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Original Article

MODELING THE INFLUENCE OF BASKETBALL GAME PARAMETERS ON THE FINAL RESULT IN TOKYO 2020

MODELANDO A INFLUÊNCIA DOS PARÂMETROS DO JOGO DE BASQUETEBOL NO RESULTADO FINAL EM TÓQUIO 2020

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RESUMO

Este estudo tem como objetivo verificar a significância dos parâmetros do jogo de basquetebol que discriminam entre equipes vencedoras e perdedoras em partidas disputadas. A amostra do estudo compreende partidas disputadas no torneio de basquete masculino dos XXXII Jogos Olímpicos de Tóquio. Quatro modelos de regressão foram formados. Devido ao tamanho da amostra, o número de variáveis explicativas foi reduzido por meio de análise fatorial, seguida de regressão *stepwise* para verificar sumariamente a significância estatística dos modelos obtidos, que foram então decompostos em parâmetros individuais. Este estudo indica: (1) um dos quatro modelos de regressão definidos foi sumariamente altamente estatisticamente significativo; (2) dos demais modelos, dois foram eliminados devido à presença de multicolinearidade e um modelo não apresentou alta significância estatística; (3) a pontuação final foi mais influenciada pelas variáveis porcentagem de arremessos de dois e três pontos, número de arremessos de três pontos, *turnovers*, rebotes defensivos e porcentagem de arremessos verdadeiros. Os resultados do estudo corroboraram os resultados de outros estudos que foram realizados nos últimos anos, que o jogo de basquete está tendendo a arremessos de três pontos e bandejas, redução de *turnovers* ao passar e rebotes defensivos foram confirmados muito significativo.
Palavras-chave: Torneio Olímpico de Baquetebol, parâmetros de jogo do basquetebol, vitórias no basquetebol, modelo regressão.

ABSTRACT

This study aims to ascertain the significance of the basketball game parameters which discriminated between winning and losing teams in matches played. The study sample comprises matches played at the men's basketball tournament at the XXXII Olympic Games in Tokyo. Four regression models were formed. Due to the size of the sample, the number of explaining variables was reduced using factor analysis, followed by stepwise regression to ascertain the statistical significance of the obtained models summarily, which were then broken down into individual parameters. This study indicates: (1) one of the four set regression models was summarily highly statistically significant; (2) out of the remaining models, two were eliminated due to the presence of multicollinearity, and one model did not exhibit high statistical significance; (3) the final score was most influenced by the variables of two- and three-point shot percentages, number of three-point shots, turnovers, defensive rebounds, and true shooting percentage. The results of the study corroborated the results of other studies which were carried out in recent years, that the game of basketball is trending towards three-point shots and lay-ups, reduction of turnovers when passing, and defensive rebounds have been confirmed to be greatly significant.
Keywords: Olympic Tournament, game parameters, winning in game, regression model.

Introduction

The performance or productivity of athletes in matches was the subject of numerous academic studies, and performance indicators in basketball are usually explored using biomechanical and notational analysis[1]. Notational analysis is a tool for objectively gathering statistical data on player skills[2]. In fact, it is the transformation of events in the field into numbers, which the coach can interpret and use for targeted training to mitigate deficiencies of both individual players and the team as a whole[3].

Henry Chadwicks, the famous sports journalist, was the first to see the need to analyse player performance as early as 1858, so he devised his "box score" for gathering data from baseball matches. In early 20th century the first academic paper was published on performance analysis, by Hugh Stuart Fullerton III, on baseball in 1910. The game of baseball can be modelled as a separate set of individual plays, whereas basketball is a continuous set of interactions which are harder to convert into numbers[4]. But still, basketball is a sport with a long history of notational analysis. The first papers on this topic in basketball were published by Lloyd Lovell Messersmith. Further development of gathering "statistics" and the development of notational analysis in basketball followed the development of basketball on one hand, and the academic development of notational analysis on the other. It can be said that basketball has historically been very dependent on statistics – in order to provide an analytical tool for both the coaches and the media. For a long time now, the natural development of sports in general, and hence basketball as well, has included records kept for matches, which helped with statistical analysis[5].

Men's basketball was included as an Olympic sport at the 1936 Games in Berlin, and women's basketball at the 1976 Games in Montreal. At the 1936 Olympics only the score was recorded. But in the following Olympic Games in 1948, the basic variables related to the match were also recorded: Free throws, personal fouls and field goals per individual player. Unlike in the NBA, field goals were not being recorded until 1964. In the 1970s and 1980s, basketball grew greatly in popularity across the world, which led to the recording of rebounds, assists, turnovers and steals, following the NBA model. When the three-point line was introduced at the 1984 Olympic tournament, the three-point shot began to be recorded separately[6].

Notational analysis in basketball based on statistical data and game indicators is very popular among coaches, while serious scientific studies on the usefulness of these variables in understanding skill in matches is fairly recent. Bryson Johnson points out that "basketball in particular has seen a drastic rise in the use of analytics"[7;2], because after each match there is a statistical report available which "provides for each player and each team, quantitative information on 15 variables"[8;51]. Or, in other words: "one of the main differences between basketball teams and other sports comes from the availability of information"[9;2]. Technological advancements and the need for a better and deeper understanding of the players' technical and tactical performance make this topic increasingly interesting for academic circles. There are various ways in which researchers analyze structure. Martinez ascertained that there are over 200 systems for objective assessment of performance in basketball and that finding the best way to valuate basketball players is looking more and more like the quest for the "Holy Grail"[10].

The first to use the stepwise regression statistical method in assessing value in a basketball match was Kathleen Shanahan[11]. Eric Scot Jones used the stepwise selection technique in his Master's theses to "determine which of the variables are significant and to develop both the point spread and the logistic models"[12]. In his Doctoral dissertation, which he defended at the United States Sports Academy in 2020, Hugh Morrissey pointed out that one of the methods used in previous studies on basketball parameters that affect game outcome in basketball is stepwise regression analysis, citing two papers by the first two authors of this study[13].

This manuscript aims to use stepwise regression, following the selection of independent variables, to ascertain which basketball game parameters discriminated winners and losers in matches played at the latest men's Olympic basketball tournament in Tokyo.

Methods

Sample

The study sample in this paper comprises matches (n=26) played at the men's basketball tournament at the XXXII Olympic Games in Tokyo. The tournament was played between 24 July and 08 August 2021 at the Saitama Super Arena in Saitama. The participants of the men's Olympic basketball tournament were 12 national teams: Argentina, Australia, Czech Republic, France, Germany, Iran, Italy, Japan, Nigeria, Slovenia, Spain and the United States. The preliminary round of this competition followed the single round robin system, where the national teams were divided into three groups of four teams each. The best two teams from each group advanced to the second, knockout stage, along with the two best-ranked third-placed teams. The knockout stage took place in three rounds (the quarterfinals, semi-finals and finals)

Procedures

The team that scores more points in a basketball match, under the rules of the game of basketball, is the team that wins the match. This regulation was used for the purposes of this study in such a way that the difference in points scored (ΔPTS) was taken as a dependable variable in the formed regression models. The difference in points is a consequence, or better said, is a function of all the observed game parameters.

A problem that arises in modelling is the optimal selection of the included independent variables. It should be noted that including a large number of parameters into the model does not mean that the error margin will be reduced to zero. More often than not the opposite occurs: introducing a large number of predictive factors increases the error factor. Hence, we can speak of multiple models, All the more so because of the fact that some of the variables which were used have been derived from others, indicating that such models cannot be assessed.

Because of all the above, for the purposes of this study, several models were formed. The models have the following mathematical form:

$$Y_i = \beta_0 + \sum_{i=1}^{j} \beta_j X_{ji} + \varepsilon_j$$

j = 1,2, ... (9, 13, 16).

In model 1, $X_1 = \Delta A2$ (difference two points attempted), $X_2 = \Delta M2$ (difference two points made), $X_3 = \Delta A3$ (difference three points attempted), $X_4 = \Delta M3$ (difference three points made), $X_5 = \Delta FTA$ (difference free throws attempted), $X_6 = \Delta FTM$ (difference free throws made), $X_7 = \Delta OR$ (difference offensive rebounds), $X_8 = \Delta DR$ (difference defensive rebounds), $X_9 = \Delta AS$ (difference assists), $X_{10} = \Delta PF$ (difference personal fouls), $X_{11} = \Delta TO$ (difference turnovers), $X_{12} = \Delta ST$ (difference steals), and $X_{13} = \Delta BS$ (difference blocked shots).

Model 2, aside from the variables already included in the basic model ($X_1 = \Delta A2$, $X_2 = \Delta M2$, $X_3 = \Delta A3$, $X_4 = \Delta M3$, $X_7 = \Delta FTA$, $X_8 = \Delta FTM$, $X_9 = \Delta OR$, $X_{10} = \Delta DR$, $X_{12} = \Delta AS$, $X_{13} = \Delta PF$, $X_{14} = \Delta TO$, $X_{15} = \Delta ST$ and $X_{16} = \Delta BS$) also includes: $X_5 = \Delta FGA$ (difference field goals attempted), which is obtained by the sum $\Delta A2 + \Delta A3$, $X_6 = \Delta FGM$ (difference field goals made), which is obtained by the sum $\Delta M2 + \Delta M3$ and $X_{11} = \Delta TR$ (difference total rebounds), which is obtained by the sum $\Delta OR + \Delta DR$. These variables are provided in the official statistical report published by FIBA after each match.

Experts' experience, prior studies by other authors and these authors, and ultimately the results of this study as well, indicate the significance of shot for the outcome of a match in basketball. In accordance with that, Model 3 was formed out of parameters which track a team's shot performance during a match: $X_1 = \Delta 2inPTS\%$ (difference in percentage of two points made in relation to the total points made $\left[\frac{(M2\times 2)}{PST}\right] \times 100$), $X_2 = \Delta 3inPTS\%$ (difference in percentage of three points made in relation to the total points made $\left[\frac{(M3\times 3)}{PST}\right] \times 100$), $X_3 = \Delta FTinPTS\%$ (difference in percentage of free throws made in relation to the total points made $\left(\frac{FTM}{PST}\right) \times 100$), $X_4 = \Delta 2\%$ (difference in percentage of two points made $\left(\frac{M2}{A2}\right) \times 100$), $X_5 = \Delta 3\%$ (difference in percentage of three points made $\left(\frac{M3}{A3}\right) \times 100$), $X_6 = \Delta FG\%$ (difference in percentage of field goals made $\left(\frac{FGM}{FGA}\right) \times 100$), $X_7 = \Delta FT\%$ (difference in percentage of free throws made $\left(\frac{FTM}{FTA}\right) \times 100$), $X_8 = \Delta 2PTS_{eff}$ (difference in two-point shot efficiency coefficient $2 \times M2 \times 2\%$), $X_9 =$

$\Delta 3PTS_{eff}$ (difference in three-point shot efficiency coefficient $3 \times M3 \times 3\%$), $X_{10} = \Delta FTPTS_{eff}$ (difference in free throw efficiency coefficient $FT \times FT\%$), $X_{11} = \Delta eFG\%$ (difference in field goal effective percentage $\frac{(M2+1.5\times M3)}{A2+A3}$), $X_{12} = \Delta TS\%$ (difference in true shooting percentage $\frac{PTS}{2\times(FGA+0.44\times FTA)}$) and $X_{13} = \Delta FTr$ (difference in free throw rate $\frac{FTM}{A2+A3}$.

The last, fourth model was built on relative game parameters from the basic model (basic parameters which were so far used to derive relative parameters). In addition to the already mentioned shot percentages ($\Delta 2\%$, $\Delta 3\%$, $\Delta FG\%$ and $\Delta FT\%$), there are also: $X_5 = \Delta OR\%$ (difference in offensive rebound percentage $\left[\frac{OR}{(OR+DR_{opp})}\right] \times 100$), $X_6 = \Delta DR\%$ (difference in defensive rebound percentage $\left[\frac{DR}{(DR+OR_{opp})}\right] \times 100$), $X_7 = \Delta AS\%$ (difference in assists percentage $\left(\frac{AS}{FGM}\right) \times 100$), $X_8 = \Delta TO\%$ (difference in turnover percentage $\left[\frac{TO}{(FGA+0.44\times FTA+TO)}\right] \times 100$) and $X_9 = \Delta BS\%$ (difference in blocked shot percentage $\left(\frac{BS}{FGA_{opp}}\right) \times 100$).

Statistical analysis

Having in mind the relatively small sample (*n* = 26), and a relatively large number of observed independent variables, a dimensionality reduction was carried out, using factor analysis. The principal component method and varimax rotation were used to obtain factor scores, which were further regressed to the set of the original variables. Based on the obtained results of regression analysis, five of the original independent variables were kept in each of the four observed models.

The information on the interconnections and interrelations of the observed variables was obtained based on the correlation coefficient, adjusted multiple coefficients of determination and partial correlation coefficients.

The stepwise regression method was used to evaluate the regression models, and this paper present only the most important results of the obtained regression models. The presence of outliers was analyzed and adjustments were made as needed. The variable inclusion criterion for the stepwise regression was the level $F = 0.05$, and the exclusion criterion was $F = 0.10$. The presence of multicollinearity, heteroscedasticity and autocorrelation were then tested.

Further analysis determined the statistical significance of the obtained models overall and broken down into individual parameters. After that, based on the values of the obtained coefficients in the models and based on the results of establishing the relationship between the regressors in such obtained models and the dependent variable, and also based on the appropriate coefficients of partial correlation, statistical significance was determined regarding the level of importance of the included independent variables.

It is especially important to note that all the steps in the quantitative analysis were accompanied by continuous qualitative analysis, while respecting the theoretic framework and empirical experiences in the field of basketball.

Results

The sample comprised 26 matches. As it was the case with prior studies on this topic, the limitation of observing a competition is the fact that the sample includes all the observed cases. For this study, the analysis of the presence of outliers (atypical values) showed that the match USA vs Iran (ΔPTS is 54) is an atypical value, so it was eliminated from further analyses, reducing the sample to 25 matches (*n* = 25).

The most important results of the factor analysis for all the models have been provided in

Figure 1.

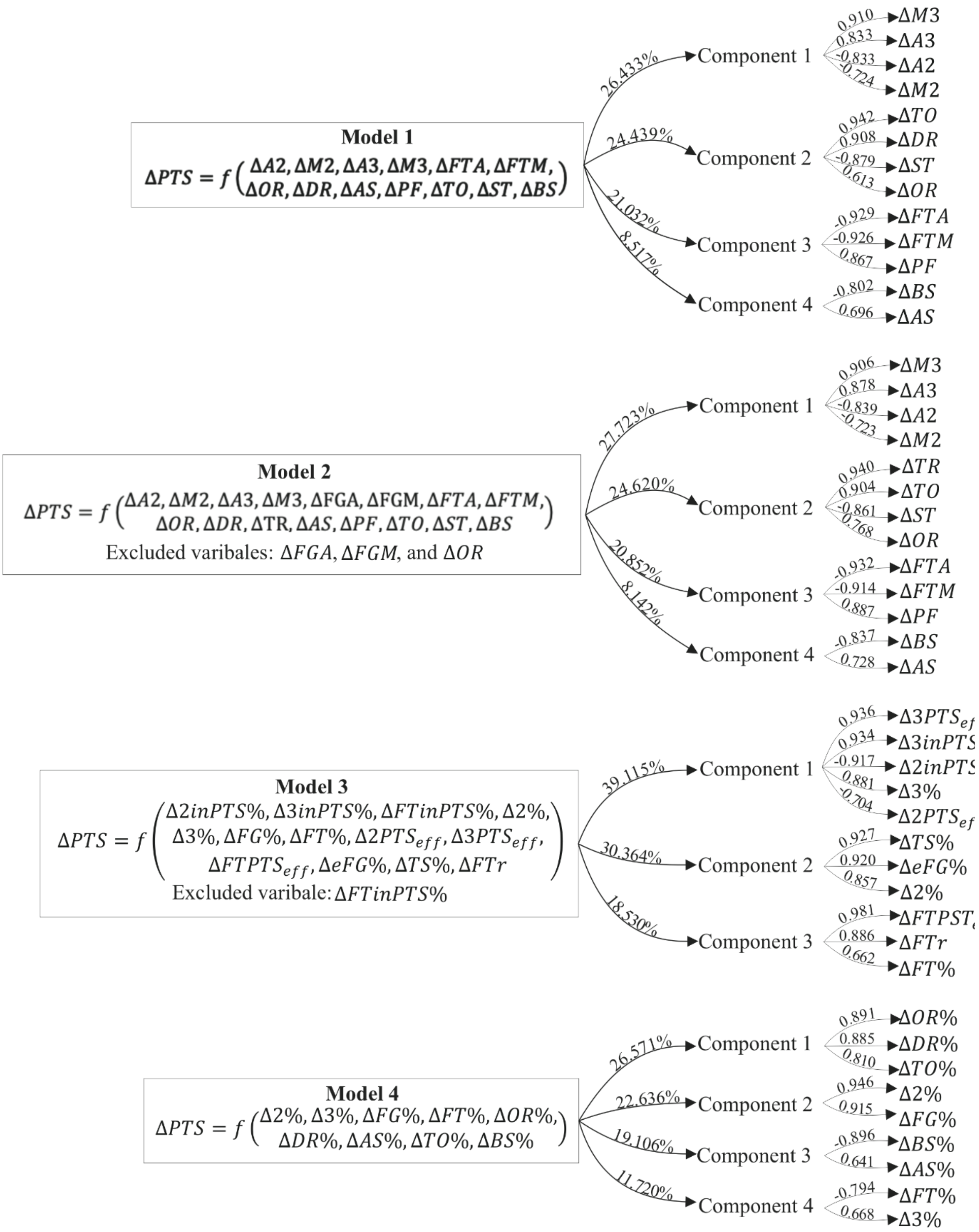

Figure 1. Total explained variability and rotated components
Source: Authors

Regression results for individual factors in relation to the appropriate original variables have been given in Table 1.

Table 1. Regression of individual factors in relation to original variables

Model	Factor	Variables	b^*	t	p	r_p	Analysis of the presence of multicollinearity: Tolerance	VIF
Model 1	F1	Const.		-.767	.452			
		$\Delta M3$	.264	4.417	.000	.703	.265	3.779
		$\Delta A3$	.454	8.927	.000	.894	.366	2.730
		$\Delta M2$	-.285	6.937	.000	-.840	.559	1.790
		$\Delta A2$	-.161	-3.217	.004	-.584	.379	2.642
	F2	Const.		3.316	.003			
		ΔTO	.347	.134	.000	.876	.222	4.499
		ΔDR	.374	.633	.000	.922	.326	3.071
		ΔST	.289	8.509	.000	.855	.351	2.851
		ΔOR	.118	.931	.000	.741	.705	.419
	F3	Const.		.284	.004			
		ΔFTA	.257	3.175	.005	.570	.197	5.083
		ΔFTM	.478	7.080	.000	.840	.283	3.528
		ΔPF	.366	.670	.000	.778	.369	2.709
Model 2	F1	Const.		.494	.626			
		$\Delta M3$	.254	.811	.001	.649	.265	3.779
		$\Delta A3$	.437	.714	.000	.865	.366	2.730
		$\Delta M2$	.283	6.159	.000	.809	.559	1.790
		$\Delta A2$	.188	3.368	.003	.602	.379	2.642
	F2	Const.		2.522	.020			
		ΔTR	.319	.663	.000	.722	.141	7.071
		ΔST	.258	5.938	.000	.799	.351	2.851
		ΔTO	.341	.246	.000	.813	.222	4.499
		ΔOR	.204	.256	.000	.689	.288	3.472
	F3	Const.		.316	.003			
		ΔFTA	.269	3.703	.001	.629	.197	5.083
		ΔPF	.384	.247	.000	.845	.369	2.709
		ΔFTM	.424	7,009	.000	.837	.283	3.528
Model 3	F1	Const.		7.596	.000			
		$\Delta 3inPTS\%$	.314	1.012	.000	.923	.190	5.269
		$\Delta 3\%$	.416	3.445	.000	.981	.489	2.045
		$\Delta 2inPTS\%$	.367	13.845	.000	.949	.219	4.559
	F2	Const.		46.464	.000			
		$\Delta TS\%$	.643	2.990	.000	.990	.630	1.588
		$\Delta 2\%$	.465	3.845	.000	.981	.630	1.588
	F3	Const.		6.560	.000			
		$\Delta FTPTS_{eff}$	.981	4.149	.000	.981	1.000	1.000
Model 4	F1	Const.		5.210	.000			
		$\Delta OR\%$	.315	.942	.000	.792	.320	3.121
		$\Delta TO\%$	.403	.775	.000	.920	.643	1.555
		$\Delta DR\%$	.423	.437	.000	.879	.358	2.790
	F2	Const.		15.466	.000			
		$\Delta 2\%$	.595	.330	.000	.871	.351	2.852
		$\Delta FG\%$	.435	.094	.000	.792	.351	2.852
	F3	Const.		.391	.699			
		$\Delta BS\%$	.769	13.999	.000	.948	.896	1.116
		$\Delta AS\%$	.393	.157	.000	.836	.896	1.116
	F4	Const.		.928	.363			
		$\Delta FT\%$	.794	12.234	.000	.934	.974	1.027
		$\Delta 3\%$	.553	.614	.000	.899	.974	1.027

Note: b^*= standardized regression coefficient; t = t-test; p: significance probability; r_p= partial correlation; VIF = variance inflation factor.
Source: Authors

Table 2 provides the final models where the dependant variable is ΔPTS, while independent variables are the original variables obtained by dimensionality reduction based on factor and regression analysis.

Table 2. Parameters of the models used in the study according to the results of the stepwise regression

Model	Variables	b^*	t	p	r_p	Analysis of the presence of multicollinearity	
						Tolerance	VIF
1a	Const.		1.056	.303			
	$\Delta A3$	.241	1.774	.091	.361	.712	1.404
	ΔDR	1.236	5.463	.000	.766	.257	3.888
	ΔTO	-1.057	-4.462	.000	-.698	.235	4.260
1b	Const.		7.132	.000			
	$\Delta M3$	.650	4.103	.000	.650	1.000	1.000
2a	Const.		7.393	.000			
	$\Delta A3$	.572	3.344	.003	.572	1.000	1.000
2b	Const.		7.132	.000			
	$\Delta M3$	.650	4.103	.000	.650	1.000	1.000
3	Const.		4.014	.001			
	$\Delta TS\%$	.825	7.001	.000	.825	1.000	1.000
4a	Const.		4.764	.000			
	$\Delta 2\%$	.531	3.004	.006	.531	1.000	1.000
4b	Const.		-.532	.600			
	$\Delta 2\%$	.912	11.201	.000	.929	.802	1.247
	$\Delta 3\%$	.839	9.750	.000	.909	.718	1.392
	$\Delta TO\%$	-.706	-7.518	.000	-.859	.603	1.659
	$\Delta DR\%$	.535	6.046	.000	.804	.680	1.471

Note: b^*= standardized regression coefficient; t = t-test; p: significance probability; r_p= partial correlation; VIF = variance inflation factor
Source: Authors

In further interpretation of the results, models 1b, 2a, 2b and 4a were dismissed due to very low values of the adjusted multiple determination coefficient. Specifically, the multiple determination coefficient of *Model 1b* is $\bar{R}^2 = .397,\ F = 16.831,\ p = .000$; *Model 2a* ($\bar{R}^2 = .298, F = 11.180, p = .000$), *Model 2b* ($\bar{R}^2 = .397, F = 16.831, p = .000$) and *Model 4a* ($\bar{R}^2 = .250,\ F = 9.021,\ p = .006$).

The values of the adjusted multiple determination coefficients of the remaining three models indicate that these models are statistically representative. The best statistical model is *Model 4b* ($\bar{R}^2 = .872,\ F = 42.004,\ p = .000$), i.e. the results of this model explain 87.2% of the variations of the dependable variable, followed by: Model 1a ($\bar{R}^2 = .684, F = 48.305, p = .000$) and Model 3 ($\bar{R}^2 = .667, F = 49.021, p = .000$).

According to the values of the standardized coefficient in model 1, it can be concluded that the greatest contribution is in variations of the dependable variable *ΔDR* (b_8^* = 1.236, p < .000), *ΔTO* (b_8^* = -1.057, p < .000) and *ΔA3* (b_8^* = .241, p < .091). This almost entirely coincides with the partial correlation coefficients which are largest for the explanatory variables *ΔDR* (r_p= .766), *ΔTO* (r_p = -.698) and *ΔA3* (r_p = .361). In model 3, only one difference variable was extracted, true shooting percentage – *ΔTS%* (b_{12}^* = .825, p < .000, r_p = .825). In model 4, the winners of matches at the Tokyo 2020 Olympic basketball tournament benefited the most from: *Δ2%* (b_1^* = .912, p < .000, r_p = .929), *Δ3%* (b_2^* = .839, p < .000, r_p = .909), *ΔTO%* (b_8^* = -.706, p < .000, r_p = -.859) and *ΔDR%* (b_6^* = .535, p < .000, r_p = .804) (Figure 2).

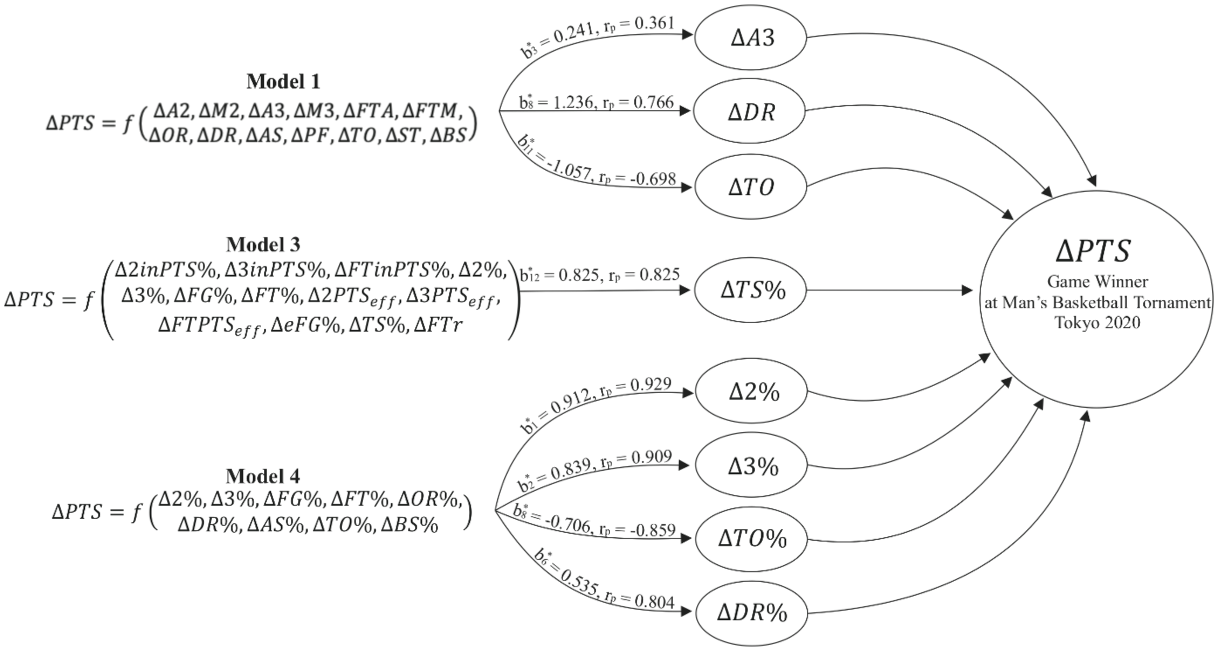

Figure 2. Variables that discriminated between winners and losers at the Tokyo 2020 men's Olympic basketball tournament
Source: Authors

Discussion

Game-related statistics allows for the application of prospective research, with the use of statistical methods to improve the qualities of a team's performance (skills, mental strength, anthropometric characteristics etc.) and achieve success. Ilkag Doğan and Yasin Ersoz found that a high level of these team characteristics provides game-related statistical data and allow for success[14]. Game-related statistics is used to describe variables which may aid in differentiating successful teams in relation to other teams. In the past decades we are witness to an incessant quest for understanding and interpretation of the complex actions which are present in basketball, which has lead authors and coaches to use "statistics techniques"[15].

In this study, the four set models were used to extract eight variables which discriminated between winners and losers in this competition. Out of the eight variables, four (or 50%) relate to shooting skills. Shooting is a key element of basketball technique and is congruent with the first rule of basketball, which says: the team that has scored the greater number of game points at the end of playing time shall be the winner[16]. A shot attempt is the final action that leads to scoring a field goal in basketball[17].

Although the other basketball skills that we call fundamental (passing, dribbling, defence and rebounding) may provide a high shot percentage for a player, he or she still has to be able to score. It is clear that team with the higher percentage of field goals made has a higher chance to win the match. If they have a lower percentage of field goals made than the opponent, they can only win the match if they have more field goal attempts, more free throws or a better percentage of free throws, which is not the case in the observed competition. Winners had a greater difference in two-point shot percentage – Δ2% (M = 58.997, SD = 9.549) and three-point shot percentage – Δ3% (M = 37.833, SD = 7.637), in true shooting percentage – ΔTS% (M = 60.662, SD = 6.121) as well as three-point shot attempts – ΔA3 (M = 31.654, SD = 6.032) in relation to the losers: Δ2% (M = 49.060, SD = 8.305), Δ3% (M = 34.254, SD = 7.619), ΔTS% (M = 53.051, SD = 5.398) and ΔA3 (M = 28.577, SD = 6.344). If we observe the matches individually, we can see that in six matches (24%) the losing teams had a better two-point shot percentage (Δ2%) than the winners, and in 10 matches (40%) a better three-point shot percentage (Δ3%). It is important to note here that in only one of these matches the losing team had a higher percentage of both two-point and three-point shots. The winners made up for the disbalance with a larger number of two-point shot attempts (on average for these matches 5.667 attempts more) and three-point shot attempts (1.800). Studies on men's Olympic tournaments have also found that field goals have a significant impact on the match outcome: Athens 2004, Beijing 2008[18-19], London 2012[20] and Rio 2016[21].

Prior studies have shown that shot percentage, and not number of shot attempts, is the parameter with a decisive impact on the final score[22]. The impact of shot percentage on the final score was also found in prior studies of men's Olympic basketball tournaments: In Beijing, the impact of the two-point shot percentage[19], and in Athens, Beijing, London and Rio, the field goal percentage[21]. In this study, we can see that the extracted variables are *Δ2%* and *Δ3%*. The difference in two-point shot percentages is greater than the difference in three-point shot percentages for the simple reason that a smaller shot distance leads to greater shot precision. Winners in this tournament had a slightly larger number of two-point shots (M = 38.963, SD = 5.072), which accounted for a total of 55.174% of all field goals in relation to the losers (M = 18.115, SD = 7.024) i.e. 57.121% of field goals, which is incongruent with what has been followed in terms of trends of game dynamics and evolution. Individual linear regression models, especially in studies done in recent years, have shown that the final score in a match is very significantly influenced by the three-point shot (in this study, out of the eight variables that have proven to be significant for the final score, two are in the domain of the three-point shot – *Δ3%* and *A3).* Authors have then rightly asked the question what brings about such a trend, despite the fact that the probability to score points decreases with shot distance[23]. Studies that have dealt with player interaction found that space-time coordination across the longitudinal axis (i.e. Interaction between inside and outside play) is a key element in player performance in a match[24]. The inside and outside player coordination increases the number of short distance shots, but also increases the possibilities of longer distance shots after open passes. Studies have found that offensive efficiency is higher when the ball is dribbled closer to the basket. In any case, offensive efficiency in modern basketball depends on the balance between inside and outside play[25]. The reasons for the fault in the logic can be also found by analyzing defensive play. It is obvious that most basketball coaches base their defensive philosophies on stopping close-range shots, which leads to more shots being made from a distance and behind the three-point line (set shot) after outside passing following a penetration or after back passes from low-post positions[26].

Following the evolution of basketball, it can be foreseen that group-tactical behaviour will go towards open three-point shots during set play and transition (e.g. inside and outside passing) and easy scoring during quick counterattacks (e.g. quick plays following a defensive rebound)[27]. The results of this study have confirmed this trend, but have also again confirmed the correlation between shot dynamics and basketball rule changes. Namely, the skill of the half-distance shot is increasingly stepping down for the skills of the lay-up shot and the three-point shot.

What is also interesting are the results of Model 3, which contains all the variables related to shooting in basketball. Only one variable was extracted, difference of the true shooting percentage $\Delta TS\%$, which is the indicator of the true shooting efficiency, and which now includes field goals and free throw shots. It is obvious that these new, derived variables warrant more attention in future studies.

Out of the variables that are not in shot domain the extracted variables indicate the significance of the difference in balls won by defensive rebounds and the difference in turnovers, both in the model where absolute values were observed (Δ*DR* and *ΔTO*) and in the model where relative values were observed (*ΔDR%* and *ΔTO%*).

Turnovers discriminated between winners and losers in Athens, Beijing, London and Rio[20-21], while offensive rebounds did in London[19]. When we talk about turnovers, we actually mean ball passing in basketball, which is a fundamental technique of player cooperation. After shot technique, it is the second most used technique in a match. Moreover, some coaches believe that passing is the most important technical element of offence because it tolerates a very low level of error, if any. If a player makes the slightest mistake, the pass ends in loss of the ball. In contrast, it is assumed that a player should have a shot percentage of around 50%[28]. Turnovers reduce the shot percentage and increase the opponents' shot percentage, which can be seen as a double inefficiency[29]. Losers in this competition had an average of 2.364 more lost balls than the winners. Consequently, they had a greater percentage of lost balls (M = 16.898, SD = 5.358) in relation to the winners (M = 14.030, SD = 4.771).

The team that control rebounding in a match, controls the match itself, i.e. higher rebounds provide for a better chance of winning the match[30]. Even though many of the standardly observed variables have evolved over time, defensive rebounds were and have remained stable over the years, with an impact on the outcome of the match[31]. The sum of the gathered data alone, especially when it comes to rebounds, is not sufficient or a detailed analysis of all the events that take place during a match, meaning that the "consequences of rebounding percentages should be used both in offense and in defence instead of the number of rebounds"[32;363]. In other words, the winning team forced their opponents to miss field goal attempts, which opened up space for more attempts of defensive rebounds – which is, in turn, a key indicator of the efficiency of both defence and rebounds[29]. When a team on the defence acquire the ball with a rebound, they decrease the opponents' number of field goal attempts and has an opportunity for a quick counterattack. Accelerating play through counterattacks creates opportunities for scoring "easy points" with a two-point shot from close proximity to the basket and for open three-point shots, which has had an impact on the shot dynamic in this competition. This is visible in the extracted variables which discriminated between winners and losers at the Tokyo 2020 Games.

The impact of winning the ball with defensive rebounds on the final score was ascertained in the Olympic basketball tournaments from Athens to Rio[21], which was also corroborated by separate studies for Beijing[19] and London[20]. At the Tokyo Olympic tournament, winning teams had a total of 4.500 rebounds per match more than the losing teams in those matches. But more importantly, the winners had a 5.988 higher percentage of defensive rebound efficiency.

The limitations of such studies pertain primarily to the nature of notational analysis. This is not the case in our study. Namely, the greatest objection is in gathering data on efficiency in matches, because the data is gathered by third persons who may make mistakes in the gathering process. This endangers the validity and reliability of the study findings. This study analyzed data from a top-tier basketball event, the Olympic basketball tournament – from the management and organization of the competition to the quality of the participating national teams. The source for the data was the official website: https://www.fiba.basketball/olympics/men/2020, while the statistics for this competition were recorded in line with the FIBA Statistician's Manual. Further, it is generally accepted that in most sporting events a "systematic advantage does exist for the home team"[33;34]. This is also not the case in this study, because all the matches were played in one place, and it was only the Japan national team that could have had the home field advantage (they came in 11th in the tournament).

In basketball, statistical analysis is of special importance for predicting match outcome and the evaluation of the teams' capabilities. Identifying the strong and weak sides of a basketball team or player and what should be improved is the key to progress and good performance in matches. The combinations of performance variables selected for analysis indicate that certain aspects have a significant impact on the final scores in competitions. They represent the starting point in preparing a team's match strategy and allows for individual and team assessments. What is certain is that the significance of the practical application of the results of a study on game-related statistics is undeniable both in prior[34] and in more recent studies[35-36].

The authors of this paper are aware that the obtained answers are not final and unambiguous. This is primarily because of the complexity of relations in sports, i.e. in every individual match, where it is difficult to create models that would encompass the full scale of activity of all the factors being monitored, because of the differences in their effect, i.e. intensity, direction and time of activity. In addition, it is certain that the final score is affected by other factors which are not being monitored, because they are seemingly less important, or are not measurable etc. There are other models and methods and other analytical procedures, which may induce some other results and conclusions, which is understandable given that the fundamental characteristic of sport is competition and is especially pronounced in basketball. Not being able to predict the result of a match with certainty may well be a fortunate thing after all, because if we knew the outcome in advance, the sporting event would lack one of its fundamental characteristics and would likely not appeal to spectators. Prognostic analytics should be pursued, but there should also be room for suspense in anticipation of the result and the sweet taste of victory. In his book "Sacred hoops: Spiritual lessons of a hardwood warrior", Phil Jackson said: "Like life, basketball is messy and unpredictable. It has its way with you, no matter how hard you try to control it. The trick is to experience each moment with a clear mind and open heart. When you do that, the game – and life – will take care of itself"[37;19].

Conclusion

The results of this study may lead to the conclusion that only one statistical regression model is highly representative. One model (2) did not show high representativeness. Two models (1 and 4), due to the evident detrimental impact of multicollinearity, underwent the necessary adjustments and re-evaluation, which yielded statistically significant models. Two out of three of the obtained regression models may lead to the conclusion that the final score at the men's Olympic basketball tournament in Tokyo, when it comes to the standardly observed parameters of the game of basketball, was impacted by the variables related to field goals (three-point shot and two-point shot), turnovers and defensive rebounds. This is congruent with the findings of prior studies carried out on men's Olympic basketball tournaments since 2004, as well as with the evolution of the game of basketball and trends in men's basketball in recent years. When it comes to the complex variable of true shooting percentage, it came into use in recent years, especially in the NBA. This study has recognized its significance, and future studies are needed to examine its impact on tendencies in modern-day basketball.

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