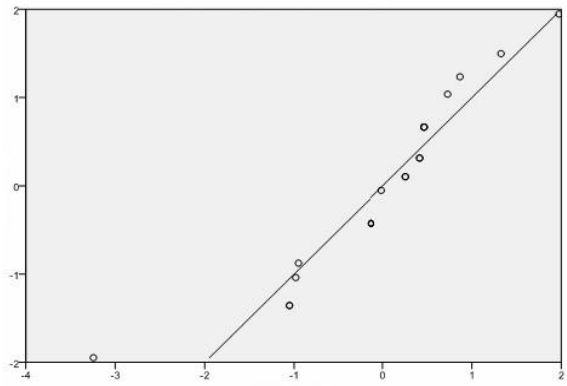

Figure 3: Right side score ratio normal Q-Q figure

From Figure 2、Figure 3, it is clear that two group data normality is good, can make variance test on them, but left side score ratio normality is better than that in right side, therefore only implement variance test on left serve times and their score ratios. Apply SPSS into analyzing Table 1 left and right two sides score ratios; get following results, Table 3:

Table 3: Left score ratio

ANOVA					
	Squares sum	df	mean square	F	Significance
Intergroup	.137	12	.011	1.012	.496
Intra-group	.124	11	.011		
Total	.261	23			

$P = 0.496 > a = 0.05$, so accept H_0 that means left side serve times and their score ratios have significant influences. Right side serve times and their score ratios have no significant influences. Apply Excel into analyzing Table 1 left and right two sides serve times data, get Table 4.

Table 4: Paddler left serve times and right serve times relationships

Variance analysis						
Difference source	SS	df	MS	F	P-value	F crit
Intergroup	638.0208	1	638.0208	3.376435	0.072599	4.051749
Intra-group	8692.292	46	188.9629			
Total	9330.313	47				

From Table 4, it can get $P = 0.072599 > a = 0.05$, so accept H_0 that means right side serve times and their score ratios have no significant differences. Apply Excel into analyzing Table 1right side serve times and their score ratios data, get Table 5.

Table 5: Paddler right serve times and their score ratios relationships

Variance analysis						
Difference source	SS	df	MS	F	P-value	F crit
Intergroup	6083.12	1	6083.12	85.28027	4.81E-12	4.051749
Intra-group	3281.222	46	71.33092			
Total	9364.343	47				

From Table 5, it can get $P = 4.81\text{E-}12 < a = 0.05$, right serve times and their score ratios have significant influences. Apply Excel in analyzing Table 1 left serve times and their score ratios data, get Table 6.

Table 6: Left serve times and their score ratios relationships

Variance analysis						
Difference source	SS	df	MS	F	P-value	F crit
Intergroup	10650.25	1	10650.25	90.52995	1.93E-12	4.051749
Intra-group	5411.594	46	117.6433			
Total	16061.84	47				

From Table 6, it can get $P = 1.93\text{E-}12 < a = 0.05$, left serve times and their score ratios have significant influences. Therefore peddler left serve improved his scores.

CONCLUSION

Table tennis competition strategy was different from normal game theory researching, through researching on paddler left and right two sides serve times in competition process, it got those paddlers all inevitable applied game theory. Then on the basis of original game theory, first made normality test on data, on the premise P value conforms to requests, then carried out variance analysis, achieved that paddler left serve times and their score ratios had no significant influence. And paddler inevitable applied game theory thoughts in competition process, then by researching on some data in paddler competition, studied score probability influences when paddler made left serve or right serve, and paddler had no significant influences on left and right two side serve times, finally through comparison feature values conditions, it got that score probability could be improved when made left serve.

REFERENCES

[1] Liu Win-ming; Tang Jian-jun. *Journal of Beijing Sport University*, **2012**, 35(8), 134-138.
[2] Cao Li. *Journal of Pingyuan University*, **2007**, 24(3), 1-4.
[3] Ju Jiang. *Liaoning Sport Science and Technology*, **2011**, 33(3), 85-87.
[4] Dong Yang; Zhu FengJun;Gu JianPing. *Journal of Chengdu Physical Education Institute*, **2005**, 31(4), 73-75.
[5]SHI Jian-Xin; HAN Wen-xiu. *Transactions of Tianjin University*, **2001**, 7(1).
[6] Xiaomin Zhang. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(12), 8-14.
[7]Wang Bo; Zhao Yulin. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(12), 21-26.
[8]Mingming Guo. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(12), 64-69.
[9] Bing Zhang; Zhang S.; Lu G.. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(9), 256-262.
[10] Bing Zhang. *Journal of Chemical and Pharmaceutical Research*, **2014**, 5(2), 649-659.