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The production process in basketball: Empirical evidence from the Spanish league

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Abstract

The main objective of this paper is to provide an empirical assessment of the production process in a basketball team. We estimate a logit model in which the output produced by a team is the game outcome (win or loss) and the inputs are those play characteristics that impact on that outcome. From the results obtained it is clear that, on average, there is a substantial difference between the impact of each play characteristic on a basketball team's winning probability and that probability varies as the quality/quantity of the inputs used changes, albeit not proportionally.

JEL Classification Codes: C25, L83

Keywords: sports economics, team sport, professional basketball, productive process, logit model

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I. INTRODUCTION

The sporting performance of a team can be considered the result of an underlying production process which combines the players' abilities to try and win games and, eventually, championships. In academic literature this production activity has been the object of extensive research. The characterization of a team as that of a company that obtains output combining inputs, was first discussed in Rottenberg's seminal article (1956) on the labour market in professional sport. Indeed, in most theoretical and empirical studies into sports competitions the assumption has prevailed that a team's winning percentage depends on the 'talent' that this team possesses in relation to its rivals[2].

The discussion about both the existence and the estimation of a production function for a professional sport has, apart from its purely academic interest, an unquestionably practical relevance. If team managers are to adopt rational decisions, then they have to be familiar with feasible and technically efficient production programs. In this sense, the information provided by the aforementioned estimation is essential for the successful management of a professional team, since it allows for the determination of the extent to which the result obtained by a team in a game depends on a series of play variables (actions).[3]

The present article can be framed within a series of studies that aim to approach empirically the underlying production process of a basketball team. The main objective of

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[2] For a review of this literature see Fort and Quirk (1995) and Szymanski (2003).

[3] Scully (1974) was the first author in trying to shape some of these ideas empirically as part of his study on the relationship between wages and the value of the marginal productivity of the players in the Major League of American baseball (MLB). This author opts for a linear model, but there are other more recent examples of empirical studies on the production function in the sphere of sport which are based on linear logarithmic models (Gustafson, Hadley and Ruggiero, 1999) or in models of more structural character that try to specifically incorporate the interaction among inputs that is characteristic of team sports (Atkinson, Stanley and Tschinhart, 1988).

our work is to identify the level of output (measured as the probability of winning a game) attainable for each vector of applied quantities of the inputs. This objective is plausible, because in the sports industry both inputs and outputs are directly observable, and quantifiable to a considerable degree of accuracy.

Although the inputs list is the same in almost all studies, the way of measuring the output changes depending basically on the object of study of the investigation. Zak, Huang and Siegfried (1979) define the output of professional basketball teams as the ratio between the score obtained by the team under consideration and that of its rival. Grier and Tollison (1990) characterize the output of the production function in basketball as the team's score, but in their empirical analysis they consider output to be the number of wins obtained by the various clubs in each season. McCormick and Clement (1992) and Hofler and Payne (1997) measure output by using the number of wins in the regular season. Scott, Long and Somppi (1985), Chatterjee, Campbell and Wiseman (1994) and Berri (1999) consider that output is the winning percentage on games played during each season. Finally, McGoldrick and Voeks (2005) approach the output of a basketball team through the probability of winning a game by taking the games played during a season as the sample.

In our case, and with the purpose of adopting an empirical approach to the basketball production function, the remainder of the article is organized as follows: in section 2, starting from basketball theory, it is posed the existence of a production function with a series of properties. In section 3, we present the empirical evidence regarding the relationship between a team's winning probability and input quality-quantity. Subsequently, we estimate the marginal effects of the different play actions on the winning probability. In section 4 the main conclusions are summarized.

II. PRODUCTIVE PROCESS IN BASKETBALL

In terms of a production theory view, a basketball team can be considered as a technical unit that produces an output combining inputs. Within this framework, a reasonable starting point is the assumption that a team's objective is to maximize its sporting successes (utility) subject to the constraint of not incurring in economic losses. Indeed, it is supposed implicitly that team owners sign up a coach who takes responsibility for technical aspects, as well as for maximizing the team's percentage of wins. Each coach has his/her own vision of what makes a winning team, and this is represented as a production process where the wins will be the output and the play actions the inputs.

The solution of this problem would require a functional representation of technology. To a large extent the production function represents the transformation of the production services of the inputs (players-play actions) in output flows (outcomes). Hence, in order to justify the existence of that function and to interpret the resulting empirical evidence, various considerations about the nature of basketball and, consequently, the basic theory behind this sport must be taken into account. The objective of a basketball team in each game is to beat its rival and in order to achieve this, it must develop a series of play actions that, if carried out wisely, increase the winning probability.

The basic principles of basketball theory allow us to assume the existence of a set of possible input-output vectors that would represent the feasible plans for the firm (team) given the technology state. This technology can be represented by means of a generic production function,

$$f\colon R^n_+ \longrightarrow R_+$$

$$Y = f\,(X_1, \ldots, X_n) \qquad (1)$$

where *Y* stands for the output and *X* the vector whose components show the quantities of inputs used in the production.

Equation (1) provides the maximum level of production attainable for each vector of applicable quantities of inputs. Passing from such a generic specification as (1) to a production function that can be estimated empirically involves deciding how to measure output and inputs, as well as opting for a specific functional form. In the present article it is assumed that the objective of a professional basketball team is to obtain the maximum number of wins throughout the season, a fact that will ultimately lead to the achievement of the championships at stake. Therefore, if we consider each game separately, the objective of a team is to win, since the sum of individual wins is what determines the eventual outcome of the season. In accordance with this approach, in our technology representation the output of a team is the outcome of a game and has two possible values: win or loss. On the other hand, the inputs are those play actions that are considered to be decisive factors so that a team gets to win.[4]

As the result of a game depends on offensive and defensive variables, thus it is necessary to identify the play actions that define the quality of the attack and defence of a basketball team[5]. In general, it is considered that there are four decisive elements which

[4] It could be considered that the inputs of a professional basketball team are the players, whose physical and professional experience characteristics, as well as their remuneration, are fairly easy to measure. However, the issue addressed in this article is the production process of professional basketball, where technical development can be evaluated by taking into account not the players' characteristics but the significance of their on-court actions for the team. The measuring of these actions is carried out by the statistical services of the respective professional basketball leagues.

[5] Berri (1999), Berri and Brook (1999) and Berri and Schmidt (2002) opt for the elaboration of different econometric models for the analysis of the defensive and offensive actions of basketball teams. In our paper

determine a team’s success: defensive pressure, rebounding capacity, efficiency in ball handling and shot effectiveness in attack.

In addition to the aforementioned statistically quantifiable play actions, there are further qualitative factors that determine the success of basketball teams. Examples of these factors include players’ attitude, star players’ leadership skills, team chemistry, control of the ‘tempo’ of the game and the coach's degree of efficiency in performing his/her functions. All these qualitative elements somehow reflect on the team’s final statistics, although the statistics themselves fail to single them out. There is a further aspect of particular relevance that has a significant influence on winning probability: the home-court advantage. This factor would account for the impact of all those aspects that contribute to a basketball team’s enhanced winning probability when playing as a home team than when it does so as a visiting team.

In this sense, and keeping in mind the four generic factors identified as decisive for a team win in accordance with the basketball theory discussed above, we went on to consider the selection and quantification of the indicators that measure inputs. In this selection of indicators we also indicate, by means of the use of the symbols ‘+’ and ‘-‘, the theoretical sign of the marginal effect of each play action on the winning probability.

The *defensive skills* of a professional basketball team can be quantified by using statistics both of the team itself and its rival[6]. The following are the statistics that can initially be considered as representative inputs of the *defensive pressure* of a basketball team: rival field goal percentage (-), number of blocked shots (+), rival turnovers (+) and

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we preferred to use a model (model I) which allowed us to evaluate simultaneously the impact of offensive and defensive play actions on the winning probability.

personal fouls committed (-). The basic statistics used in order to measure offensive and defensive *rebounding capacity* are defensive (+) and offensive (+) rebounds, whilst in order to determine *efficiency in ball handling* the assists (+) and the turnovers (-) are counted. Lastly, the indicators chosen to measure the *shot effectiveness* of basketball teams are the percentage of field shots made (+), the percentage of free throws scored (+), the blocked shots received (-) and the personal fouls received (+).

III. EMPIRICAL ANALYSIS

The numerical estimation of the production function parameters provides an empirical content and allows us to determine the extent to which the result obtained by a team in a basketball game depends on a series of variables. The data used in the empirical analysis come from the official statistics of the regular session games of the Spanish ACB (Basketball Clubs Association) League Championships during the 2002-2003 and 2003-2004 seasons. In each one of those seasons 18 teams competed in the ACB over 34 league days. Nine games are played on each regular league day, so the total sample used has 612 observations (number of games disputed in the two seasons considered). In ACB League games the possibility of a draw does not exist, and there are only two possible results: a win or a loss. The result of a game can therefore be expressed in probabilistic binary terms and, in consequence, it is possible to use dichotomous variables. This means that dependence of the results (win or loss) can be expressed in terms of a series of play actions that are considered to be determinant.

[6] The most recent studies into efficiency and productivity in professional basketball consider that it is essential to use rival statistics in order to analyse many of the phases of basketball production process (Berri,

When estimating the relationship between that binary variable and the explanatory variables considered in econometric terms, we opted for a logit probabilistic model. This model is especially appropriate because, besides allowing the estimation of the marginal effects of each play action on the probability that a team wins a game, it exhibits other two highly advantageous characteristics with reference to discriminant analysis and the linear regression model. On the one hand, logistical regression does not establish any restriction on the distribution of independent variables, in contrast to discriminant analysis, which involves the assumption of multivariant normality. On the other hand, the logit model also overcomes the limitations of the linear regression model regarding the dichotomous nature of the dependent variable: estimated probabilities outside the range (0, 1), non normality of the errors, their heteroskedasticity and non normality of the dependent variable (Hosmer and Lemeshow, 1989).[7]

Within the present scope, the logit specification is expressed as shown below:

$$\text{P (Win)} = \text{P (Y = 1)} = \frac{\exp(X \cdot \beta)}{1 + \exp(X \cdot \beta)} \qquad (2)$$

where *P (·)* stands for 'probability', *X* is the regressors matrix and *ß* is the regression coefficient vector.

For the purpose of our research we have estimated two differentiated models (models I and II) that seek to quantify the impact of a series of variables on the probability of winning a game in the ACB League. The models differ in terms of the dependent

1999).

[7] With regard to other alternative binary models, such as the probit, it must be pointed out that, in general, there is very little difference between using the probit or the logit specification, except in those cases where the data are heavily concentrated in the tails of the distribution or where the sample shows a considerable variation in an important independent variable, especially if the previous case is also true, circumstances that did not occur in this study.

variable, the regressors used and the sample size (n = 612 and n = 1.224, respectively). In general terms, this approach, based on the estimation of two different specifications, has the advantage of combining three types of factors that explain the output of a basketball team: the play actions carried out by the team, the quality of the rival and the home-court advantage, in other words, the fact of acting or not as the home team.

Model I is focuses on the estimation of the impact of the different play variables on the probability of winning a game in the ACB League considering the statistics of the home team and those of its rival in each game in relative terms. In this model the dependent variable (Y) is dichotomous and takes the value 1 if the home team wins and 0 otherwise; therefore, it tries to explain the home club winning probability. The variables included in model I are ratios or differences between the statistics of the home team and those of the visitor in relation to the main play actions (see Table 1)[8].

<INSERT TABLE 1 HERE >

The influence of the home-court advantage on the outcome can be clearly perceived from Table 1, since, on average, the home team wins in 61.93% of the games. As for the ratios of success in field shots and free throws and of defensive rebounds, one can observe that home team means are slightly higher than those of the visiting team. The difference is substantially larger in the case of assists and offensive rebounds. In the remaining regressors, both teams values are very similar.

[8] In the case of variables X_7 and X_9 we opted to calculate differences between the data of the home club and its rival, because in some observations those statistics can take a zero value, so the corresponding ratios would be indeterminate.

In model II, and with the purpose of specifically analysing the influence of the home-court advantage on the winning probability, the different variables have been used as inputs, considered separately for the home team and the visitor in each game (percentages instead of ratios or differences are directly employed). Additionally, it incorporates the *dummy* variable X_{12}, which adopts the value 1 when the team plays at home and 0 when it plays away. In this case, the sample size is of 1,224 observations. The descriptive statistics corresponding to the variables included in model II are summarized in Table 2.

<INSERT TABLE 2 HERE >

The estimation of both models[9] [expression (2)] was carried out by means of the maximum likelihood method (Newton-Raphson algorithm). The principal results are summarized in Tables 3 and 4.

With regard to model I, it can be concluded from Table 3 that all the variables are significant at 1% level except for the differences in steals and in blocked shots (X_7 and X_9), which are not significant (p-values of 0.8884 and 0.8801, respectively). On the other hand, in accordance with all the main indicators, the model shows a considerable goodness of fit and predictive capacity[10].

<INSERT TABLE 3 HERE>

[9] Prior to the estimation we analysed the correlation between the different variables. It rejected the presence of multicollinearity problems.
[10] The Huberty test showed significativity at 1% level.

Furthermore, the signs of the coefficients estimated in model I correspond clearly to those deduced from basic basketball theory. A team improves (reduces) its probability of winning a game when it increases (diminishes), in relation to the rival, its field goal percentage and free throws, its defensive and offensive rebounds, its assists, its steals and its blocked shots. Likewise, a team reduces (increases) its probability of winning a game when it increases (diminishes) its personal fouls and its turnovers in comparison with the rival team.

In model II, the results of Table 4 reveal that, on the one hand, all the regressors are significant at a 1% level, except X_{10} (favourable blocked shots) and X_{12} (playing at home), that are significant at 5%, and X_{11} (unfavourable blocked shots), which is not significant (p-value = 0.2104). On the other hand, in this case all the indicators also point out the considerable goodness of fit and predictive capacity of the model: the three 'pseudo-R^2' statistics obtained (Mc Fadden, Cox and Snell, and Nagelkerke) show high values, the likelihood ratio and Hosmer-Lemeshow tests are overcome (at 1%) and the model shows a success percentage of 83% (against 50% of the restricted model)[11], whilst the outliers proportion is less than 3%. Once more, the signs of the coefficients obtained are as expected: the probability of a basketball team winning a game depends positively on its success in field shots and free throws, defensive and offensive rebounds, assists and steals, fouls received, favourable blocked shots, and the fact of playing at home. On the other hand, fouls committed, turnovers and unfavourable blocked shots have a negative influence.

<INSERT TABLE 4 HERE>

Both models show considerable robustness, and are therefore suitable in order to measure the differential impact each characteristic of play has on the probability of a basketball team winning a game. In econometric terms, this requires the calculation of the so-called *marginal effects*, $\frac{\partial P}{\partial X_i}$. Obviously, as in any logit model, the magnitudes of these effects vary according to the values of the regressors. In order to interpret the estimated model, one option would be to calculate these marginal effects in several values of interest (for example, they can be obtained for the regressors means). Another alternative is to evaluate the marginal effects in each observation and to calculate the mean of individual marginal effects later. In the case of large samples, the same results would be obtained in both cases, but it will not occur with small or medium-sized samples. The most common option is to use the second procedure, the one adopted for the purpose of this reasearch.

In model I we estimate the marginal effects on the probability of winning a game of a series of play variables that seek to consider jointly the behaviour of the home team and its rival by means of the use of ratios and differences (Table 5).

<INSERT TABLE 5 HERE>

An examination of the marginal values indicates that there is a substantial difference between the impacts each additional play characteristic has on the probability of winning. In particular, the results obtained in model I show mainly the considerable importance that the success ratio in field shots of both teams has on the outcome of a game. Logically, an

[11] Again, this success percentage was significant at a 1% level, according to the Huberty test.

increase in the ratio of field goal percentage can be the consequence either of an appropriate shot selection that improves the success percentages in attack or of a defensive pressure that, forcing shots from bad positions, affect the opponent’s proficiency in converting attempts into points. In addition to the aforementioned variable, the following elements, listed in order of importance, could be considered as decisive factors in order to win a game: personal fouls, turnovers, success percentage in free throws and defensive rebounds. On the contrary, differences in steals and in blocked shots are almost insignificant. These results can be explained in accordance with the logic of the sport of basketball.

In model II, in addition to estimating the marginal effects of the main play actions of a team on the probability of winning a game, we have estimated the marginal effect of the home-court advantage (see Table 6). In fact, the principal interest of the results of model II lies in the estimation of the marginal effect of that factor.

<INSERT TABLE 6 HERE>

As can be noted from table 6, the empirical evidence suggests that playing as a home team increases a standard team’s probability of winning a game by 4.54%. This would explain the fact that on many occasions, in games between teams with similar potential, forecasts favour the home team simply because it is playing on its own court. Aspects such as an optimum knowledge of the court and the facilities (where the team trains daily), the absence of a long journey in the hours prior to the game and, mainly, the pressure that the public can exert on the morale of both teams and on certain referee rulings, are some of the factors that can explain why in a league like the ACB on average the home team wins on a 61.93% of the occasions. This marginal effect is actually higher than other variables considered in the model, such as defensive rebounds, field goal percentage, steals, turnovers and offensive rebounds.

IV. CONCLUSIONS

In this paper we have presented an econometric model that provides a quantitative assessment of production function for a professional basketball team. In particular, we have examined the relationship between a basketball team statistics (inputs) in the Spanish ACB League and team winning probability (output). The evidence is suggestive in several ways:

Firstly, if the team output is measured as the probability of winning a game, a probabilistic model based on a logistical distribution is an appropriate method in order to quantify the marginal effects of the various play actions (inputs) on wins.

Secondly, the results of the models estimated in our research provide us with an insight into the key factors that are most critical in determining a team's probability of winning a basketball game. In this sense, as a rule, one can conclude that on the average the winning probability of a team varies as the quality-quantity of the used inputs fluctuates, albeit not proportionally.

Thirdly, if we consider the statistics of both teams that play a game, for the home team the play actions with highest marginal effects on the winning probability are, in this order, the field goal percentage (marginal effect of 1.36%), not committing personal fouls (marginal effect of -0.34%), not turning balls over (marginal effect of -0.33%), success in free throws (marginal effect of 0.28%) and defensive rebounds (marginal effect of 0.20%). In particular, in the most evenly-matched games we can verify the special relevance of the results obtained in order to draw conclusions regarding those aspects of the game that must be improved in order to have a significant impact on a team's winning probability.

Fourthly, in addition to play actions, it can be seen that the home-court advantage has a significant influence on winning probability, since, according to the results of our estimation, the fact of playing as a home team increases the probability of winning a game by 4.54%, provided that a team has some standard statistics in the main play actions. This evidence supports the view that on many occasions, in games between teams with similar potential, sports forecasts favour the home team simply because it is playing on its own court.

Finally, at a normative level, the approach and the results drawn from this research provide decision makers – both the team owner and coach – with valuable data for the efficient management of their team's talent. In the short term, certain elements of the team production function are fixed, so if the coach aims to do his/her task efficiently, he/she should behave in such a way whereby the management of the available resources (control variable) allows him/her to maximize the winning probability of his/her team. In the long term, everything about the team's production process is variable and could lead to the possible modification of the team line-up. Hence, decisions in this respect should be taken keeping in mind the characteristics (skills) of future incorporations and their predicted contribution to improving those inputs that have a highest impact on the winning probability (objective variable).

Further research might attempt to improve the present empirical study of basketball team production functions in several directions. Firstly, a more 'structural" approach could be adopted in order to incorporate additional qualitative factors and interdependency between inputs. Secondly, the reliability and general validity of our estimating technique can be confirmed by using new data sets containing information for individual teams and for the main European professional basketball leagues. Finally, the improved specification along with new data would give rise to relevant conclusions for each professional league and for each team (i.e. applying fixed effects panel data models).

REFERENCES

ATKINSON, S., STANLEY, L. AND TSCHIRHART, J. (1988). Revenue sharing as an incentive in an agency problem: an example from the National Football League. *Rand Journal of Economics*, 19, 1, 27-43.

BERRI, D. J. (1999). Who is most valuable? Measuring the player's production of wins in the National Basketball Association. *Managerial and Decision Economics*, 20, 8, 411-27.

BERRI, D. J. AND BROOK, S. L. (1999). Trading players in the National Basketball Association: for better or worse? In J. L. Fizel, E. Gustafson and L. Hadley (Eds.), *Sports Economics: Current Research* (pp. 135-52). Vestport: Praeger.

BERRI, D. J. AND SCHMIDT, M. B. (2002). Instrumental versus bounded rationality: a comparison of Major League Baseball and the National Basketball Association. *Journal of Socio-Economics*, 31, 3, 191-214.

CHATTERJEE, S., CAMPBELL, M. R. AND WISEMAN, F. (1994). Take that jam! An analysis of winning percentage for NBA teams. *Managerial and Decision Economics*, 15, 5, 521-35.

FORT, R. AND QUIRK, J. (1995). Cross-subsidization, incentives, and outcomes in professional team sports leagues. *Journal of Economic Literature*, 33, 3, 1265-99.

GRIER, K. B. AND TOLLISON, R. D. (1990). Arbitrage in a basketball economy. *Kyklos*, 43, 4, 611-24.

GUSTAFSON, E., HADLEY, L. AND RUGGIERO, J. (1999). Alternative econometric models of production in major league baseball. In J. Fizel, E. Gustafson and L. Hadley (Eds.), *op. cit.* (pp. 95-108).

HOFLER, R. A. AND PAYNE, J. E. (1997). Measuring efficiency in the National Basketball Association. *Economics Letters*, 55, 2, 293-9.

HOSMER, D. W. AND LEMESHOW, S. (1989). *Applied logistic regression.* New York: John Wiley & Sons.

MCCORMICK, R. E. AND CLEMENT, R. C. (1992). Intrafirm profit opportunities and managerial slack: evidence from professional basketball. In G. W. Scully (Ed.), *Advances in the Economics of Sport (Volume 1)* (pp. 3-35). Greenwich: JAI Press.

MCGOLDRICK, K. AND VOEKS, L. (2005). We got game! An analysis of win/loss probability and efficiency differences between the NBA and WNBA. *Journal of Sports Economics*, 6, 1, 5-23.

ROTTENBERG, S. (1956). The baseball players' labor market. *Journal of Political Economy,* 64, 242-58.

SCOTT, F., LONG, J. AND SOMPPI, K. (1985). Salary versus marginal revenue product under monopsony competition: the case of professional basketball. *Atlantic Economic Journal*, 13, 3, 50-9.

SCULLY, G. (1974). Pay and performance in major league baseball. *American Economic Review*, 64, 6, 915-30.

SZYMANSKI, S. (2003). The economic design of sporting contests. *Journal of Economic Literature*, 41, 4, 1137-87.

ZAK, T. A., HUANG, C. J. AND SIEGFRIED, J. J. (1979). Production efficiency: the case of professional basketball. *Journal of Business*, 52, 3, 379-92.

Table 1

Variables and descriptive statistics of Model I (N = 612)

	Minimum	Maximum	Mean	Stand. Dev.	Skewness	Kurtosis
Y (Home team wins)	0	1	0.6193	0.4860	-0.4925	-1.7632
X_1 (Ratio of field goal percentage)	52.7778	203.1348	104.4990	21.3296	0.5979	0.6057
X_2 (Ratio of free throws)	32.7273	328.3951	104.6376	24.9608	1.9035	11.4978
X_3 (Ratio of defensive rebounds)	42.4242	270.0000	107.5196	30.5394	1.2656	3.2002
X_4 (Ratio of offensive rebounds)	23.8095	1,300.0000	129.2016	93.8347	4.9127	47.4113
X_5 (Ratio of assists)	11.1111	566.6667	126.7928	65.1921	1.9972	7.6520
X_6 (Ratio of personal fouls)	51.6129	184.6154	99.8020	21.1248	0.6285	0.6471
X_7 (Difference in steals)	-10	14	0.8366	4.1434	0.0054	-0.0141
X_8 (Ratio of turnovers)	26.0870	250.0000	98.1701	37.1876	1.0147	1.2973
X_9 (Difference in blocked shots)	-10	11	0.4706	2.7380	0.0838	0.6682

Table 2

Variables and descriptive statistics of Model II (N = 1,224)

	Minimum	Maximum	Mean	Stand. Dev.	Skewness	Kurtosis
Y (Team wins)	0	1	0.5008	0.5002	-0.0033	-2.0033
X_1 (Field goal percentage)	23.2323	70.3704	46.6467	6.7418	0.2527	0.0844
X_2 (Free throws)	15.7895	100.0000	72.4382	10.9126	-0.3957	0.4030
X_3 (Defensive rebounds)	10	37	23.1315	4.4549	0.0137	-0.3208
X_4 (Offensive rebounds)	1	26	10.8766	3.9009	0.5030	0.3379
X_5 (Assists)	2	31	12.1577	4.0647	0.4382	0.5292
X_6 (Committed fouls)	11	39	22.5131	3.9690	0.2338	0.2652
X_7 (Received fouls)	11	39	22.4984	3.9727	0.2388	0.2615
X_8 (Steals)	1	19	8.4444	3.0464	0.4350	0.1276
X_9 (Turnovers)	4	28	13.6969	3.7494	0.3323	0.2622
X_{10} (Favourable blocked shots)	0	13	2.8350	1.9081	0.8536	1.1266
X_{11} (Unfavourable blocked shots)	0	44	2.8513	2.2291	5.5893	94.2673
X_{12} (It plays at home)	0	1	0.5000	0.5002	0.0000	-2.0033

Table 3

Main results of logit regression. Model I

Variables	**Coefficients**	**Standard errors**
X_1 (Ratio of field goal percentage)	0.1738**	0.0196
X_2 (Ratio of free throws)	0.0357**	0.0081
X_3 (Ratio of defensive rebounds)	0.0260**	0.0100
X_4 (Ratio of offensive rebounds)	0.0133**	0.0026
X_5 (Ratio of assists)	0.0107**	0.0034
X_6 (Ratio of personal fouls)	(-0.0439)**	0.0077
X_7 (Difference in steals)	0.0068	0.0484
X_8 (Ratio of turnovers)	(-0.0428)**	0.0072
X_9 (Difference in blocked shots)	0.0085	0.0565
Constant	(-17.5108)**	2.1095
Measures of goodness of fit / predictive capacity		
(-2)·Log likelihood of extended model	308.9067	
(-2)·Log likelihood of constant-only model	813.2440	
Mc Fadden R^2	0.6202	
Cox and Snell R^2	0.5614	
Nagelkerke R^2	0.7635	
p-value of likelihood ratio test	0.0000	
p-value of Hosmer-Lemeshow test	0.9854	
Overall % success of extended model	88.56	
Overall % success of constant-only model	61.93	
Akaike criterion (AIC)	0.5374	
Number of outliers	14 (2.29%)	

(*) Significant at 5%; (**) Significant at 1%.

Table 4

Main results of logit regression. Model II

Variables	**Coefficients**	**Standard errors**
X_1 (% field goal percentage)	0.2725**	0.0196
X_2 (% free throws)	0.0501**	0.0083
X_3 (Defensive rebounds)	0.3057**	0.0241
X_4 (Offensive rebounds)	0.1665**	0.0244
X_5 (Assists)	0.0827**	0.0240
X_6 (Personal fouls committed)	(-0.1301)**	0.0235
X_7 (Personal fouls received)	0.1272**	0.0229
X_8 (Steals)	0.2531**	0.0309
X_9 (Turnovers)	(-0.1798)**	0.0249
X_{10} (Favourable blocked shots)	0.0890*	0.0447
X_{11} (Unfavourable blocked shots)	(-0.0475)	0.0379
X_{12} (It plays at home)	0.3722*	0.1695
Constant	(-26.0900)**	1.7971
Measures of goodness of fit / predictive capacity		
(-2)·Log likelihood of extended model	935.4434	
(-2)·Log likelihood of constant-only model	1,696.8210	
Mc Fadden R^2	0.4487	
Cox and Snell R^2	0.4632	
Nagelkerke R^2	0.6175	
p-value of likelihood ratio test	0.0000	
p-value of Hosmer-Lemeshow test	0.5424	
Overall % success of extended model	83.09	
Overall % success of constant-only model	50.08	
Akaike criterion (AIC)	0.7855	
Number of outliers	33 (2.70%)	

(*) Significant at 5%; (**) Significant at 1%.

Table 5

Marginal effects of Model I

Variables	**Marginal effects (%)**
X_1 (Ratio of field goal percentage)	1.36
X_2 (Ratio of free throws)	0.28
X_3 (Ratio of defensive rebounds)	0.20
X_4 (Ratio of offensive rebounds)	0.10
X_5 (Ratio of assists)	0.08
X_6 (Ratio of personal fouls)	(-0.34)
X_7 (Difference in steals)	0.05
X_8 (Ratio of turnovers)	(-0.33)
X_9 (Difference in blocked shots)	0.07

Table 6

Marginal effects of Model II

Variables	**Marginal effects (%)**
X_1 (% field goal percentage)	3.32
X_2 (% free throws)	0.61
X_3 (Defensive rebounds)	3.73
X_4 (Offensive rebounds)	2.03
X_5 (Assists)	1.01
X_6 (Personal fouls committed)	(-1.59)
X_7 (Personal fouls received)	1.55
X_8 (Steals)	3.09
X_9 (Turnovers)	(-2.19)
X_{10} (Favourable blocked shots)	1.09
X_{11} (Unfavourable blocked shots)	(-0.58)
X_{12} (It plays at home)	4.54