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## Measuring the Efficiency of Football Clubs: Empirical Evidence From Professional Czech Football

### Abstract

Football is a very popular sport in the Czech Republic. However, like clubs elsewhere in Europe, Czech clubs are currently facing some hurdles. The expenditure levels of some of these clubs are considered excessive. What is more, results on the field are not always forthcoming. The aim of this paper is to propose a method for evaluating the performance of football clubs based on data envelopment analysis (DEA). Professional Czech football clubs playing in the Czech football competition Fortuna:Liga were selected for empirical analysis. Fortuna:Liga is the major football league in the Czech Republic. The performance evaluation of Fortuna:Liga football clubs is an important reference for team managers. To analyse the relative efficiency of football clubs, two frequently used models were employed, the Banker Charnes Cooper (BCC) and the Charnes Cooper Rhodes (CCR) model. The study was conducted on a sample of 20 clubs through 2 inputs and 1 output collected during the 2015/16–2019/20 seasons. The results show that Czech football clubs achieved a relatively high level of efficiency in the period monitored and that traditional clubs achieved the highest efficiency score. These results could help club managers improve the performance of their teams.

### Key Words

*efficiency, data envelopment analysis, sport, football, Fortuna:Liga, Czech football*

**JEL Classification: C10, L83, C67, C44**

## Introduction

Professional sports competitions attract millions of spectators worldwide and, among other advantages, also create a significant amount of jobs and business opportunities. Sports activities then expand further and reach other critical economic sectors, such as hospitality, the media, or tourism. Due to their international importance, sports competitions are also an essential element in promoting international trade. One of the world's most important sports competitions is mainly football competitions, which are extremely important for their economic and social activity. In the Czech Republic, professional football clubs are represented by a professional football league (Fortuna:Liga). The analysis performed in 2015 confirmed that the economy around the first and second football leagues is a full-fledged part of the Czech economy. The total consumption associated with the organization of Fortuna:Liga and Fortuna:Národní Liga represents more than 3.6 billion crowns; the benefits to the state budget amount to more than one billion crowns. Both professional Czech football leagues create around 6,000 full-time jobs (LFA & 2Score, 2021).

Although football clubs operate within the same legal framework as other companies, they are a particular type of business due to being mainly conditioned by sporting activities. The question, therefore, arises as to how to measure the performance of football clubs. Some studies mainly show a positive relationship between sports and financial performance. In this context, there is a need to recommend football managers' practices that could help clubs achieve both sports and business achievements. In this paper, a method of evaluating the performance of football clubs based on data envelopment analysis will be proposed.

## **1. Data Envelopment Analysis**

The central part of this is the research of competitiveness and performance of Czech professional football clubs playing the highest competition Fortuna:Liga, through the method of data envelopment analysis (further DEA). DEA is used as a specialized modelling tool for evaluating the efficiency or productivity of a group of comparable decision making units (further DMUs). In this article, these units are football clubs playing the highest competition of Fortuna:Liga.

The use of the DEA method for evaluating the productivity of football clubs seems to be appropriate mainly because not only one variable is evaluated here, but a set of different variables (Dlouhý et al., 2018). In general, DEA models are based on the inputs and outputs of the evaluated units and then compare the efficiency with which the football club can transform its inputs into outputs, i.e. the extent of the outputs the football club can achieve with the number of available inputs (Jablonský and Dlouhý, 2004).

Another fundamental term is production possibility frontier. This frontier consists of a set of those units that are considered the most efficient within the production possibility set. If a unit is outside the production possibility frontier, it is considered inefficient (Ji and Lee, 2010).

In general, DEA models can be divided according to the model's orientation into input-oriented, output-oriented, and non-oriented models. Further sorting of DEA models can be done based on the nature of the production process. In this case, a distinction can be made between models based on the assumption of constant returns to scale, e.g., the Char-Cooper-Rhodes (CCR) model, and models based on the assumption of variable returns to scale, e.g., Banker-Charles-Cooper (BCC) model (Cooper et al., 2011).

## **2. Fortuna:Liga**

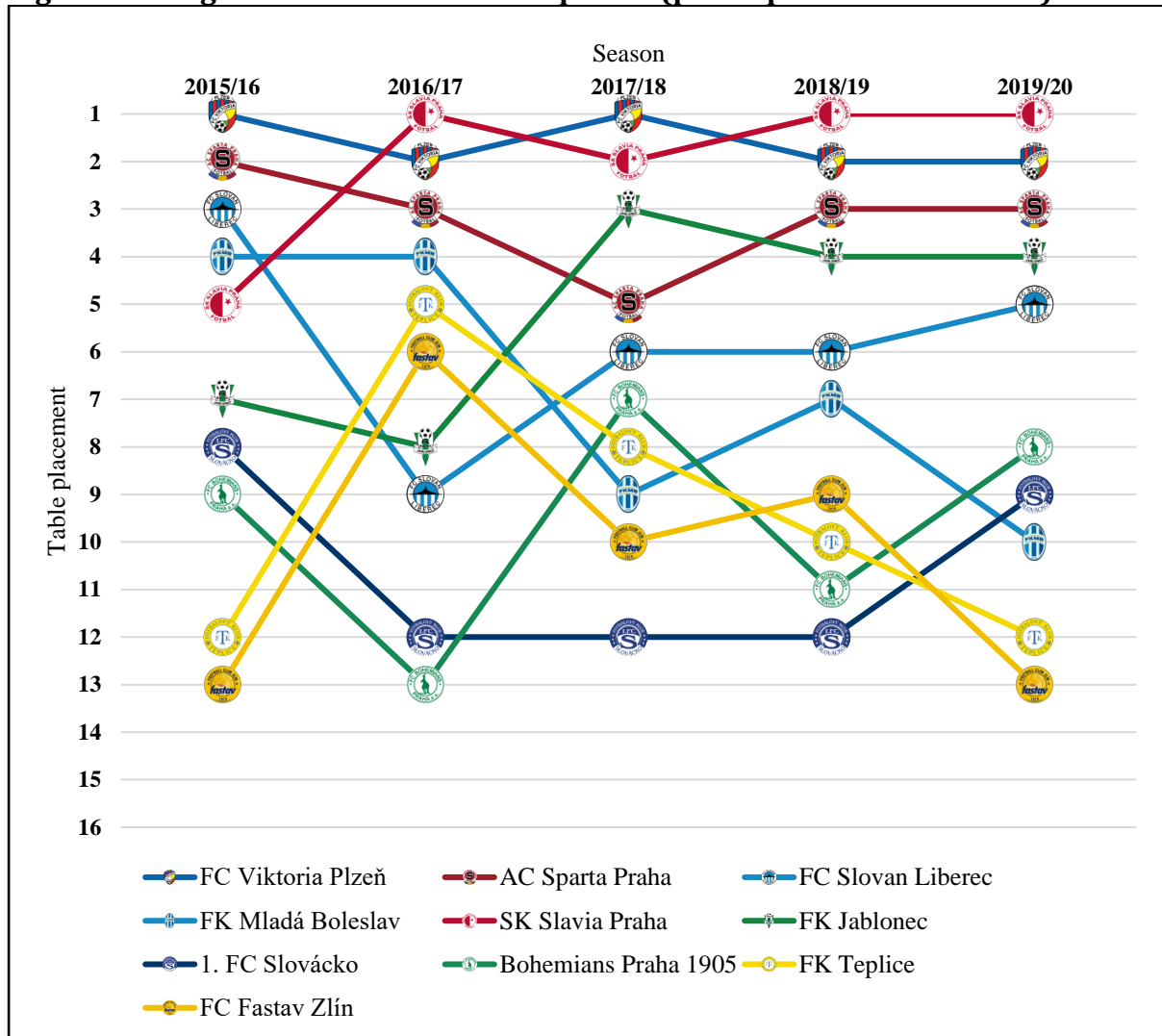
A total of 16 teams from Bohemia, Moravia, and Silesia participate in the Czech highest football competition. Historically, the most successful club has been Prague AC Sparta with 36 titles, followed by SK Slavia Prague with 20 titles. In the last five seasons, the Czech leagues have been dominated by the FC Viktoria Plzeň and SK Slavia Praha teams (Fortuna:Liga, 2020).

Since the 2018/19 season, the Czech highest football competition has been officially named Fortuna:Liga. Only three teams have participated in all 27 years of the independent Czech league (since 1993): AC Sparta Praha, SK Slavia Praha and FC Slovan Liberec. These teams are also in the first three places of the historical table, which is the sum of all league seasons since the beginning of the independent Czech highest competition (Fortuna:Liga, 2021).

An overview of the ranking of clubs that participated in all five seasons researched is shown in Figure 1. One can observe the separation of the three strongest clubs of the Czech highest competition from the rest of the league. These are financially “bounced” clubs that were able to transfer their financial strength to the results framework. Other clubs are in a position to compete for European Cups, but not for the championship. These are mainly the clubs FC Slovan Liberec, FK Jablonec and FK Mladá Boleslav. For the aforementioned FK Jablonec, the performance shift in the order after the basic part from the 2017/18 season can be clearly seen. After the unsuccessful autumn, the club was taken over by coach Petr Rada and after a successful spring part of the season, FK Jablonec placed third in the table (FK Jablonec, 2017). The opposite trend can be observed for another football club from the north of Bohemia, Teplice, and also for FK Mladá Boleslav (Fortuna:Liga, 2021).

Currently the most successful club in the Czech league, SK Slavia Praha, has combined its recent rise in performance with investors from the People’s Republic of China. China Energy Company Limited joined the club on September 4, 2015, acquiring almost 60% of the club’s shares and becoming its general partner. The company significantly contributed to the repayment of the club’s debts (SK Slavia Praha, 2015).

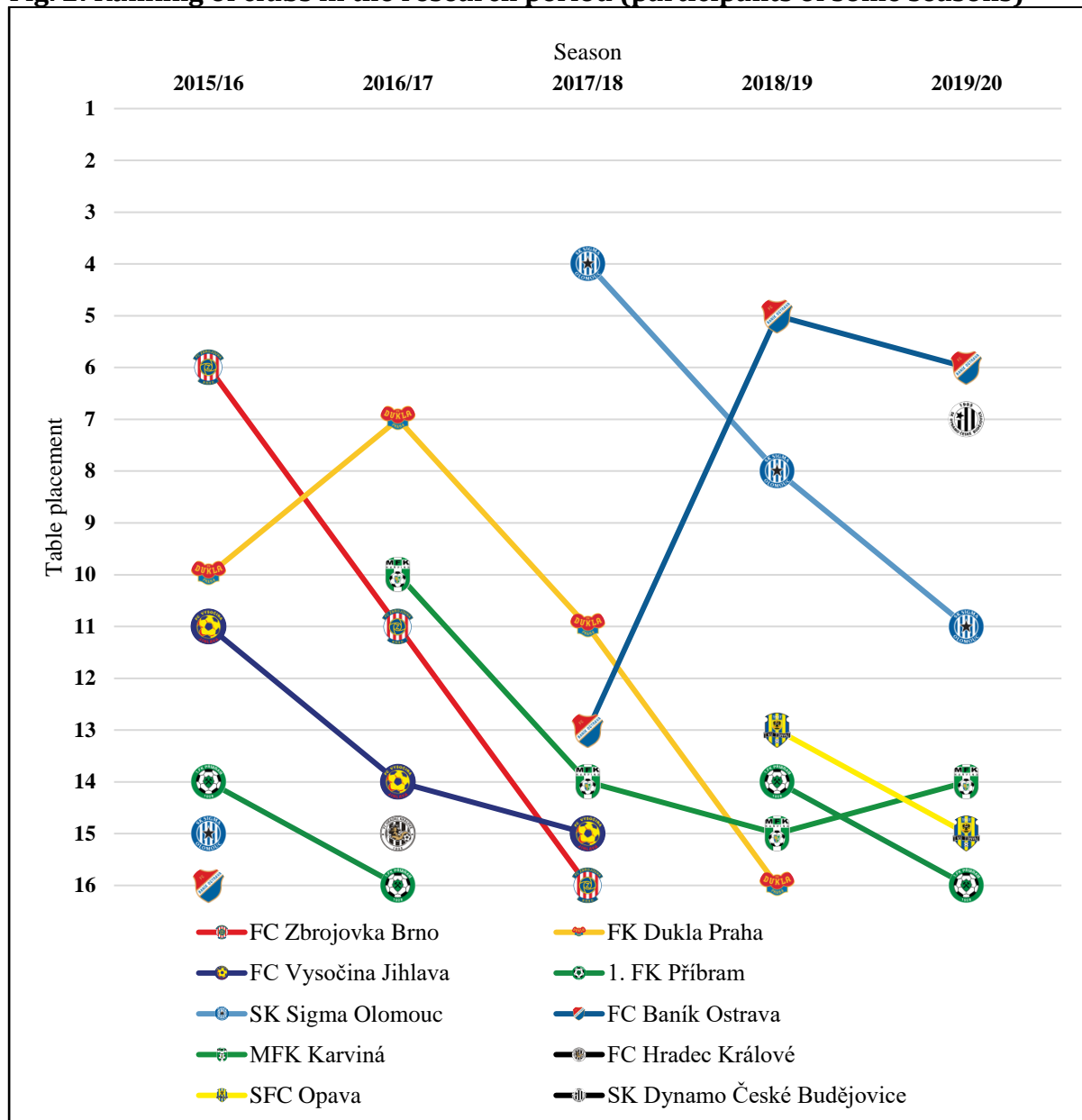
**Fig. 1: Ranking of clubs in the research period (participants of all seasons)**



*Source: authors' own processing*

The order of the teams that did not participate in all the examined seasons is shown in Figure 2. These are clubs balancing on the edge of participation in the highest and second-highest league competitions and clubs with a rich history, which especially financially lost contact with the highest competition in some seasons, or they had other serious problems. The club of FC Vysočina Jihlava, MFK Karviná, SFC Opava, 1. FK Příbram, FC Hradec Králové and SK Dynamo České Budějovice can be clearly included in the first category. On the contrary, FC Zbrojovka Brno, SK Sigma Olomouc, and especially FC Baník Ostrava can be considered traditional clubs; the latter was the only one of the aforementioned clubs that managed to win an independent Czech football league (in the 2003/04 season). The highest Czechoslovak football competition was won by Baník Ostrava a total of three times, Hradec Králové and Zbrojovka Brno once.

**Fig. 2: Ranking of clubs in the research period (participants of some seasons)**



*Source: authors' own processing*

The largest clubs in the eastern part of the Czech Republic, Sigma and Baník, came down together after the 2015/16 season but immediately took advantage of the first opportunity to return to the elite society of Czech clubs. SK Sigma Olomouc even took fourth place in its “premiere” season after the promotion. In the following seasons, Sigma was unable to repeat this success; against Sigma, Baník placed back in the highest competition only one point from the relegation after the first season. In the following two seasons, the club steadily placed just below the rungs, which guarantee participation in European cups.

It can be noted that the graphically mentioned units “miss” the first three places of the table; they are almost exclusively occupied by the three strongest Czech clubs. Furthermore, with a few exceptions, a declining trend of placement in the table from progression to the highest competition can be observed. A typical example is FC

Zbrojovka Brno (6th, 11th, 16th), FC Vysočina Jihlava (11th, 14th, 15th) or the aforementioned SK Sigma Olomouc (4th, 8th, 11th). After advancing to the highest competition, the only FC Baník Ostrava was able to improve its position in the table in the second season and thus stabilized in the upper half of the table. The fate of FK Dukla Praha, which left the highest competition after the 2018/19 season, did not meet them (Fortuna:Liga, 2021).

### 3. Methods of Research

The data used for the purposes of the research come from the official databases of the examined sports competition and are supplemented by private databases of companies from the football environment. The researched period includes the seasons from 2015/16 to 2019/20. The research is divided into the following four steps.

**1. Collection of necessary data.** The research included a group of 20 football clubs playing in the highest Czech football league called Fortuna:Liga. Information about these clubs was subsequently obtained for the entire selected period, i.e. 5 seasons. The core is data from InStat (InStat,2020), which analyzes the performance of athletes and sports teams. They are supplemented by the database of the Transfermarkt.com server (Transfermarkt, 2021) and the databases of the Czech Fortuna:Liga (Fortuna:Liga, 2021).

**2. Determination of output and input variables.** Due to the number of DMUs (16 clubs in one season), two input and one output variable were included in the DEA model. For the model with 16 football clubs (DMUs) and three variables included in the efficiency model, the model has sufficient discriminant power for the subsequent calculation of efficiency scores. Individual variables were selected using correlation analysis. The first input variable is the number of players (I1). The second input variable is total squad market value (I2). The number of points achieved in the season was chosen as the output variable (O1). Descriptive statistics of the efficiency model variables are given in Table 1.

**Tab. 1: Efficiency Model Variables: Descriptive Statistics**

Variables	Mean	Standard deviation	Maximum	Minimum
<b>Season 2015/16</b>				
Number of Players	25.88	4.43	39	19
Total Squad Market Value	10,570.31	5,696.35	26,125	5,825
Points	41.31	15.59	71	14
<b>Season 2016/17</b>				
Number of Players	27.31	3.28	35	20
Total Squad Market Value	12,700	8,174.87	32,800	5,950
Points	40.69	12.29	69	22
<b>Season 2017/18</b>				
Number of Players	26.19	3.87	33	21
Total Squad Market Value	14,382.81	11,412	42,050	6,250
Points	40.75	12.96	66	24
<b>Season 2018/19</b>				
Number of Players	27.06	4.15	35	20
Total Squad Market Value	16,476.56	14,091.51	51,600	5,875
Points	42.06	13.96	72	20
<b>Season 2019/20</b>				
Number of Players	28.88	3.84	38	23
Total Squad Market Value	16,449	15,540.64	61,400	5,775
Points	41.25	14.28	72	21

Source: authors' calculations

**3. Selection and construction of DEA models.** In the presented paper, the CCR and BCC model with input orientation was applied to the obtained data. In the basic input-oriented CCR model with the assumption of constant returns to scale, the objective function (1) is maximized under restrictive conditions (2), see e.g., Jablonský and Dlouhý (2004). Symbol  $x_j$  denotes inputs,  $y_i$  outputs,  $u_i$  is the weight of the output,  $v_j$  is the weight of the input and  $z$  is the value of the objective function.

$$z = \sum_{i=1}^r u_i y_{iq} \quad (1)$$

$$\sum_{i=1}^r u_i y_{ik} \leq \sum_{j=1}^m v_j x_{jk}, \quad k = 1, 2, \dots, n$$

$$\sum_{j=1}^m v_j x_{jq} = 1 \quad (2)$$

$$u_i \geq \varepsilon, \quad i = 1, 2, \dots, r,$$

$\varepsilon$  very small non – Archimedean number ( $> 0$ )

$$v_j \geq \varepsilon, \quad j = 1, 2, \dots, m.$$

In the case of considering variable returns from scale (BCC model), it is sufficient to extend the previous model by the condition of convexity (Subhash, 2004). The CCR and BCC models differ only by a variable  $\mu$ . In the CCR model, this variable takes zero values; in the BCC model it can take any values. The BCC model consists of equations (3) and (4).

$$z = \sum_{i=1}^r u_i y_{iq} + \mu \quad (3)$$

$$\sum_{i=1}^r u_i y_{ik} + \mu \leq \sum_{j=1}^m v_j x_{jk}, k = 1, 2, \dots, n$$

$$\sum_{j=1}^m v_j x_{jq} = 1 \quad (4)$$

$$\begin{aligned} u_i &\geq \varepsilon, i = 1, 2, \dots, r, \\ \varepsilon &\text{ very small non - Archimedean number } (> 0) \\ v_j &\geq \varepsilon, j = 1, 2, \dots, m, \\ \mu &\in R \end{aligned}$$

**4. Technical efficiency score calculation.** Technical efficiency (further TE) and scale efficiency (further SE) scores were determined for each football club. All necessary calculations were performed using OSDEA-GUI software. The technical efficiency score determined using the CCR model is called the overall technical efficiency (further OTE). In contrast, the score determined using the BCC model is called pure technical efficiency (further PTE). The overall technical efficiency score can, therefore, be decomposed into the pure technical efficiency score and the scale efficiency score, see relation (5). The scale efficiency measures the degree to which a unit can improve its efficiency by changing its size (Zhu, 2014).

$$SE = \frac{OTE}{PTE} \quad (5)$$

## 4. Results of the Research

This part of the paper is devoted to empirical research, where the nonparametric DEA methodology was used. In this research, professional football teams of the highest Czech football competition Fortuna:League are evaluated as DMU.

Table 2 shows the average level of efficiency of the clubs. Assuming variable returns to scale (BCC model), it achieves pure technical efficiency at an average level of 86.9% over the five evaluated seasons evaluated. The clubs should reduce the inputs used (i.e., number of players and total squad market value) by 13.1%. However, assuming constant returns to scale (CCR model), the overall technical efficiency is 75.6%, and, therefore, inputs should be reduced by approximately 24%. The scale efficiency (SE) of clubs reaches the level of 86.4%, which indicates that football clubs are operating below their optimal scale of operations. Table 2 also shows that the best season was 2017/16, followed by a deterioration in the 2018/17 season. Gradual stabilization can be observed in recent seasons.

**Tab. 2: DEA Scores (Input-Oriented Models)**

Seasons	CCR model		BCC model		Scale efficiency	
	Average OTE	SD	Average PTE	SD	Average SE	SD
2015/16	0.709	0.202	0.893	0.096	0.785	0.183
2016/17	0.843	0.120	0.900	0.088	0.934	0.064
2017/18	0.724	0.156	0.847	0.116	0.849	0.098
2018/19	0.764	0.168	0.821	0.124	0.924	0.099
2019/20	0.739	0.175	0.886	0.104	0.829	0.142
<b>Means</b>	<b>0.756</b>	-	<b>0.869</b>	-	<b>0.864</b>	-

*Source: authors' calculations*

Table 3 contains the resulting efficiency scores for each model and for all clubs examined from all seasons of the Fortuna:Liga. The last row of Table shows the average values of all DEA scores. The CCR-I model resulted in the identification of up to four efficient clubs in a single season. Table 3 also shows that all clubs that were classified as efficient according to the CCR-I model are also classified as efficient according to the BCC-I model. This means that the size of these clubs is optimal and at the same time the clubs are able to efficiently transform the given inputs into outputs. It is apparent that the PTE score in the BCC-I model is higher than the OTE score in the CCR-I model, as the CCR-I model considers the scale efficiency (SE), which reduces the OTE value.

For clubs that are classified as inefficient according to the CCR-I model yet as efficient according to the BCC-I model, it can be concluded that their technical inefficiency is caused by scale inefficiency. Therefore, it can be stated that the size of these clubs is not optimal and an inappropriate sports tactic was chosen.

**Tab. 3: DEA Scores**

Club	2015/16			2016/17			2017/18			2018/19			2019/20		
	CCR	BCC	SE	CCR	BCC	SE	CCR	BCC	SE	CCR	BCC	SE	CCR	BCC	SE
SLO	0.85	0.99	0.86	0.89	0.92	0.97	0.87	1	0.87	0.72	0.8	0.89	0.85	0.88	0.97
PRI	0.52	0.85	0.60	0.71	0.9	0.78	-	-	-	0.74	0.81	0.91	0.50	0.84	0.59
SPA	0.69	0.74	0.93	0.63	0.73	0.86	0.55	0.66	0.84	0.66	0.67	0.98	0.62	0.82	0.76
BOH	0.64	0.8	0.80	0.76	0.88	0.86	0.85	1	0.85	0.82	0.84	0.98	0.76	0.79	0.96
OVA	0.23	0.76	0.30	-	-	-	0.71	0.81	0.87	1	1	1	1	1	1
ZLN	0.69	1	0.69	0.99	1	0.99	0.58	0.84	0.69	0.85	0.86	0.99	0.54	0.84	0.64
HKR	-	-	-	0.96	1	0.96	-	-	-	-	-	-	-	-	-
LIB	0.85	0.88	0.96	0.60	0.7	0.85	0.63	0.75	0.83	0.71	0.77	0.92	0.72	0.76	0.95
PLZ	1	1	1	0.78	0.83	0.94	1	1	1	1	1	1	1	1	1
JIH	0.65	0.97	0.67	0.89	0.93	0.96	0.70	0.83	0.85	-	-	-	-	-	-
BRN	1	1	1	0.87	0.91	0.95	0.55	0.81	0.68	-	-	-	-	-	-
DUK	0.66	0.86	0.76	0.83	0.84	0.99	0.79	0.91	0.86	0.48	0.79	0.61	-	-	-
JAB	0.70	0.86	0.81	0.85	0.97	0.88	0.81	0.81	1	0.83	0.83	1	0.86	1	0.86
MBL	0.87	0.95	0.91	0.84	0.87	0.96	0.46	0.64	0.72	0.54	0.59	0.91	0.61	0.74	0.82
TEP	0.51	0.75	0.68	1	1	1	0.60	0.78	0.76	0.63	0.76	0.83	0.67	0.92	0.72
KAR	-	-	-	0.89	0.91	0.98	0.80	0.95	0.83	0.56	0.65	0.86	0.44	0.69	0.65
OPA	-	-	-	-	-	-	-	-	-	1	1	1	0.65	1	0.65
CEB	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1
OLO	0.53	0.87	0.61	-	-	-	1	1	1	0.68	0.77	0.89	0.73	0.89	0.82
SLA	0.97	1	0.97	1	1	1	0.70	0.76	0.92	1	1	1	0.90	1	0.90
<i>Mean</i>	<i>0.71</i>	<i>0.89</i>	<i>0.78</i>	<i>0.84</i>	<i>0.90</i>	<i>0.93</i>	<i>0.73</i>	<i>0.85</i>	<i>0.85</i>	<i>0.76</i>	<i>0.82</i>	<i>0.92</i>	<i>0.74</i>	<i>0.89</i>	<i>0.83</i>

*Source: authors' calculations*

In the 2015/16 season, FC Victoria Plzeň and FC Zbrojovka Brno were efficient from the point of view of OTE. In terms of placement in the league table, Plzeň finished in first place and Brno in sixth place. From the point of view of the PTE score, FC Fastav Zlín and SK Slavia Praha were also described as efficient, the source of their inefficiency being scale inefficiency. In the 2016/17 season, SK Slavia Praha and FK Teplice were efficient from the point of view of OTE. In terms of placement in the league table, Slavia Praha finished in first place and Teplice in fifth place. From the point of view of the PTE score, FC Fastav Zlín and FC Hradec Králové were also classified as efficient. The source of their inefficiency is scale inefficiency. In the 2017/18 season, FC Victoria Plzeň and SK Sigma Olomouc were efficient from the point of view of the OTE score. In terms of placement in the league table, Plzeň finished in first place and Olomouc in fourth place. From the point of view of the PTE score, Bohemians Praha and FC Slovácko were also classified as efficient. The source of their inefficiency is scale inefficiency. In the 2018/19 season, SK Slavia Praha, FC Baník Ostrava, SFC Opava and FC Victoria Plzeň were efficient from the point of view of the OTE score. In terms of position in the league table, Slavia Praha finished in first place, Plzeň in second place, Ostrava in fifth place and Opava in 13th place. For SFC Opava, it is important to emphasize that it was their return to the highest football competition. Due to this fact, 13th place overall can be considered a success. In the 2019/20 season, FC Baník Ostrava, FC Victoria Plzeň and SK Dynamo České Budějovice were efficient from the point of view of OTE. In terms of placement in the league table, Plzeň finished in second place, Ostrava in sixth place, and České Budějovice in seventh place. For SK Dynamo České Budějovice, it is essential to emphasize that their return to the highest football competition, despite the fact that they placed seventh overall, can be considered a success. From the point of view of PTE, SK Slavia Praha and SFC Opava were also described as efficient, the source of their inefficiency being scale inefficiency.

## **Conclusion and discussion**

Given football clubs' current economic and financial situation, there is an increasing need to know how efficiently a club uses its resources. In addition, this analysis is also crucial for evaluating the sports performance of clubs. Among the various tools that are widely used to measure efficiency, the DEA method was chosen in this paper.

In this article, the DEA was applied to the best clubs in the Czech Republic, which participate in the highest football competition Fortuna:Liga. There were 20 different clubs that played Fortuna:Liga in five seasons (2015/16 to 2019/20). This number of seasons made it possible to provide interesting conclusions for each season and for all seasons. The research provided several conclusions.

The first conclusion: from the analyzed period from the point of view of the OTE score, the winner of Fortuna:Liga was always described as efficient with the exception of the 2019/20 season and the club with the lowest OTE score of Fortuna:Liga mostly left the league at the end of the season.

The second conclusion can be drawn from the larger number of seasons included in the research. As can be seen, in the five seasons analyzed, no club was able to maintain efficiency throughout the period under review. It is important to note that the clubs and resources used change from season to season, as do the opponent's teams. So when an

efficient club uses the same resources in the same way in past seasons, it is not enough to be efficient in the coming seasons.

As a third conclusion, various sources of inefficiency were identified. The first source of inefficiency is observed in pure technical efficiency (PTE) and is related to the waste of inputs. To achieve the same output, a lower value of inputs (i.e. a lower total squad market value or a lower number of players) should suffice. The second source of inefficiency can be observed by calculating scale efficiency and is associated with the selection of inappropriate sports tactics. In this case, of course, the team's head coach is the most involved. The problem is not just how they use their sports resources. These clubs should seek to develop a medium- and long-term strategy to develop new and different tactics with the resources they have or could have in the future. The purchase of players should also take place in the context of the development of these new sports tactics. There are also clubs that suffer from both sources of inefficiency. In this case, clubs should reduce resources and, in terms of size, find out how effective clubs are developing sports tactics.

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