

MEASURING EFFICIENCY USING SELECTED DETERMINANTS. AN EMPIRICAL ANALYSIS BY USING DEA METHODOLOGY

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Abstract

This study deals with the efficiency evaluation of English Premier League clubs through six seasons (2010/11 - 2015/16). The main objective of the study is to assess the possible sport and managerial determinants of the of the premier league clubs efficiency. For this purpose, two-step DEA has been applied. The CCR and BCC DEA models have been implemented in the first step. We have used input oriented models, where inputs – expenses on new purchases and wages of players, are considered adjustable by the managers. The only output is points collected throughout the season. In the second step, impact of environmental variables, which are not easily adjustable by the managers, have been applied using double-bootstrapped CCR and BCC efficiencies using the truncated regression. Both types, financial and sport oriented variables have been examined. Results point out that clubs should focus rather than on improving of the number of passes and shots on goal, on improving of game results “directly-influencing” statistics such as goals scored and goals conceded. We have found that the higher value of turnover does not implicate the higher efficiency.

Key words: premier league, efficiency, data envelopment analysis, two-step DEA

JEL Code: C34, C67, M20

Introduction

Sport clubs or sport individuals do their jobs to be successful. We can say that sport club (individual) is successful if it wins trophies, if we maximizes its profit or increases revenues. We can measure all of these criterions and subsequently evaluate their activity. On the other hand, it is not only way, how to evaluate sport clubs (individuals). There is possibility focus not only on variables mentioned above, but also on the efficiency itself, using parametric or non-parametric methods.

The problem of the measuring the efficiency in the area of sport is oriented mostly on the clubs, but some studies are oriented on the players (Arabzad, Ghorbani, and Shahin 2013) and other subjects –mostly on clubs and national teams (Rubem and Brandão 2015). Most of processes in the sport, especially in football, are oriented on the value and wealth creation. One can achieve success, but is the question, whether it was been gained with more resources than were needed (Zambom-Ferraresi, García-Cebrián, et al. 2017). There are studies (Halkos and Tzeremes 2013) according to which, it appears that money are not the only thing in the sport efficiency improvement. They suggest that decisions of decision-makers, i.e. managers and other subjects play the significant role in the improvement of clubs performance.

It is believed, that highly ranked clubs should be efficient (Zambom-Ferraresi, Lera-López, and Iraizoz 2017). But this situation is strictly connected to variables taken into account and could be not as clear (Kounetas 2014). The combination of economic variables taken as inputs and sport variables taken as outputs can be found in previous literature . There is also discussion if one should use match related statistics or some like market value inputs, but research suggest it does not really matter (Zambom-Ferraresi, Lera-López, et al. 2017). In most of the studies regarding to the efficiency in sport context, Data Envelopment Analysis (DEA) is performed. Researchers suggest that it is a power tool which could support the managerial decision (García-Sánchez 2007). Despite of fact that exist two main approaches (financial and sport efficiency), many authors combine financial and sport-related variables. It can be argued, that it is complicated to evaluate financial efficiency of clubs without factors related to sport results. On the contrary, high sport efficiency could not be achieved without satisfying financial results.

The goal of this study is, based on the above-mentioned paragraphs to examine not only the efficiency of the clubs combining the sport and economic variables. It has been done by many studies, but also to determine the impact of selected economical and sport-related indicators of English Premier League (EPL) clubs, which cannot be easily adjustable, by the management of the clubs.

1 Methodology and methods

We have used the two-step DEA method in order to fulfil the goal of this study. Similar method was used by (Halkos and Tzeremes 2013). The main difference is in the decision making units and in the combination of variables. The main idea of this approach is to obtain the values of DEA efficiency in the first step, and in the second step to determine the impact of the selected determinants of the efficiency calculated in the first step. In the first step, the

Farrell efficiency (Farrell 1957) was used, using the input models. This DEA methods were proposed by (Cooper, Seiford, and Tone 2007). Following equations are expressing the input oriented CCR model, which is assuming the constant returns to scale are observed in the researched decision-making units and BCC model, which takes into account variable returns to scale researched decision-making. We have used DEA window approach, in which every observation is taken as unique, i.e. if one club appears in more seasons, it is considered to be unique decision-making unit.

We use second algorithm of double bootstrapping proposed by (Simar and Wilson 2007) to get the consistent regression results. This procedure is needed because of the fact, that DEA is deterministic method, and after the double bootstrapping, we can get stochastic efficiencies. According to their recommendations we apply the truncated regression, which is applied in many studies from other areas.

In the literature review, we primary describe an efficiency evaluation approaches of clubs from the same league. The main reason is that focusing on the one league offers the same conditions and data are more available and comparable. In our research, we deal with clubs English Premier League (EPL) for six season (from 2010/11 to 2015/16). EPL consists of 20 clubs - each club plays 38 matches per season (19 home, 19 away). Clubs are awarded by 3 points for win and 1 point for draw. Clubs from the top of the final league table are promoted to the Champions League and European League. The last three club from the bottom of the table are relegated to the Championship and in the next season are replaced by three clubs from Championship.

Data were obtained from the official web sites of EPL, The Guardian and The Transfermarket. Based on literature review we focus both on sport and on financial efficiency. Selection of input and output variables is described below. We have obtained 120 observations in total. The reason for selecting the EPL is, that this league is considered o be the most attractive (Zambom-Ferraresi, Lera-López, et al. 2017) in marketing and financial aspects. Some studies use teams from several leagues and the EPL clubs are mostly represented (Halkos and Tzeremes 2013) It is considered also as the best league in the world, where the largest number of clubs are able to win the league (Zambom-Ferraresi, García-Cebrián, et al. 2017).

In the DEA model (first step), we combine financial and sport variables. As the input variables we use economically oriented variables, since we compute input oriented models, because this can be easily adjusted by the management. Regarding input variables, the most

common used variable is *Wages* (WAG) (Barros and Leach 2006). This variable refers to the amount of money which club spend on wages of players. The more money club spend, the more top players play in the club. Therefore, we can conclude that such a club is also more successful. The second input variable is *Total players' transfer expenses* (EXP) (Kounetas 2014). Similarly, to previous input, the clubs spending higher amount of money on purchase of new players are considered more successful. The output variable of proposed DEA model is *Number of points obtained in the season* (P) (Barros and Douvis 2009). This variable shows most important sport result of the club in the end of the season. This variable is better than final ranking because point gap shows more realistic differences than ranking gap. The second output is players' transfer incomes. This variable can be considered as another indicator of efficiency. If club want to be successful, the sale of useless players is vital. On the other hand, some clubs are dependent on sale of their top players.

The results of DEA show efficiencies of analysed clubs. These results could be insufficient, and further analysis is needed. The DEA results point to efficiency, but do not analyse impact of environmental variables. To solve this problem truncated regression analysis is used through regression models with the values of double bootstrapped CCR and BCC DEA efficiency as the dependent variable. We propose to not use following variables in the first step, because they are not directly adjustable by the management of the clubs.

In the regression model (second step), the seven independent variables are used. These variables are commonly used in DEA models to evaluate efficiency of football clubs. The first independent variable is *Turnover* (TURN) (Barros and Leach 2006). This variable allows to us compare if clubs with higher turnover have a higher efficiency. The next variable is *Attendance* (ATT) (Barros and Douvis 2009; Barros and Garcia-del-Barrio 2011; Kounetas 2014) calculated as the average attendance of the season. Other independent variables are *Goals scored* (GS) and *Goal conceded* (GC) (Boscá et al. 2009). We assume that higher number of goal scored and lower number of goal conceded can affect the efficiency of clubs. The probability of the better club performance is directly connected to higher number of goals scored and the lower number of goals conceded. The fifth variable is *Shots on goal* (SG) (Boscá et al. 2011). Obviously, the clubs with higher number of shots on goal use attack tactics and have better chance to score more goals. The sixth variable is *Number of passes* (PSS) (Zambom-Ferraresi, Lera-López, et al. 2017), we assume that if the club have higher number of passes it probably has better possession of the ball and higher potential to win the game. The variables shots on goal and number of passes are calculated as average per match.

The last explanatory variable is *Total players' transfer income* (INC). If clubs want to be successful, they sometimes need to acquire new, better players. The one way to find resources to do it is a sale of current players. Presented truncated regression model has then the following form:

$$\hat{\delta}_i = \beta_0 + \beta_1 SG + \beta_2 PSS + \beta_3 GS + \beta_4 GC + \beta_5 INC + \beta_6 TURN + \beta_7 ATT + \varepsilon_i, \quad (1)$$

Where the $\hat{\delta}_i$ are double bootstrapped DEA CCR and BCC efficiencies computed in the first step.

2 Results

In this section, the results of research are summarized. Table 1 consists of descriptive statistics of input and output variables of DEA model. We can observe large differences in the dataset. The lowest numbers of expenses and wages is relatively low opposite to the highest number. Some teams are spending many financial resources, which could implicate the inefficient spending.

Tab. 1: Descriptive statistics of input and output variables of DEA model

Statistic	EXP	WAG	P
N	120	120	120
Mean	40.43	92.12	52.08
St. Dev.	36.08	55.03	16.30
Min	1.45	28	17
Max	179.77	233	89

In the table 2, the descriptive statistics characteristics of explanatory variables are presented. We can see again the biggest differences, as in the case of first-step variables, in the economic variables such as income, turnover and attendance. Some of the clubs did not sell the players, so they have zero income from this operation.

Tab. 2: Descriptive statistics of explanatory variables

Statistic	SG	PSS	GS	GC	INC	TURN	ATT
N	120	120	120	120	120	120	120
Mean	4.47	428.17	52.04	52.04	20.75	145.69	35,842.11
St. Dev.	0.97	76.26	15.08	12.30	26.10	101.64	14,283.37
Min	2.47	272.34	27	27	0.00	47	11,189
Max	6.79	581.76	102	85	124.27	515	75,530

Table 3 shows the results of efficiency, both CCR and BCC models. All results are calculated as an average for individual club. The sample consists of 32 clubs - 12 of them were in the EPL in each of the six seasons and seven of them were in the EPL for one season in researched period.

Tab. 3: Results of CCR and BCC DEA models

TEAM	N	CCR NB	CCR DB	BCC NB	BCC DB
Bournemouth	1	0.50256	0.48941	0.50614	0.47553
Arsenal	6	0.33614	0.31247	0.53251	0.44434
Aston Villa	6	0.34918	0.32664	0.38963	0.34819
Birmingham	1	0.73684	0.71606	0.73684	0.67559
Blackburn	2	0.60664	0.55562	0.68350	0.60598
Blackpool	1	1.00000	0.87464	1.00000	0.82383
Bolton	2	0.60575	0.54534	0.62797	0.54561
Burnley	1	0.81698	0.78782	0.96552	0.88205
Cardiff	1	0.40639	0.39568	0.52830	0.49290
Crystal Palace	3	0.52713	0.50848	0.54173	0.50527
Everton	6	0.67853	0.61327	0.78969	0.68946
Fulham	4	0.51178	0.46666	0.58856	0.53204
Hull City	2	0.53324	0.51881	0.57558	0.53444
Chelsea	6	0.26467	0.25670	0.39633	0.34634
Leicester	2	0.62167	0.60067	0.76013	0.64383
Liverpool	6	0.41799	0.40552	0.53313	0.47030
Manchester City	6	0.28041	0.26967	0.51243	0.43969
Manchester United	6	0.29992	0.28325	0.62482	0.51024
Newcastle	6	0.54197	0.50261	0.59744	0.53649
Norwich City	4	0.58362	0.55095	0.64142	0.58941
QPR	3	0.32772	0.31739	0.40843	0.37610
Reading	1	0.43701	0.39187	0.60870	0.52188
Southampton	4	0.58377	0.56776	0.66021	0.61124
Stoke City	6	0.65302	0.59488	0.67767	0.60879
Sunderland	6	0.43635	0.41885	0.44508	0.40777
Swansea City	5	0.60253	0.57383	0.64068	0.59089
Tottenham	6	0.52648	0.49875	0.69906	0.60646
Watford	1	0.55703	0.54267	0.56443	0.52922
WBA	6	0.61840	0.56904	0.65579	0.59146
WHU	5	0.48949	0.46826	0.53542	0.49134
Wigan	3	0.73827	0.69104	0.76336	0.68653
Wolverhampton	2	0.61404	0.58678	0.74723	0.67722

Note: (N – number of observations; QPR - Queens Park Rangers; WBA – West Bromwich Albion; WHU – West Ham United, DB – Double-Bootstrapped, NB – Not Bootstrapped)

Focusing on clubs that regularly reach the highest position in EPL (Arsenal, Chelsea, Tottenham, Liverpool, Manchester City, Manchester United), their efficiency is lower than average value (except Tottenham - BCC model). The first reason for this result is that while the variable number of points has its restriction, variables wages and players' transfer expenses are almost limitless.

Comparing to these clubs, efficiency of other clubs that reached position in the middle and the end of EPL table is higher. These clubs spent less money on purchase of players and subsequently wage expenses are lower too. Similarly to previous section: higher level of efficiency is balanced through position in EPL, which is not on the top of the table. The

results of efficiencies after double bootstrap is lower, and in some case it is significantly lower, which presumes the existence of hidden managerial decisions, which can be improved.

Tab. 4: Regression analysis results – DEA CCR

Dependent variable	DEA CCR Input Efficiency double bootstrapped		DEA BCC Input Efficiency double bootstrapped	
Explanatory variables	Truncated regression			
Intercept	7.5885e-01	***	5.8168e-01	**
SG	-1.0165e-02		-1.0187e-02	
PSS	-4.3882e-05		-3.8716e-05	
GS	4.1195e-03	*	8.3387e-03	***
GC	-3.5503e-03	**	-3.7051e-03	**
INC	-1.5320e-04		-3.8033e-04	
TURN	-1.5408e-03	***	-1.6297e-03	***
ATT	-7.4833e-07		4.1144e-07	
Sigma	1.3332e-01	***	1.3898e-01	***
Log-Lik (df)	71.75 (9)		67.859 (9)	
R ²	0.5612		0.5067	

(Note: significance lvl. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.)

In table 4, the results of regression analysis are presented – the dependent variable is efficiency of DEA CCR model and BCC model. Depending on the regression used, three explanatory variables (goal scored, goal conceded and turnover) have both positive and negative statistically significant impact on dependent variable. Other explanatory variables are not statistically significant. According to the results, model using CCR DB efficiencies is more significant than BCC DB.

3 Discussion

Based on the results of DEA - there are clubs which are not efficient, but reach top positions. There are efficient clubs, but do not reach top positions. Does exist the way to be efficient and reach top positions in the same time? Technically, yes. The easiest way consists of three steps: do not purchase expensive (or any) players, stabilize wages on the average level and get more point than opponents. Of course it is a utopian and unrealizable idea which excludes a number of internal and external variables affecting the outcome. One way how to ensure higher efficiency is to buy undervalued players, as proposed in (Zambom-Ferraresi, Lera-López, et al. 2017). These results could be linked to the expectations and aims of each club. Our results are different than the other studies (Zambom-Ferraresi, Lera-López, et al. 2017). It is also based only on the use of selected input and output variables. The results of DEA analysis are relatively expected. Obviously, the club that will promote to the EPL will try to not relegated from the EPL in the next season. On the other hand, the goal of traditionally successful clubs

is to win the league, or achieve a position guaranteeing the participation in Champions League, or European league in next season.

Conclusion

The aim of the study was to find out whether selected variables have impact on dependent variable expressed as result of CCR and BCC DEA. We have used two-step DEA, in the first step financial variables were used as inputs and sport oriented variable as single output. The combination of such factors using input oriented model, which assumes that inputs are adjustable by managers, looks like right approach. We have found that the top ranking clubs are likely to spend resources inefficiently. Explanatory variables were both financial and sport-related. These variables are common use variables to evaluate sport efficiency through DEA. We identified three statistically significant variables: goal scored, goal conceded and turnover. The results showed that clubs should focus on the efficiency of sporting processes, because if a club reduces the number of passes and shots on goal at the same time while increasing the number of goals scored and reducing the number of goals conceded, it could increase its overall efficiency. Unlike economic indicators, where it can be stated that high revenues from player transfers, or high club turnovers tend to lower efficiency.

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