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Productive efficiency of Premier League teams using an enhanced data envelopment analysis approach

Jan Šíma, Josef Voráček, Jiří Kraft, Veronika Krause*

Department of Sport Management, Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic
* Corresponding author: nika.krause@seznam.cz

ABSTRACT
The study focuses on evaluating the economic efficiency of professional football clubs. It builds on the Haas Study, which examines the effectiveness of individual clubs through Data Envelopment Analysis (DEA). DEA analyses different types of inputs and outputs for homogeneous production units (in this case football clubs). The thesis proposes the modification of this model. The author considers the initial "hometown population" contribution of Haas as particularly outdated with regard to the increasing commercialisation of professional football and globalisation of the market, where the size of demand is primarily determined by the global popularity measured in terms of interest of the fans, sponsors, and television broadcasting companies. The global popularity of the club can easily be estimated at present using the number of fans in social networks. The clubs reflect this target on the side of the outputs – "increase of the number of fans in the social network". Facebook was chosen as the representative of the social networks. The proposed model is used in the paper for calculation of the economic efficiency of the participants in the English Premier League in the 2016–2017 season.

KEYWORDS
football club; social network; DEA-BCC

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INTRODUCTION

The efficiency evaluation of professional football clubs is carried out in many expert studies. Most authors agree that the highest league competitions can be described as imperfect competition with cartel elements (Kesenne, 2003; Fort & Quirk, 2004;

Andreff & Bourg, 2006). Professional clubs as a whole negotiate the conditions for the sale of broadcasting rights, and they act in the same way when entering into sponsorship agreements for the entire league competition. According to Szymanski & Kesenne (2004), they make use of the exclusivity principle, when they are the only entity on the given market offering the given product. Unlike industry sectors, however, sporting production would not exist without cooperation between companies and clubs that compete with each other (Fort & Quirk, 1995; Flynn & Gilbert, 2001; Pawlowski & Nalbantis, 2015).

The specificity of a sports cartel, according to Kesenne (2000), is that clubs need to compete in the sporting sense of the term (the winner and the loser), but they need to closely cooperate and support each other at the same time. This is not about maximising profit in a purely theoretical and economic sense. In order to maintain the league, clubs consciously renounce part of their profits, and there is a certain reallocation of profits within the league. This principle, according to Fort & Maxcy (2003), aims to slow down the growing gap between rich clubs and those that are less financially successful. Rosen & Sanderson (2001) discuss a curious combination of collaboration and competition that is natural for professional sport.

Despite the above, clubs must primarily focus on their investments and evaluate their effectiveness in achieving sporting or economic goals. According to several authors, this can be solved economically by means of a production function or production boundary (Scully 1974; Sommers, & Quinton, 1982; Hofler & Payne, 1997; Dawson et al., 2000; Carmichael et al., 2017). A club tries to achieve the highest possible value of outputs by means of input transformation. The goal of an economic entity is to make this transformation as efficient as possible. As professional clubs can be seen as economic entities, traditional economic models measuring effectiveness can also be applied to them.

Scully (1974) was the first to examine the relationship between the sporting performance of a baseball player and the size of their salary by means of production function. He responded to the 1972 player strike, which began solely because of the players' salaries. The result of the strike was the introduction of a salary arbitrage and a pension fund for players. The amount of players' salaries did not correspond to their economic contribution to the team, and Scully (1974) tried to resolve this issue. Scully (1974), by his work, has developed an initial methodology and laid down the foundations for examining effectiveness not only in baseball, but also in other sports. In the following years, many economists built on Scully's work, and the topic of examining efficiency with regard to sporting performance is still current today.

Sommers & Quinton (1982) in their research also focused on baseball players' salary and the performance of free players (free agents) this time, who, after signing a long-term contract, did not perform as expected by fans and experts. Zak et al. (1979) examined the production boundary at basketball clubs, using only game performance indicators as inputs and outputs.

We can also find a great deal of research in football evaluating effectiveness by examining multiple inputs and outputs, such as in Carmichael et al. (2000) early research, that explored the English Premier League clubs' performance. A study conducted by Carmichael et al., 2017, which examines effectiveness through game performance indicators in the English Premier League and Italian Serie A during the 2015–2016 season, can be viewed as very up to date.

The second group of research is focused on sports teams' coaches and managers. Dawson et al. (2000) examined the effectiveness of using various inputs by way of the example of the English Premier League. Koning (2003), on the other hand, examined whether the team's results would be improved after a coach was dismissed and a new one was hired. By way of the example of the Dutch Football League, unlike the previous findings within the literature, he found no economic support for claiming that the dismissal of a coach leads to better team results.

Research that examines long-term factors can be included in the last area evaluating the effectiveness of professional sports clubs. Most of the features are typical for one competition season, the number of points gained, total revenues, total costs, etc. We can point to the research by Carmichael & Thomas (1995) here, who created a production function for the evaluation of professional rugby teams, and to Hofler & Payne (1997) on the effectiveness of basketball clubs in the American NBA.

Dieter J. Haas is a pioneer in the research of football competitions, who applied findings from other sports research to football competitions in Germany, England, and the USA. Haas (2003a, 2003b) and Haas et al. (2004) examined the effectiveness of football clubs through Data Envelopment Analysis (DEA), specifically the Charnes-Cooper-Rhodes (CCR) and Baker-Charnes-Cooper (BCC) models.

In his first research, he compared the effectiveness of German Bundesliga football clubs during the 1999–2000 season. As an input, he chose annual salary costs and separated them for players and coaches. Among the outputs there was the number of points gained, the club's total income, and the stadium's occupancy during home matches. Haas (2003a) focused his other research on the Premier League and, unlike the previous research, added one additional input to the selected inputs – the population of the club's home city. At the same time, Haas (2003a) removed the stadium's occupancy during home matches from the examined outputs. In the research, he concluded that the club's sporting results alone would not guarantee its maximum efficiency. Ineffective teams most often spent too much money on the players' team and the coach's salary, which did not result in the expected achievements.

Other experts then built on Haas's (2003a) work. The effectiveness of the highest French competition using the CCR and BCC model was examined by Jardin (2009). The inputs of the DEA model included the total salary cost and the size of the population of the city where the club was based. The outputs included the number of points gained and the club's annual turnover.

The effectiveness of English Premier League clubs was examined by Barros & Leach (2006), who again applied CCR and BBC models, but used different inputs and outputs. The inputs for the purposes of their research included total wage costs and the club's net asset value. The observed outputs included the number of points, total attendance, and annual turnover.

One of the last survey studies concerning Premier League clubs is the work of Badmus et al. (2017). They measured the efficiency of clubs from 2005 to 2015. The variables on the input side included the total wage expenses, annual consumption of assets, and total number of club employees. The standard outputs of other studies (number of points, annual turnover) were expanded with the Rate of Attraction. This newly created indicator is the percentage of wins multiplied by the number of the population in the given country in which the football competition is taking place.

There is a lack of consensus among the individual authors regarding the phenomenon of optimal inputs and outputs for measurement of the productive efficiency of the football clubs. The presented efficiency assessment procedures are used for optional discussion of the economic approaches of the professional football clubs. This article should contribute to this discussion.

AIM

The study examines the productive efficiency of football clubs that played in the highest English Premier League competition during the 2016–2017 season. The goal was to introduce a new approach of measuring efficiency of a football club and determine the clubs that were effective (achieved the so-called "effective boundary") and the ones that were not effective. The effectiveness of individual clubs is examined through a multi-criteria decision-making method known as DEA. The model inputs include player salaries and coach salary. The outputs include the number of points gained in the season, total club revenue, and the increase of the number of followers on the Facebook social network. Based on a comparison of production units, the model will determine the effective and non-effective units.

METHODS

To measure the productive efficiency of football teams from the English Premier League, this study uses Data Envelopment Analysis (DEA). DEA estimates the effective boundary for the monitored set of units, determines which units are effective, and calculates deviations from this effective boundary for ineffective units (Charnes et al., 1994).

The use of the DEA method is particularly beneficial in cases where a large number of inputs and outputs need to be considered for a decision-making unit (DMU). The main advantage is the non-parametric character of the model, which makes it unnecessary to know the precise shape of the production function or the mutual functional relationships between the inputs and outputs.

The DMU in this study is a football club that participated in the Premier League competition during the 2016–2017 season. By comparing 20 professional football clubs, the following questions were answered: Which football clubs were effective in the analysed period and which could have worked better? What are the specific weaknesses of inefficient teams?

An important step towards the most accurate effectiveness assessment is the choice of appropriate inputs and outputs that must have significant impact on the performance of the unit. The selection of entries and outputs for individual football clubs was based on Haas' (2003a) study, which analysed the effectiveness of the Premier League clubs during the 2000–2001 season using the DEA. Two inputs were chosen for evaluation of the efficiency of the Premier League clubs in the 2016–2017 season – the salaries of the players and the salary of the manager, as described above. Both inputs may be very easily influenced by the club management. According to Freyer (1991), there are three production function outputs that reflect three objectives – sports, economic, and social. The sports objective of the club is represented by the number of points won

in the domestic league competition. The economic objective is represented by the club's overall income. The social objective is represented by the number of fans in the social networks. Specifically, the increase in the number of fans on the club's official Facebook site is monitored from 1 June 2016 to 31 May 2017. Facebook was selected as the sole representative of the social networks. It is the largest social network worldwide, has more than 1.5 billion active users, and has been fully translated into 84 world languages (in 2016). Moreover, from the work of Williams (2016) it follows that the ratio of fan representation in other social networks (Twitter, Instagram, YouTube) approximately corresponds with the ratio of representation on Facebook. The number of fans in the social networks primarily provides information about the global popularity of the club, not only in England.

To measure the efficiency for a selected sample of Premier League football clubs, the CCR and BCC models were chosen. Both are input-oriented models. These are applied as inputs change more easily than outputs in the context of football clubs.

The first model (CCR) assumes a constant return to scale in efficiency evaluation. The DEA models facilitate obtaining an efficiency rate estimate for units of the monitored set, but also, based on this rate, provide information on how the behaviour of the evaluated unit should be improved in order to make the unit effective. This is achieved by converting the primary model to a dual model.

The dual CCR model is input-oriented (1):

$$
\begin{aligned}
&\text{Minimise} && \theta_q - \varepsilon\left(\sum_{j=1}^{m} s_j^- + \sum_{k=1}^{r} s_k^+\right) && \\
&\text{subject to} && \sum_{i=1}^{n} x_{ij}\lambda_i + s_j^- = \theta_q x_{qj}, && j = 1,2,\ldots,m, \qquad (1)\\
& && \sum_{i=1}^{n} y_{ik}\lambda_i + s_k^+ = y_{qk}, && k = 1,2,\ldots,r,\\
& && s_k^+ \geq 0, && k = 1,2,\ldots,r,\\
& && s_j^- \geq 0, && j = 1,2,\ldots,m,\\
& && \lambda_i \geq 0, && i = 1,2,\ldots,n.
\end{aligned}
$$

where x represents the input units and y the output units, λ is a dual variable that is a constraint on the individual units. Another variable is θq, which determines the effectiveness of a given unit. Vectors s+ and s- are vectors of the slack variables for the inputs and outputs (Dlouhý et al., 2018).

By compiling this dual model, we determine the particular units forming a sample (virtual) unit set for the examined inefficient unit. The relative effectiveness rate of the examined unit can be calculated using these units.

The CCR model assumes a constant return to scale, and the effective boundary forms a conical cover. In 1984, Banker et al. (1984) proposed a modification of this

model that considers a variable return to scale (growing, declining, constant) – the BCC model.

To analyse the efficiency of units when considering variable return to scale, the model (1) extended by the condition of convexity (2) is now used:

$$\sum_{i=1}^{n} \lambda_i = 1 \quad (2)$$

For the purposes of this study, two programs were used which enable the problems of linear programming to be resolved: Microsoft Excel Solver and MDeap 2. Table 1 contains the input data. The data was collected from reputable sources.

Table 1 Raw data for the Premier League season 2016–2017

Final rank	**Club**	**Player's salaries × M £**	**Coach's salaries × 1000 £**	**Points**	**Revenue × M £**	**Increase of Facebook followers × 1000**
1.	Chelsea	221	6,500	93	368	1,901
2.	Tottenham	127	3,500	86	306	624
3.	Man. City	264	15,000	78	473	4,768
4.	Liverpool	208	7,000	76	364	1,476
5.	Arsenal	199	8,300	75	427	1,579
6.	Man. United	263	13,800	69	581	3,907
7.	Everton	105	6,000	61	171	315
8.	Southampton	112	3,200	46	182	180
9.	Bournemouth	72	750	46	139	72
10.	West Brom	79	2,000	45	138	81
11.	West Ham	95	3,000	45	183	467
12.	Leicester	112	1,500	44	233	813
13.	Stoke	85	900	44	136	406
14.	Crystal Palace	89	1,500	41	125	101
15.	Swansea	99	1,000	41	128	73
16.	Burnley	61	420	40	121	61
17.	Watford	75	1,250	40	124	65
18.	Hull City	61	1,000	34	117	41
19.	Middlesbrough	65	355	28	121	29
20.	Sunderland	84	3,000	24	126	164

Source: Annual Review of Football Finance 2017, www.footballtransfers.net, www.statista.com

RESULTS

Application of the CCR model

An efficiency analysis of Premier League football clubs was carried out according to the CCR input-oriented model. The model considers a constant return to scale and can be considered more stringent than the second BCC model used. The resulting efficiency values of individual teams are shown in Table 2.

Table 2 Efficiency in the CCR model

	Club	Effectivity
1.–7.	Tottenham	1
1.–7.	Manchester City	1
1.–7.	Manchester United	1
1.–7.	Leicester	1
1.–7.	Stoke	1
1.–7.	Burnley	1
1.–7.	Middlesbrough	1
8.	Bournemouth	0.97
9.	Arsenal	0.92
10.	Chelsea	0.91
11.	Hull City	0.88
12.	Everton	0.86
13.	West Brom	0.84
14.	West Ham	0.81
15.	Watford	0.80
16.	Liverpool	0.78
17.	Crystal Palace	0.69
18.	Southampton	0.67
19.	Swansea	0.63
20.	Sunderland	0.62

Source: own

The CCR input oriented model designated a total of seven clubs as efficient. These clubs achieved one hundred percent values and are marked number one in the table. 13 clubs are designated as non-efficient in the CCR model while the worst was Sunderland AFC, which coincidentally also ended last in the Premier League Table and was demoted from this competition.

DEA analysis also states ineffective clubs with information on the circumstances under which teams would be effective in the given season (Table 3).

Table 3 Input and output optimization in the CCR model

Club	Player's salaries	Coach's salaries	Points	Revenue	Facebook followers
Bournemouth	–3%	–3%	0%	+3%	+62%
Arsenal	–8%	–19%	+27%	0%	0%
Chelsea	–9%	–9%	0%	0%	0%
Hull City	–12%	–12%	+5%	0%	+270%
Everton	–14%	–59%	0%	+27%	+41%
West Brom	–16%	–16%	0%	+14%	+268%
West Ham	–19%	–22%	+7%	0%	0%
Watford	–20%	–20%	0%	+6%	+166%
Liverpool	–22%	–22%	0%	0%	0%
Crystal Palace	–31%	–31%	0%	+8%	+76%
Southampton	–33%	–35%	+11%	0%	+107%
Swansea	–37%	–37%	0%	0%	+39%
Sunderland	–38%	–52%	+48%	0%	+56%

Source: own

The fact that the model proposes to reduce the input level to achieve efficiency is based on the application of an input-oriented model. If a mere reduction in inputs does not lead to reaching the effective boundary for inefficient teams, the model also suggests an increase in inputs. Optimisation results suggest that only two of the teams (Chelsea and Liverpool) would achieve the effective boundary by solely reducing inputs.

The achieved objectives in the form of outputs are indicated in the case of the non-efficient clubs by the high salaries of the players and managers. Their reduction is the path to efficiency. The model recommends reduction of the salary expenses in three clubs by more than one third (Southampton, Swansea, and Sunderland), both in the case of the players and the managers.

Application of the BCC model

Table 4 Efficiency in the BCC model

	Club	Effectivity
1.–10.	Chelsea	1
1.–10.	Tottenham	1
1.–10.	Manchester City	1
1.–10.	Manchester United	1
1.–10.	Bournemouth	1
1.–10.	Leicester	1
1.–10.	Stoke	1

	Club	Effectivity
1.–10.	Burnley	1
1.–10.	Hull City	1
1.–10.	Middlesbrough	1
11.	Arsenal	0.97
12.	West Ham	0.91
13.	Everton	0.87
14.	West Brom	0.86
15.	Watford	0.83
16.	Liverpool	0.83
17.	Sunderland	0.78
18.	Southampton	0.74
19.	Crystal Palace	0.71
20.	Swansea	0.64

Source: own

The BCC input-based oriented model identified a total of ten teams as effective based on analysis (Table 4). The remaining ten clubs do not reach this value, and thus they are inefficient in this model. The worst of them was the Swansea team, which only achieved 64% of the required efficiency. Due to the assumption of variable return to scale, not only the number of effective units but also the order of the units in the table are different.

DEA analysis provides inefficient clubs with information on the inputs under which teams would be effective in case of the BCC model as well. The optimisation results for the model with variable inputs are shown in Table 5.

Table 5 Input and output optimization in the BCC model

Club	Player's salaries	Coach's salaries	Points	Revenue	Facebook followers
Arsenal	–6%	–3%	+5%	0%	+31%
West Ham	–9%	–35%	+6%	0%	0%
Everton	–13%	–70%	0%	+20%	+1%
West Brom	–14%	–62%	0%	+2%	+51%
Watford	–17%	–62%	+2%	0%	+9%
Liverpool	–23%	–17%	0%	0%	0%
Sunderland	–22%	–75%	+7%	+2%	0%
Southampton	–26%	–55%	+2%	0%	+37%
Crystal Palace	–29%	–62%	0%	+1%	0%
Swansea	–36%	–46%	+2%	0%	+14%

Source: own

Only Liverpool would achieve efficiency solely by reduction of the inputs. The remaining ten non-efficient teams must also increase the number of points won, size of income, or number of fans on Facebook in order to achieve the effective threshold. The level of the inputs for one hundred percent efficiency would again require the highest reduction in the case of Southampton, Swansea, and Sunderland, to which the BCC model also added Crystal Palace.

It is clear from the results that the BCC input-oriented model identified more clubs as effective than the CCR input-oriented model, which corresponds to the theory of DEA analysis as described by Cooper et al. (2004).

The average efficiency of a Premier League club in the CCR model is 87%, and even 91% in the BCC model. This high value indicates that the English clubs act very efficiently in the transformation of inputs to outputs. Moreover, the average value is substantially reduced by four clubs – Sunderland, Southampton, Swansea, and Crystal Palace, whose efficiency is not even 80%.

The DMUs make an effort to minimise the value of the inputs and maximise the value of the outputs with the objective to achieve the highest profit (or suffer the least losses). In spite of this, we can see from the results tables that the clubs can achieve the efficiency thresholds in very different ways. Clubs that use smaller inputs are at an advantage because the outputs need not reach a high level and, even in this case, the club can achieve the efficient threshold. An example may be Burnley F.C., which has the least total expenses in the Premier League in terms of players' and manager's salaries but is evaluated as efficient by both models. Another example may be AFC Bournemouth, whose input values also ranked among the lowest in the entire competition. Although it also had relatively low income on the output side, it ranked in the first half of the Premier League Table. Its function may be considered as efficient. The club fulfilled its sports objective, and successfully remained in the competition with relatively low salary costs. The club fans were also probably satisfied with this result.

Other Manchester clubs – United and City – achieved efficiency almost in the opposite way. They coped with all the economic indicators of the competition. Of all the Premier League clubs, they spent the highest amounts. Both clubs were also dominant on the income side and acquired the largest number of new fans on Facebook. The excellent results of these two outputs resulted in the models evaluating the clubs as efficient. Despite this, their fans may perceive the 2016–2017 season as unsuccessful because Manchester City ranked third on the table and United was sixth.

Tottenham achieved efficiency using a third approach that we can term as the middle course. It spent 127 million British pounds on players' salaries, which is only slightly higher than the entire Premier League average (123.8). This London club paid a salary in the amount of 3.5 British pounds to manager Mauricio Pochettino, which in comparison with other Premier League managers is below average. Tottenham achieved second place with this expenditure in the 2016–2017 season, which guaranteed the club's participation in the Champions League in the following season. It exceeded the average income of the clubs in the Premier League (228.15 million British pounds) by almost 80 million and the increase in the number of fans on Facebook was also above average as compared with other clubs.

Based on the results, we can say that there is no general way to enable efficiency maximisation for each club. The club's strategy must be adapted to its sporting and

economic potential, according to which the club must then set its goals and steps to achieve them.

DISCUSSION AND CONCLUSION

The study brings a new methodical approach to the assessment of the production efficiency of professional football clubs. Unlike the approach of Haas (2003a), who as an input for production analysis uses, among others, the number of the population in the area where the club has its seat, the study suggests exclusion of this input from the model and on the contrary to include the number of fans (increase or decrease) among the inputs. The clubs make an effort to not only actively win a larger number of fans through their own performance on the field, but also directly via their marketing activities.

Haas (2003a) justifies the inclusion of the city's population as an uncontrollable variable (clubs cannot affect it) because clubs come from different parts of the country where the population density, as well as the demand for the football product, is different, which affects the clubs' potential income. This idea is later supported by Jardin (2009), who states that a larger population means a bigger fan base, which brings higher income from entry tickets and stronger merchandising. The inclusion of the home city population in the Data Envelopment Analysis was justifiable at that time. The football environment was characterised by the fact that most of the club's fans were local residents. The residents of the city and the surrounding area attended the matches, bought club souvenirs, and were a significant source of the club's income. Especially for the Premier League's average clubs from the result and economic point of view, it was not unusual to be supported by larger groups abroad.

Since the original research (Carmichael et al., 2000; Haas, 2003a; Haas et al., 2004; Barros & Leach, 2006), professional football has changed, and globalisation has greatly influenced it. This trend is clearly visible by the example of the English Premier League.

The Premier League competition during the 2016–2017 season included players of 64 nationalities and was watched by 4 billion people from over 150 countries each week on TV (Eurosport, 2017). With the internet and social networks, clubs communicate with fans on an everyday basis, no matter which part of the world they come from. The geographical location of the fans is losing importance in today's interconnected world, and almost anyone can become a fan of the club.

Local residents are gradually losing the power they once had. This trend is most evident in big clubs, such as Manchester United, Chelsea, and Arsenal. The London club, Chelsea, has official fan clubs in 80 countries around the world, Arsenal in 79 countries, and Liverpool in 67 countries (Eurosport, 2017). The importance of foreign fans and sponsors is also highlighted by statistics of pre-season tours and camps that are used by clubs for marketing purposes, in addition to sporting preparation. Before the 2016–2017 reference season, the clubs visited 15 countries around the world during the pre-season tour. Countries with large populations including the USA, China, and Australia, where clubs see the highest number of potential fans and hence higher potential incomes (Eurosport, 2017), were the most visited.

Merchandising has a significant impact on the club's revenues. Not only in the brick-and-mortar shops but mainly on the Internet, which substantially eases sales worldwide. Clubs with large worldwide fan bases are also attractive to sponsors, often

from the ranks of the wealthy supranational companies. The interest of foreign fans is further reflected in rising revenues from the sale of TV rights. An increasing number of fans is therefore a logical objective.

The ideal feature according to which we can assess the current global interest in football clubs is offered by social networks. Each club in the Premier League has its official profile on Facebook, Twitter, and Instagram (Williams, 2016). Social networks today represent an indispensable tool for clubs to communicate with their fans. The total number of fans on the club's profile is then related to the club's popularity around the world.

The Facebook social network was chosen as the social network representative, and football clubs have the largest number of fans there (Williams, 2016). Twitter, Instagram and Youtube are among the other social networks used by the Premier League clubs. The proportion of fans of individual clubs on these other social networks approximately corresponds to the proportions of fans of individual clubs on Facebook (Williams, 2016). Additionally, a number of fans follow their favourite club on more than one of the social networks mentioned above, so there may be a misrepresentation of the resulting number of fans.

Differences in the number of clubs' Facebook followers are enormous. English clubs Manchester United, Chelsea, Arsenal, Liverpool, and Manchester City are known all over the world, and their profiles on Facebook are followed by tens of millions of people. It is not a coincidence that these clubs generate the highest income.

Inputs are the salaries of the players and the salary of the coach. The first input was selected based on Szymanski & Smith's (1997) approach, which evaluates the quality of the team based on the amount of the financial salary costs. However, Haas (2003a) distinguishes only players' and coach's salaries, not the salary of other staff that has no direct influence on team performance.

An important factor of the absolute amount of wage costs for players is not only the value of individual salaries, but also the size of the player's team. Successful clubs that participate in European Cups in addition to the League Competition are forced to have a larger number of players, so that the team is able to cope with the match load.

The team also has a larger number of coaches, but the main coach's salary was still only considered as the second input. We rather find the term "manager" in English clubs. It is solely this person who manages other coaches and cooperates with other club employees. The job of a manager can vary greatly across clubs, and it is impossible to claim that they influence the club's performance the most of the entire team.

Another problem situation for evaluating the effectiveness of the coach's (manager's) activity occurs when the club executives dismiss the manager during the season. However, in this study only the salary of a manager who started the 2015–2016 season with the club, even though they were dismissed or resigned, was considered. The immediate change of the coach does not necessarily lead to a guaranteed improvement in sporting results, as Koning (2003) says, and, in addition, it can be assumed that the amount of the new coach's salary will be similar.

The effectiveness of coaches is, particularly in team sports, a phenomenon that has often been studied. It is obvious that a coach (manager) influences team performance (Clement, & McCormick, 1989; Dawson et al., 2000). As in the case of players, the high demand for the best coaches forces club management to pay coaches increasingly higher wages.

Three outputs were selected for the requirements of this research. Achievement of the sports objective is represented by the number of points obtained in the league competition. The economic objective is represented by the total revenues of the club. The social (or marketing) objective in the form of acquisition of new fans is monitored through changes in the number of fans on Facebook within one year.

The first output represents the club's sporting success in the league competition. The number of points gained determines the ranking in the final table, on the basis of which the overall winner is designated and the clubs that have qualified for European Cups are designated. The three teams at the end of this ranking drop into the league competition below. It is obvious that ranking in the league table is the main sporting goal of each football club. It is a basic output that positively correlates with the fans' interest in the club and the amount of income earned.

The second output, the club's total income, serves as an indicator of the team commercial output and primarily consists of the share of the TV rights sale, income from sponsorship, merchandising, and the sale of tickets. Financial success is, to a large extent, linked to sporting success. Sporting success in both domestic and European competitions is linked to significant rewards for the achieved ranking. There is also an increase in fans' interest in the club, where the attendance at home matches or the sale of club merchandising increases. At the same time, sponsors are more interested in concluding a contractual partnership with the club.

The third output is change in the number of fans on Facebook. This output represents the modification of the current approaches to the assessment of productive efficiency. It takes into account the objective of the club to win new fans. Football is played for the fans. Without fans, football would lose its meaning.

The argument for modification of the current models was the ever-increasing commercialisation of football associated with globalisation, where people worldwide can become active club fans. Their allegiance to the club need not be expressed by their presence at the stadium, but also by support of the club on social networks. Through the social networks fans get the feeling of belonging to the club, which leads to motivation for long-term support of and identification with the club. The social objectives in a modern world full of social networks are becoming one of the most important factors, an integral part of the club's image and spread of club harmony (Going Global, 2017). The club's interest in winning new fans and keeping the "loyal" fans in the modern concept of professional sport is becoming another battlefield on which all clubs are competing. Of course, this leads to a competitive struggle between the clubs, and improvement of the quality of the offered products and services. The continuous efforts at improvement usually attract more fans of the given sport. According to Madden (2012) this increases the number of viewers, quality, and balance of the competition.

Regardless of the social aspect, the focus on the fans is also economically prudent. Every new club fan represents potentially higher revenues for the club in the form of ticket sales and merchandising. This also increases the interest of the sponsors who want to present themselves to the fans. The increasing interest of the fans in the clubs and in the entire competition is also manifest in the rising price of television rights. It is this interest that is dominant in the English Premier League.

As mentioned above, Data Envelopment Analysis (DEA) estimates the effective boundary for the monitored set of units. It also determines which units are effective

and calculates deviations from this effective boundary for ineffective units (Charnes et al., 1994). Ineffective units are clubs that did not reach the effective border. To prevent this, they would have to have a lower level of inputs, as indicated in Tables 3 and 5.

However, these results cannot be seen as clear recommendations of input reductions to clubs, for example, for the following seasons. For example, if the London club, Arsenal, achieved the adjusted values the following season, just as the model suggests, it would not guarantee it would achieve 100% efficiency. The values of other clubs would also change, a new situation would appear for measuring efficiency, and there would probably be an effective boundary shift. Thus, the results as indicated in Tables 3 and 5 only express the hypothetical situation in which clubs would be effective in the reference season. They can be the basis or inspiration for thinking about lowering input levels.

The model presented in this study, designed to evaluate the sporting and economic efficiency of clubs, cannot and does not seek to provide specific recommendations for future periods. The model only identifies a situation in which clubs would be effective and compares the club's effectiveness with other competition participants. The model sets out the conditions under which all clubs would be effective, although in reality it is unlikely.

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