



Karolina Nessel  

Faculty of Management and Social
Communication, Jagiellonian University,
Poland

Szczepan Kościółek  

Faculty of Management and Social
Communication, Jagiellonian University,
Poland

Beyond Resources? Efficiency and Technology as Explanations for the English Premier League's Advantage over the Polish Ekstraklasa

Czy zasoby to wszystko? Wydajność i technologia
w wyjaśnianiu przewagi angielskiej Premier League
nad polską Ekstraklasą

Abstract

This study compares the technical efficiency and technological level of professional football clubs from the Polish Ekstraklasa and the English Premier League over the 2021/22–2023/24 seasons. Using a Slack-Based Model within a meta-frontier Data Envelopment Analysis framework, we assess two outputs – sporting performance (Elo ratings) and financial performance (total revenue) – relative to two inputs: player wage expenditure (or, in an alternative model, squad market value) and historical league ranking. The results indicate that both leagues exhibit similar average technical efficiency (≈ 0.8) and operate on the same technological frontier. Performance disparities between the two leagues are therefore attributable primarily to differences in resource endowments rather than technological or managerial inefficiency. Benchmarking analysis identifies Brentford as the most consistently efficient club, while Everton, Aston Villa, Śląsk Wrocław and Zagłębie Lubin display persistent inefficiency.

Streszczenie

Badanie porównuje efektywność techniczną i poziom technologiczny profesjonalnych klubów piłkarskich z polskiej Ekstraklasy oraz angielskiej Premier League w sezonach 2021–2023. Wykorzystując model oparty na Slack-Based Model w ramach meta-frontier Data Envelopment Analysis, oceniono dwa rezultaty – wyniki sportowe (ranking Elo) oraz wyniki finansowe (łączny przychód) – w odniesieniu do dwóch nakładów: wydatków na wynagrodzenia zawodników (lub, w alternatywnym modelu, wartości rynkowej kadry) oraz historycznej pozycji w lidze. Wyniki wskazują, że obie ligi charakteryzują się podobną średnią efektywnością techniczną ($\approx 0,8$) i funkcjonują na tej samej granicy technologicznej. Różnice w wynikach między ligami wynikają zatem przede wszystkim z różnic w zasobach, a nie z technologicznej lub menedżerskiej niewydolności. Analiza benchmarkingowa wskazuje Brentford jako klub o najbardziej konsekwentnie utrzymywanej efektywności, natomiast Everton, Aston Villa, Śląsk Wrocław i Zagłębie Lubin wykazują utrzymującą się nieskuteczność.

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Introduction

Over the past two decades, European football has witnessed a growing divergence between the financially dominant leagues – the so-called Big Five (England, Spain, Germany, Italy and France) – and the rest of the continent, underpinned by increasing financial disparities and the concentration of sporting success among a small elite of clubs [Ramchandani et al., 2023]. Previous studies consistently confirmed that clubs from the wealthiest leagues benefit from superior access to financial resources, broadcasting revenue and global sponsorship, creating a feedback loop of sporting and financial dominance [Peeters, Szymanski, 2014; Plumley et al., 2017].

This environment amplifies existing structural disadvantages for clubs from less affluent markets, especially those in Central and Eastern Europe. However, as Ramchandani et al. [2023] emphasise, efficiency in resource utilisation might be a critical factor in improving sporting performance within a polarised European football landscape. Exploring the evolution in inefficiencies may indicate whether there is room for outcomes improvement, and whether the inefficiencies are a systematic league-wide feature or a result of specific managerial and organisational choices at the club level. Identifying the most efficient clubs within structurally disadvantaged leagues may help establish internal benchmarks and inform best management practices.

Unsurprisingly, given the highly competitive and distinctive environment in which football clubs operate, the issue of their efficiency has become a prominent topic in the literature. Studies on football club efficiency adopt one of three analytical perspectives, depending on the effect under consideration: sporting efficiency [e.g. Boto-García et al., 2023; Espitia-Escuer, García-Cebrián, 2008; Frick, Lee, 2011; Gökgöz, Yalçın, 2022; Rossi et al., 2019], financial efficiency [Guzmán, 2006], or a combined approach conceptualised as managerial efficiency [Barros, Douvis, 2009; Barros et al., 2009; Haas et al., 2004; Feng, Jewell, 2021; Jewell, 2017; Miragaia et al., 2019; Pérez-González et al., 2022; Wyszynski, 2016], following frameworks established by Rohde and Breuer [2018], Kern and Süßmuth [2005], and Terrien et al. [2017].

However, recent studies on managerial efficiency have predominantly focused on the Big Five leagues [Feng, Jewell, 2021; Jewell, 2017; Miragaia et al., 2019; Pérez-González et al., 2022; Rohde, Breuer, 2018; Terrien et al., 2017]. In contrast, limited attention has been paid to less competitive football markets in Eastern Europe, which face the challenge of divergence within the global football industry. As a result, our understanding of efficiency variance in these markets, often marked by the depletion of their most valuable resources, namely their most productive players [Frick, 2009; Kesenne, 2015], remains limited. Using Poland as a prime example of such a resource-depleted market, the only relevant study to date was conducted by Wyszynski [2016, 2017]. However, his findings should be updated to cover more recent periods, expanded to include an international perspective, and could benefit from methodological refinement to mitigate efficiency variation bias caused by the inclusion of many outputs [Soares de Mello et al., 2012].

Therefore, this study aims to evaluate and compare the technical efficiency of professional football clubs competing in the Polish Ekstraklasa and the English Premier League between 2021/22 and 2023/24. The Polish Ekstraklasa represents an example of Central Eastern European league, while the English Premier League is included as a reference point, being the most commercially successful and sportingly dominant European league, with aggregate club revenue reaching £6.3 billion in the 2023/24 season [Deloitte, 2025], holding the top position in the UEFA country ranking [UEFA, 2025], and exhibiting an efficiency level representative for the Big Five [Boto-García et al., 2023]. This comparison will help determine whether the observed differences in performance between the two leagues arise solely from varying resource endowments, or also efficiency disparities and a technological gap.

For this purpose, we use a slack-based model under league and meta-frontier frameworks. The Slack-Based Model (SBM) is an efficiency analysis approach based on Data Envelopment Analysis (DEA) that directly incorporates “slacks” – that is, excesses or shortages of resources and outcomes (inputs and outputs) that traditional DEA models may overlook. Like DEA, it is particularly valued for its ability to assess entities of vary-

ing operational scales and to handle multiple outputs without assuming substitution elasticities or imposing predefined functional forms governing input-output relationships. The meta-frontier framework allows for evaluating two leagues operating in different environments.

The main contribution of this study is to provide the first attempt to compare the efficiency and technological development of a peripheral league with those of a leading league. The results suggest that while both leagues exhibit similar technical efficiency and share a common technological frontier, resource disparities determine their relative positions on the meta-frontier.

Theoretical background

Conceptual framework

In performance evaluation, an individual, organisation, system or country is assessed based on achieved production, with previously set objectives. Such an assessment often involves closely interlinked concepts: productivity, efficiency and effectiveness. Productivity is defined as the ratio of outputs to inputs used in production, while efficiency refers to a situation in which the maximum output is produced with a given input, or a given output is produced with the minimum input (i.e. when productivity is maximised). According to [Farrell \[1957\]](#), influenced by [Koopmans \[1951\]](#) and [Debreu \[1951\]](#), productive efficiency may be decomposed into technical efficiency (the maximum ratio of outputs to inputs) and allocative efficiency (the ratio that maximises benefit, given input and output prices). Effectiveness, by contrast, refers to the extent to which actual outputs achieve desired outcomes (which may be understood as final goals).

Productivity and efficiency are often evaluated relative to a production possibility frontier, which is determined by units achieving the highest productivity and hence deemed efficient. Units below the frontier are considered inefficient, and moving toward the frontier reflects an improvement in productivity and efficiency. Methods for estimating performance relative to a frontier fall into two major categories: parametric (mainly stochastic frontier analysis (SFA) – [Aigner et al. \[1977\]](#); [Meeusen, van Den Broeck \[1977\]](#)) and non-parametric (mainly data envelopment analysis – [Charnes et al. \[1978\]](#), and free disposal hull – [Deprins et al. \[1984\]](#)). The non-parametric methods have the advantage of not requiring assumptions about the functional form of the input-output transformation, and can easily accommodate multiple inputs and outputs. On the other hand, parametric frontier methods account for noise and environmental variables, and allow for stochastic inference.

According to the DEA procedure, Decision-Making Units (DMUs) operating in the market decide how to use their inputs (i.e. allocate resources) to generate specific outputs (i.e. the results of allocation). If DMUs exercise greater control over inputs than outputs, an input-oriented model should be applied, indicating the potential input reductions while maintaining the same level of outputs. On the contrary, if maximising output for a given set of inputs presents the primary challenge, an output-oriented model is more appropriate.

The basic DEA model assumes constant returns to scale (CRS) [[Charnes et al., 1978](#)]. However, the variable returns to scale (VRS) model – developed by [Banker et al. \[1984\]](#) and known as the BCC model – accounts for the fact that entities of different sizes may not experience identical scale effects. Additionally, some inputs may influence DMU performance while remaining beyond the DMUs' control. Therefore, such inputs should be included in the DEA model as nondiscretionary variables, i.e. uncontrolled inputs [[Cook, Seiford, 2009](#)].

Efficient DMUs (with efficiency scores of 100%) form the production frontier. The remaining DMUs, considered inefficient (efficiency < 100%), are compared against efficient peers identified by the linear programming solution. These peers serve as benchmarks for improvement, with adoption proportions also indicated. In the SBM extension of DEA [[Tone, 2001](#)], slack values reveal which specific categories, both among outputs and inputs, and to what extent, contribute to inefficiency.

The meta-frontier framework [Battese et al., 2004; Battese, Rao, 2002; O'Donnell et al., 2008] allows for the comparison of efficiency across groups operating under different technologies or environmental conditions by constructing a common, overarching frontier – called the meta-frontier – that envelops group-specific frontiers. This approach acknowledges heterogeneity between groups (in this case, football leagues from different countries) and distinguishes between technology gaps and efficiency differences within each group. While group frontiers represent the best possible production given each group's specific technology or context, the meta-frontier reflects the potential maximum output achievable if all units operated under the best available technology across all groups. Thus, the meta-frontier framework enables decomposition of overall inefficiency into two components: inefficiency relative to the group frontier (technical inefficiency) and the technology gap ratio (TGR), which measures the distance between the group frontier and the meta-frontier. The latter is defined as the ratio of technical efficiency relative to the group frontier to technical efficiency relative to the meta-frontier. The distinction between sorts of inefficiency is critical in assessing whether performance differences are driven by varying managerial efficiency or structural technological disparities.

In evaluating managerial efficiency in football clubs, both approaches – SFA [Barros et al., 2009; Feng, Jewell, 2021; Jewell, 2017; Kern, Süßmuth, 2005; Rohde, Breuer, 2018] and DEA [Barros, Douvis, 2009; Haas et al., 2004; Miragaia et al., 2019; Terrien et al., 2017; Wyszynski, 2016] – have been widely applied. Although SBM has been employed in efficiency analyses of other team sports [e.g. Jablonský, 2022], its application to football remains exceptionally rare, as it has been used only by Gökgöz and Yalçın [2022].

Football clubs' managerial efficiency

Building upon the framework introduced by Scully [1974], the sports production function can be defined as a function of the playing abilities of the team and various environmental conditions. In essence, this sporting production function explains how player talent, combined with managerial guidance, leads to the final sporting outcome – a victory, draw, or defeat in a match.

However, from a managerial perspective, football clubs maximise a utility function that weighs both sporting and financial performance [Garcia-del-Barrio, Szymanski, 2009]. Terrien et al. [2017] emphasise that clubs may dynamically shift the balance between sporting and financial goals from season to season, adapting to market conditions, financial constraints or competitive opportunities. Thus, the key challenge is to optimise the combination of these outputs relative to the cost and quality of employed players.

In previous studies, sporting performance was typically operationalised by the number of points earned in the league table [Barros et al., 2009; Barros, Douvis, 2009; Feng, Jewell, 2021; Haas et al., 2004; Jewell, 2017; Miragaia et al., 2019; Rohde, Breuer, 2018; Terrien et al., 2017; Wyszynski, 2016], with the exception of Kern and Süßmuth [2005], who used a synthetic index of sporting results across different competitions. However, the most common approach – total points earned – is unsuitable for our purposes, as it cannot be meaningfully applied to international comparisons. Therefore, our measure of sporting output (*O1 – Output 1*) is the Elo rating, a synthetic indicator of team strength that adjusts results for the quality of opponents and match context. Developed originally for chess by Árpád Élő, the system has been widely adopted in football research for its ability to provide dynamic, comparable assessments across teams and competitions [Csató, 2024; Stefani, Pollard, 2007]. The Football Club Elo Ratings (ClubElo.com) used here incorporate home advantage and margin of victory, with larger rating changes awarded for wins against stronger opponents and smaller changes for wins against weaker ones, ensuring that the ratings reflect both performance and competitive context. This approach offers a significant advantage over league points, enabling consistent cross-league and international comparisons by incorporating opponent strength and contextual factors rather than relying solely on match outcomes.

Financial performance has been measured inconsistently, most commonly by total revenue [Barros, Douvis, 2009; Feng, Jewell, 2021; Haas et al., 2004; Jewell, 2017; Kern, Süßmuth, 2005; Miragaia et al., 2019; Wyszynski, 2016], followed by operating revenue [Terrien et al., 2017], operating profits [Barros et al., 2009;

Rohde, Breuer, 2018], and, in some cases, by revenue from distinct sources such as broadcasting, commercial activities and matchday income considered separately [**Miragaia et al., 2019**]. Our study adopted the most common and least context-specific measures: total revenue as a proxy for financial performance (O2 – Output 2).

Some authors include additional outputs, such as stadium utilisation or match attendance [**Barros et al., 2009; Barros, Douvis, 2009; Haas et al., 2004; Wyszynski, 2016**], television audiences [**Wyszynski, 2016**], or league rank odds [**Rohde, Breuer, 2018**]. However, we align with the reasoning that these should not be treated as separate goals but rather factors contributing to broader sporting and financial objectives [**Plumley et al., 2017**]. This especially applies to attendance, which not only boosts matchday revenue but may also enhance sporting outcomes by strengthening the home advantage [**Fischer, Haucap, 2021**].

Regarding inputs, squad quality is most often proxied by player salaries [**Barros et al., 2009; Barros, Douvis, 2009; Haas et al., 2004; Kern, Süßmuth, 2005; Rohde, Breuer, 2018; Wyszynski, 2016**], although some studies have used player market value [**Feng, Jewell, 2021; Jewell, 2017**], revenue [**Barros et al., 2009**], or total wage expenditure [**Miragaia et al., 2019**]. We follow **Scully's [1974]** framework, which was applied in most prior studies, along with the empirically supported view that player wages systematically reflect their skills and abilities [**Carmichael et al., 2011; Frick, 2011**]. This leads us to use player salary expenditure as the input (I1 – Input 1) in our evaluation of managerial efficiency in the basic Model 1.

A potential conceptual concern arises from the financial nature of both the inputs and the outputs, as player wages and club revenue are closely related. Although wages and revenue are naturally connected, wage levels are determined largely *ex ante*, whereas revenue depends on sporting outcomes and the broader course of managerial and organisational processes throughout the season. At the same time, several revenue components, such as UEFA distributions, multi-year broadcasting contracts, or long-term sponsorship deals, are at least partly predetermined by past seasons, which implies that revenue is not shaped solely by current-season performance and that the relationship may involve elements of reverse causality. To strengthen the robustness of our interpretation, we develop Model 2 in which player wages are replaced by pre-season market values, thereby relying on an exogenous measure of team quality that is not affected by the revenue generated during the same season. Nevertheless, the broader issue of causal identification between revenue and costs remains a key limitation of our empirical strategy.

Some scholars have argued that managerial salaries should be included as a second input [**Haas et al., 2004; Miragaia et al., 2019**], while others have suggested controlling for tangible fixed assets [**Feng, Jewell, 2021; Jewell, 2017**] and the number of players [**Barros, Douvis, 2009**]. However, from our perspective, these elements fall within the domain of managerial decisions and thus directly affect managerial (in) efficiency.

As a second input (I2), we adopt national historical ranking, based on several arguments. First, historical rankings reflect a club's reputation and brand value [**Gladden, Funk, 2002**], influencing its ability to attract sponsors, fans and talented players – intangible resources that are critical to performance. Second, such rankings capture accumulated organisational experience and infrastructure quality, serving as proxies for managerial and human capital inputs. Third, higher historical league standings often correlate with greater financial resources from broadcasting rights, sponsorship and transfer market power, affecting clubs' resource endowments. Fourth, path dependence suggests that past success shapes current capabilities, making historical ranking a valuable indicator of built-up capital over time. Finally, including historical ranking helps mitigate endogeneity concerns by controlling for unobserved factors that systematically affect current performance, improving the robustness of efficiency estimations. Consequently, I2 captures a key dimension of club operations that prior efficiency studies have either omitted or only partially proxied via personnel costs [**Cifuentes-Faura, 2022**], tangible and intangible fixed assets [**Feng, Jewell, 2021; Jewell, 2017; Barros et al., 2009; Kulikova, Gushunova, 2014**], home-city characteristics, and participation in UEFA competitions [**Barros et al., 2009**].

Material and methods

Method

This study applies the SBM extension of DEA in a meta-frontier framework to envelop the two groups of clubs, first separately with their respective league frontiers and then with a meta-frontier (clubs from both leagues simultaneously). A model with varying returns to scale was chosen. The SBM model is non-oriented.

Data collection and analysis

Based on the literature review in the previous section, our base model (Model 1) includes the following variables:

- I1 – Players' wages, serving as a proxy for financial inputs. Measured in millions of pounds, these figures are sourced from Deloitte and Grant Thornton annual league financial reviews and reported as the total value for the given season.
- I2 – Historical ranking, serving as a proxy for other inputs. Measured as the ratio of points achieved by a team in the all-time league table prior to the given season to the total number of points in the league. To ensure comparability between the two competitions, the same time horizon was applied to both leagues, covering the period since the inception of the English Premier League in 1992, which limits the influence of distant historical results that are less likely to reflect the current market potential of clubs. For clubs promoted to the top tier for the first time (e.g. Luton Town), the historical ranking was zero; to avoid zero values, we added 0.001.
- O1 – ELO points, serving as a proxy for sporting results. These values are recorded for 30 June 2022, 2023 and 2024, corresponding to the end of the 2021/22, 2022/23 and 2023/24 seasons, respectively.
- O2 – Total revenue, serving as a proxy for financial results. Similar to I1, this is measured in millions of pounds earned per season, using data from Deloitte's and Grant Thornton's reports.

In Model 2, I1 is replaced with team value, measured in millions of euros. This variable represents the total squad value of a team in a given season, as reported by the Transfermarkt database, which is based on community and expert assessments and has consistently proven to be a reliable proxy for player valuation [Peeters, 2018].

Given the change in methodology in Polish Ekstraklasa reports, the analysis encompasses only the seasons 2021/22–2023/24. For this short period, we consider the respective technologies constant for both leagues, adopting the window approach to the data analysis (where the window lasts three years).

Importantly, in professional football leagues in Europe, the composition of clubs in the top league changes due to the promotion and relegation system. In order to balance the panel, only the clubs in the top divisions in both leagues during the period 2021–2023 were included in the analysis.

The data were analysed using the R package *deaR* [Bolos et al., 2025]. Their descriptive statistics are presented in Table 1 and illustrate the apparent divergence in the sporting and financial dimensions of the two leagues. Predominantly, the moderate correlation between inputs and outputs is shown in Table 2, indicating that a meaningful efficiency analysis is possible.

Table 1. Descriptive statistics of data

	PE				EPL			
	M	SD	Min	Max	M	SD	Min	Max
Wages	6.277	3.820	1.536	19.959	196.461	106.117	57.000	423.000
Team value	19.210	10.356	7.350	46.550	547.789	293.967	137.850	1460.000
National ranking	3.694	2.296	0.222	8.865	3.437	2.391	0.000	7.482
ELO	1364.711	74.679	1243.000	1557.000	1782.433	109.567	1607.000	2077.000
Revenue	11.084	9.582	3.037	52.525	296.473	188.120	124.639	719.000

Source: Authors' own elaboration based on data from Transfermarkt.com, ClubElo, and reports by Deloitte [2022, 2025] and Grant Thornton [2023, 2024].

Table 2. Correlation analysis based on combined data from both leagues

	M	SD	I1a	I1b	I2	O1	O2
I1a: Wages	114.953	123.845	1.000				
I1b: Team value	321.255	343.731	0.956	1.000			
I2: National ranking	3.547	2.343	0.381	0.341	1.000		
O1: ELO	1603.410	228.722	0.895	0.898	0.197	1.000	
O2: Revenue	174.164	200.632	0.972	0.954	0.419	0.868	1.000

Source: Authors' own elaboration based on data from Transfermarkt.com, ClubElo, and reports by [Deloitte \[2022, 2025\]](#) and [Grant Thornton \[2023, 2024\]](#).

Results

The analysis of league-level efficiency in the Polish Ekstraklasa and the English Premier League over the 2021/22–2023/24 period reveals predominantly structural similarities across the two competitions.

Regarding league frontier analysis (Table 3), in Model 1, the number of efficient clubs per season ranged from two to six in the Polish Ekstraklasa and from two to four in the English Premier League. In both leagues, only one club remained efficient across all three seasons: Brentford in the EPL. Average efficiency was slightly higher in the EPL (0.86) than in the PE (0.82), although in both cases it was substantially reduced by persistently inefficient clubs – Śląsk Wrocław, Zagłębie Lublin and Cracovia in the Polish Ekstraklasa, and Everton and Aston Villa in the English Premier League.

In Model 2, both leagues exhibited a similar number of efficient units and higher efficiency scores in the EPL, while the PE slightly decreased the average score. Cracovia and Górnik Zabrze in the Polish Ekstraklasa, and Everton and Aston Villa in the English Premier League, were consistently inefficient across both models. Club rankings varied only slightly between models, reflecting a low sensitivity to model specification (correlation of 0.98 for the PE and 0.76 for the EPL). Figure 1 shows that while Model 1 indicates similar average league efficiencies in both competitions, Model 2 reveals that the EP has closed the gap in recent years.

Table 3. Results assuming separate frontiers for both leagues – 2021/22–2023/24 seasons

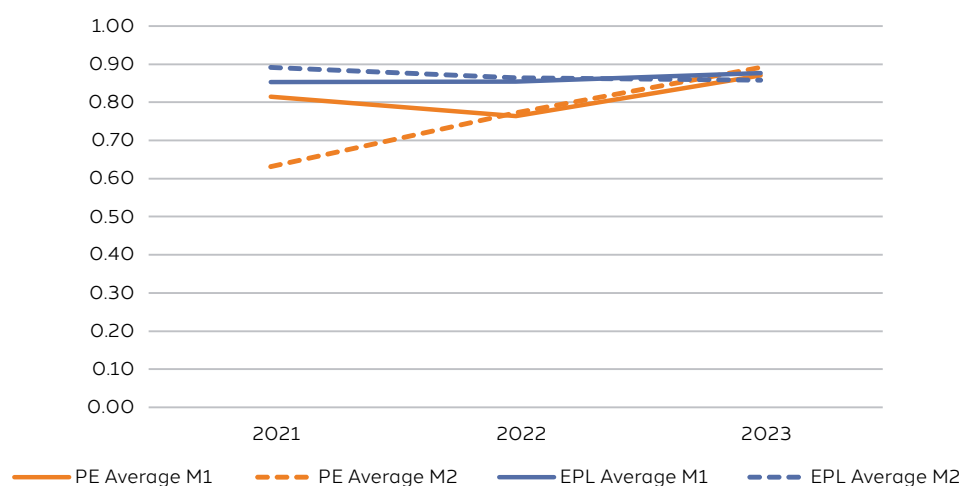
	M1					M2				
	2021	2022	2023	Average	Rank	2021	2022	2023	Average	Rank
PL										
Cracovia	0.64	0.60	0.63	0.62	10	0.56	0.60	0.77	0.64	11
Górnik Zabrze	1.00	0.78	0.92	0.90	6	0.54	0.63	0.74	0.64	12
Jagiellonia Białystok	0.64	0.75	0.89	0.76	9	0.58	0.72	0.71	0.67	10
Lech Poznań	0.72	1.00	1.00	0.91	5	0.49	0.97	1.00	0.82	5
Legia Warszawa	1.00	0.79	1.00	0.93	3	0.79	0.80	1.00	0.86	3
Piast Gliwice	0.96	0.62	1.00	0.86	7	0.49	0.67	1.00	0.72	7
Pogoń Szczecin	0.98	0.65	0.79	0.81	8	0.45	0.71	1.00	0.72	8
Raków Częstochowa	0.98	0.87	1.00	0.95	2	0.82	0.82	1.00	0.88	2
Stal Mielec	0.77	1.00	1.00	0.92	4	0.76	0.87	0.94	0.85	4
Śląsk Wrocław	0.53	0.53	0.70	0.58	11	0.60	0.85	0.75	0.73	6
Warta Poznań	1.00	0.93	1.00	0.98	1	1.00	0.85	1.00	0.95	1
Zagłębie Lubin	0.56	0.64	0.52	0.57	12	0.51	0.78	0.80	0.70	9
Average	0.81	0.76	0.87	0.82		0.63	0.77	0.89	0.77	
Minimum	0.53	0.53	0.52	0.52		0.45	0.60	0.71	0.58	
Maximum	1.00	1.00	1.00	1.00		1.00	0.97	1.00	0.99	
Standard deviation	0.18	0.15	0.16	0.14		0.16	0.10	0.12	0.13	

cont. Table 3

	M1					M2				
	2021	2022	2023	Average	Rank	2021	2022	2023	Average	Rank
EPL										
Arsenal	0.94	0.96	0.98	0.96	3	0.84	0.78	0.90	0.84	8
Aston Villa	0.72	0.65	0.69	0.69	12	0.60	0.68	0.69	0.66	13
Brentford	1.00	1.00	1.00	1.00	1	1.00	1.00	1.00	1.00	1
Brighton	0.92	0.99	1.00	0.97	2	1.00	0.86	0.85	0.90	6
Chelsea	0.85	0.81	0.81	0.82	8	0.83	0.84	0.77	0.81	9
Crystal Palace	0.75	0.80	0.81	0.79	10	1.00	1.00	0.78	0.93	4
Everton	0.63	0.61	0.68	0.64	13	0.64	0.69	0.76	0.70	12
Liverpool	0.92	0.95	0.92	0.93	6	0.94	1.00	0.95	0.96	3
Man City	0.99	1.00	1.00	1.00	1	1.00	1.00	1.00	1.00	1
Man Utd	0.87	1.00	0.96	0.94	5	0.98	0.96	1.00	0.98	2
Newcastle	0.63	0.73	0.86	0.74	11	0.92	0.72	0.79	0.81	10
Tottenham	0.99	0.86	1.00	0.95	4	0.87	1.00	0.89	0.92	5
West Ham	1.00	0.92	0.87	0.93	7	1.00	0.79	0.83	0.87	7
Wolves	0.83	0.78	0.79	0.80	9	0.86	0.76	0.80	0.81	11
Average	0.85	0.85	0.88	0.86		0.89	0.86	0.86	0.87	
Minimum	0.63	0.61	0.68	0.64		0.60	0.68	0.69	0.66	
Maximum	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	
Standard deviation	0.13	0.12	0.10	0.12		0.13	0.12	0.10	0.12	

Source: Authors' own elaboration based on data from Transfermarkt.com, ClubElo, and reports by [Deloitte \[2022, 2025\]](#) and [Grant Thornton \[2023, 2024\]](#).

Figure 1. PE and EPL in M1 and M2: average “league” efficiency, 2021–2023



Source: Authors' own elaboration based on data from Transfermarkt.com, ClubElo, and reports by [Deloitte \[2022, 2025\]](#) and [Grant Thornton \[2023, 2024\]](#).

The results of the meta-frontier analysis (Table 4) largely mirror the “league” frontier outcomes, suggesting that both leagues operate on different sections of the same production possibility frontier, differentiated primarily by resource endowment rather than technology. In Model 1, only Brentford maintained efficiency throughout the entire period in the English Premier League. The average efficiency was slightly lower in the Polish Ekstraklasa (0.81) than in the English Premier League (0.87), while variability in efficiency (as measured by standard deviation) remained comparable across leagues and models. The distribution of clubs

in meta-frontier rankings was similar in both leagues (correlation of 0.65 for the PE and 0.82 for the EPL), reinforcing the notion of comparable technical efficiency.

Table 4. Results for meta-frontier – 2021/22–2023/24 seasons

	M1					M2				
	2021	2022	2023	Average	Rank	2021	2022	2023	Average	Rank
PE										
Cracovia	0.64	0.60	0.63	0.62	23	0.56	0.60	0.77	0.64	24
Górník Zabrze	1.00	0.78	0.92	0.90	13	0.54	0.63	0.74	0.64	25
Jagiellonia Białystok	0.64	0.75	0.89	0.76	19	0.58	0.72	0.69	0.66	22
Lech Poznań	0.72	1.00	1.00	0.91	12	0.44	0.97	1.00	0.81	13
Legia Warszawa	1.00	0.79	1.00	0.93	9	0.79	0.80	1.00	0.86	9
Piast Gliwice	0.96	0.62	1.00	0.86	14	0.47	0.67	1.00	0.71	18
Pogoń Szczecin	0.98	0.65	0.79	0.81	16	0.43	0.71	1.00	0.71	19
Raków Częstochowa	0.98	0.87	1.00	0.95	5	0.54	0.65	1.00	0.73	17
Stal Mielec	0.73	1.00	1.00	0.91	11	0.70	0.80	0.87	0.79	14
Śląsk Wrocław	0.53	0.53	0.68	0.58	24	0.60	0.85	0.75	0.73	16
Warta Poznań	1.00	0.93	1.00	0.98	2	1.00	0.75	1.00	0.92	5
Zagłębie Lubin	0.56	0.64	0.52	0.57	25	0.51	0.78	0.80	0.70	20
Average	0.81	0.76	0.87	0.81		0.60	0.75	0.88	0.74	
Standard deviation	0.18	0.15	0.17	0.17		0.16	0.10	0.12	0.13	
Minimum	0.53	0.53	0.52	0.52		0.43	0.60	0.69	0.57	
Maximum	1.00	1.00	1.00	1.00		1.00	0.97	1.00	0.99	
EPL										
Arsenal	0.94	0.96	0.98	0.96	4	0.84	0.78	0.90	0.84	10
Aston Villa	0.72	0.65	0.69	0.69	21	0.59	0.67	0.69	0.65	23
Brentford	1.00	1.00	1.00	1.00	1	1.00	1.00	1.00	1.00	1
Brighton	0.92	0.99	1.00	0.97	3	1.00	0.86	0.85	0.90	7
Chelsea	0.85	0.81	0.81	0.82	15	0.83	0.84	0.77	0.81	11
Crystal Palace	0.75	0.80	0.81	0.79	18	0.96	0.99	0.78	0.91	6
Everton	0.63	0.61	0.67	0.64	22	0.62	0.66	0.72	0.67	21
Liverpool	0.92	0.95	0.92	0.93	8	0.94	1.00	0.95	0.96	3
Man City	0.99	1.00	1.00	1.00	1	1.00	1.00	1.00	1.00	1
Man Utd	0.87	1.00	0.96	0.94	7	0.98	0.96	1.00	0.98	2
Newcastle	0.62	0.73	0.86	0.74	20	0.84	0.71	0.79	0.78	15
Tottenham	0.99	0.86	1.00	0.95	6	0.87	1.00	0.89	0.92	4
West Ham	1.00	0.92	0.87	0.93	10	1.00	0.78	0.82	0.87	8
Wolves	0.83	0.78	0.79	0.80	17	0.86	0.76	0.80	0.81	12
Average	0.86	0.86	0.88	0.87		0.88	0.86	0.85	0.86	
Standard deviation	0.14	0.12	0.10	0.12		0.11	0.12	0.10	0.11	
Minimum	0.62	0.61	0.67	0.64		0.62	0.66	0.72	0.67	
Maximum	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	

Source: Authors' own elaboration based on data from Transfermarkt.com, ClubElo, and reports by Deloitte [2022, 2025] and Grant Thornton [2023, 2024].

Slack analysis, e.g. for 2023 (Table 5), indicated that in Model 1 and Model 2, both leagues exhibited slacks mainly on output variables (both sporting and financial results), with a greater frequency in the EPL, implying considerable expansion potential through efficiency improvements.

Table 5. Slacks in 2023 assuming separate frontiers for both leagues

	Model 1				Model 2			
	I1	I2	O1	O2	I1	I2	O1	O2
PE								
Cracovia	0.00	0.00	0.00	9.87	10.42	0.00	46.09	4.63
Górník Zabrze	0.00	22.44	0.00	2.14	50.91	0.00	69.39	8.00
Jagiellonia Białystok	0.00	0.00	0.00	2.76	0.00	0.00	67.13	9.19
Lech Poznań	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Legia Warszawa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Piast Gliwice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pogoń Szczecin	0.00	0.00	8.03	9.12	0.00	0.00	0.00	0.00
Raków Częstochowa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stal Mielec	0.00	0.00	0.00	0.00	0.00	0.00	65.10	0.53
Śląsk Wrocław	0.00	0.00	146.55	10.29	0.00	0.00	100.40	8.03
Warta Poznań	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zagłębie Lubin	0.00	0.00	101.05	19.00	157.40	0.00	89.05	4.78
EPL								
Arsenal	0.00	136.44	41.85	16.55	162.83	0.00	114.39	105.16
Aston Villa	0.00	0.00	42.84	232.67	0.00	0.00	42.28	239.31
Brentford	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brighton	0.00	0.00	0.00	0.00	0.00	24.97	0.00	60.93
Chelsea	0.00	125.44	186.51	172.07	57.21	0.00	175.12	227.05
Crystal Palace	0.00	0.00	0.00	87.03	0.00	0.00	0.00	104.41
Everton	0.00	164.89	47.16	171.84	77.56	0.00	110.01	104.94
Liverpool	0.00	133.46	93.10	76.59	22.61	0.00	0.00	68.75
Man City	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Man Utd	0.00	209.57	137.41	6.49	0.00	0.00	0.00	0.00
Newcastle	0.00	89.31	0.00	100.31	0.00	0.00	0.00	167.05
Tottenham	0.00	0.00	0.00	0.00	0.00	0.00	106.55	100.65
West Ham	0.00	17.57	0.00	83.95	0.00	0.00	31.05	109.72
Wolves	0.00	0.00	39.01	89.32	0.00	0.00	23.70	83.84

Source: Authors' own elaboration based on data from Transfermarkt.com, ClubElo, and reports by [Deloitte \[2022, 2025\]](#) and [Grant Thornton \[2023, 2024\]](#).

Benchmarks varied over time for most DMUs – the corresponding results, for example for model 1, are presented in Table 6. In the Polish Ekstraklasa, Lech Poznań (in 2023) most frequently served as a reference unit, while in the English Premier League, this was the case for Tottenham (in 2023) and Manchester City (in 2023).

Table 6. “League” reference units 2021–2023, Model 1

	2021	2022	2023
PE			
Cracovia (CR)	LP22 (41), RC23 (20), SM 22 (29), SM23 (28)	LP22 (40), RC23 (5), SM 22 (55)	GZ21 (14), LP22 (28), SM22 (58)
Górník Zabrze (GZ)	GZ21 (27), LW21 (38), WP23 (35)	GZ21 (70), LP22 (24), SM22 (7)	11
Jagiellonia Białystok (JB)	GZ21 (17), LP22 (28), SM22 (26)	GZ21 (14), LP22 (30), SM22 (56)	GZ21 (28), LP22 (18), SM22 (54)
Lech Poznań (LP)	-	19	GZ21 (33), LP22 (52), LW11 (16)
Legia Warszawa (LW)	1	LP22 (76), LW23 (33)	4
Piast Gliwice (PG)	1	LP22 (11), LW21 (13), RC23 (10), WP23 (67)	LW21 (2), PG23 (28), WP23 (70)

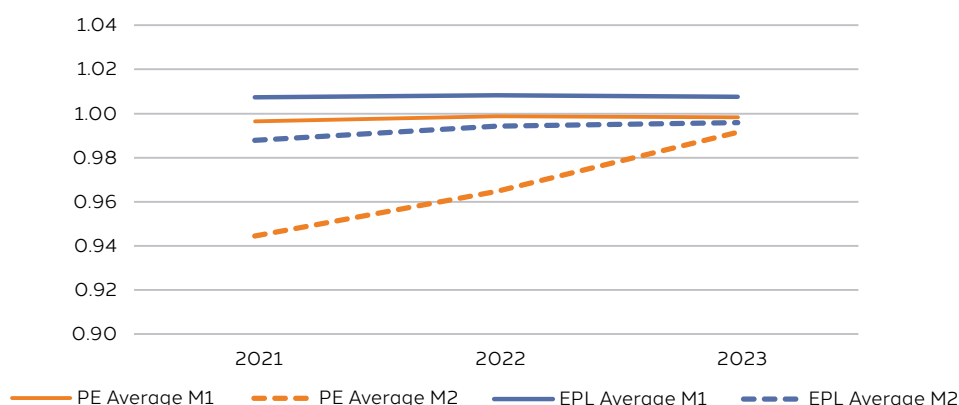
cont. Table 6

	2021	2022	2023
Pogoń Szczecin (PS)	LP22 (60), RC23 (18), SM23 (22)	LP22 (53), RC23 (4), WP23 (37)	GZ21 (8), LW21 (16), WP23 (76)
Raków Częstochowa (RA)	11	RC23 (61), SM23 (2), WP23 (36)	LP22 (1), RC23 (25), SM23 (4), WP23 (71)
Stal Mielec (SM)	1	11	RC23 (5), SM22 (46), WP21 (50)
Śląsk Wrocław (SW)	LP22 (45), RC23 (25), SM23 (30)	LP22 (49), SM22 (51)	GZ21 (14), LP22 (38), SM22 (48)
Warta Poznań (WP)	6	RC23 (3), SM23 (1), WP21 (51), WP23 (45)	2
Zagłębie Lubin (ZL)	LP22 (79), RC23 (3), SM22 (18)	GZ21 (35), LP22 (53), SM22 (12)	GZ21 (65), LP22 (30), SM22 (5)
EPL			
Arsenal (AR)	BRI23 (40), MC23 (18), TO23 (742)	BRI23 (11), MC23 (13), TO23 (76)	MC23 (56), TO23 (45)
Aston Villa (AV)	BRE21 (47), TO23 (39), WH21 (14)	BRE21 (24), MC23 (4), T23 (72)	BRE21 (21), MC23 (33), T23 (47)
Brentford (BRE)	8	2	4
Brighton (BRI)	BRE21 (30), BRE22 (62), MC23 (8)	BRE21 (43), BRE23 (5), BRI23 (48), TO23 (4)	7
Chelsea (CH)	MC23 (62), TO23 (38)	MC23 (95), TO23 (5)	MC23 (61), TO23 (39)
Crystal Palace (CP)	BRE21 (70), MC23 (5), TO23 (25)	BRE21 (51), BRE23 (18), MC23 (4), TO23 (27)	BRE21 (49), BRE23 (18), MC23 (4), TO23 (28)
Everton (EV)	BRE21 (31), TO23 (67), WH21 (2)	BRE21 (36), TO23 (64)	BRE21 (42), TO23 (58)
Liverpool (LI)	MC23 (75), TO23 (25)	BRI23 (8), MC23 (84), TO23 (9)	MC23 (86), TO23 (14)
Man City (MC)	BRI23 (11), MC2 (75), TO23 (14)	-	23
Man Utd (MU)	MC23 (97), TO23 (3)	-	MC23 (75), TO23 (25)
Newcastle (NC)	BRE21 (34), TO23 (66)	BRE21 (23), TO23 (77)	BRI23 (40), MC23 (21), TO23 (39)
Tottenham (TO)	BRI23 (21), MC23 (5), TO23 (74)	MC23 (79), TO23 (21)	29
West Ham (WH)	4	BRE21 (21), TO23 (18), WH21 (61)	BRE21 (25), TO23 (49), WH21 (27)
Wolves (WO)	BRE21 (75), BRE23 (8), MC23 (11), TO23 (6)	BRE21 (71), BRE22 (8), MC23 (21)	BRE21 (78), MC23 (21), TO23 (02)

Notes: The percentage shares of reference units in the benchmarks are shown in brackets.

Source: Authors' own elaboration based on data from Transfermarkt.com, ClubElo, and reports by [Deloitte \[2022, 2025\]](#) and [Grant Thornton \[2023, 2024\]](#).

Figure 2. PE and EPL in M1 and M2: average TGR, 2021–2023



Source: Authors' own elaboration based on data from Transfermarkt.com, ClubElo, and reports by [Deloitte \[2022, 2025\]](#) and [Grant Thornton \[2023, 2024\]](#).

The technology gap, as measured by the Technology Gap Ratio (TGR, Figure 2), was observed mainly in the PE, although it was relatively low and diminishing (and only in Model 2), indicating that in general the Polish Ekstraklasa operated with a minimal technological gap. The gap in the EPL was practically absent. These results reinforce the idea that differences in performance between leagues are primarily resource-driven rather than technology-driven. There is no evidence of systemic significant technological inferiority in the Polish Ekstraklasa.

Overall, the findings indicate that both leagues operate with comparable technical efficiency and the same technological frontier, yet resource disparities shape their place on the meta-frontier.

Discussion and conclusions

The study's main objective was to evaluate and compare the efficiency of the Polish Ekstraklasa and the English Premier League over the 2021/22–2023/24 seasons. Based on the SBM extension to DEA and using wages/team values and historical ranking as the inputs, as well as ELO points and revenue as the outputs, we have shown that the average technical efficiency in both leagues is comparable, ca. 0.8, which is less than in Jewell's study of English football [2017a]. However, the difference may be attributed to the specificity of the SBM version of DEA, which usually gives lower than DEA efficiency results [Tone, 2001]. On the other hand, it is comparable to [Pérez-González et al., 2022] or lower [Cifuentes-Faura, 2022] than the efficiencies estimated recently for Spanish clubs (albeit with different methodologies).

Brentford is the only efficient club in Model 1 in all three periods, with its efficiency rooted in its identity as a data-driven club [Chatziparaskevas et al., 2024]. It has built its recruitment, match preparation and injury prevention strategies on advanced statistical analyses and composite performance indicators such as expected goals (xG). This data-centric model has allowed Brentford to compete effectively in the Premier League despite comparatively limited financial resources, demonstrating that even in an era of significant professionalisation of football and widespread adoption of sports analytics, such an approach can still serve as a source of competitive advantage [Memmert, Raabe, 2023]. Both clubs illustrate how targeted resource allocation can yield strong sporting and financial outcomes without matching the spending levels of wealthier competitors.

Other interesting benchmarks that were efficient in at least two of the three periods include Warta Poznań, Lech Poznań and Stal Mielec. In the case of Warta, this outcome reflects the strategy of maintaining a low-cost squad that consistently secured the club's place in the Polish Ekstraklasa. Following promotion, the club retained most of its existing roster, refraining from heavy spending in the transfer market and avoiding a rapid increase in operating costs to the level of other top-tier teams. Lech's strategy, in turn, is built around a strong youth academy, which ensures a steady inflow of talent while keeping the club's wage bill at a sustainable level. This approach, however, comes at the cost of maintaining the most expensive academy in the league, with annual expenses of £3.75 million [Grant Thornton, 2024], which is outside the scope of inputs considered in the efficiency analysis. An additional benefit is the significant income from player transfers (not included in our models as they do not constitute core operating revenues), which in the analysed period generated an extra £20 million for the club [Deloitte, 2022; Grant Thornton, 2023, 2024]. Stal Mielec, in turn, builds its squad primarily through scouting undervalued players from lower divisions or foreign leagues, often on free transfers or low-fee deals, and developing them into saleable assets. The club complements this with a compact wage structure, targeted short-term contracts to manage financial risk, and a focus on players with immediate impact potential [Najtkowski, 2024; Piórek, 2023], enabling competitive performance despite operating on one of the lowest budgets in the league. This approach aligns with one of the four team-building strategies identified by the European Club Association [2012], namely the strategy of buying and developing young players, which, given the adopted set of variables, would *ceteris paribus* yield higher efficiency estimates in Model 1, as younger players typically receive lower wages. However, when efficiency is evaluated using market-value-based inputs, as in Model 2, the relative advantage of this strategy may diminish, which appears consistent with the comparison observed for Brighton.

At the other end of the financial spectrum is Manchester City, which in the 2023/24 season recorded the highest wage bill in the EPL, amounting to £413 million [Deloitte, 2025]. Despite such high salary expenditure, the club has managed to remain highly efficient, achieving efficiency scores above 0.90 in all three periods and being fully efficient in two of them. Its strategy combines substantial cash investments in the transfer market with a cumulative net spend of £1,040.19 million over the last ten seasons (since 2016), calculated in nominal terms, which represents the fourth-largest deficit in the EPL after Chelsea, Manchester United and Arsenal [Transfermarkt, n.d.], with the leadership of an exceptional manager [Narita et al., 2024]. This combination of financial strength and managerial expertise enables Manchester City to consistently convert its considerable resources into both domestic and international success.

The diversity of efficient clubs in our study allows for a better understanding of sporting strategies related to team building, which, according to the European Club Association [2012], can be categorised into four main types: (1) relying on players promoted from the youth academy, focused on nurturing homegrown talent and later selling them for profit; (2) buying and developing young players, centred on acquiring promising talents, providing them with first-team opportunities, and selling them in their prime; (3) remaining competitive by acquiring mature players at moderate cost, often through free transfers or players unwanted by top clubs; and (4) acquiring star players, building the club's business model around high-profile signings that drive media exposure and revenue. In our results, Lech Poznań appears to follow the first strategy, Brentford the second, Warta Poznań and Stal Mielec the third, and Manchester City the fourth, which indicates that there is no single strategy guaranteeing success, but rather that efficiency can be achieved through different approaches when the chosen model is well matched to a club's resources and capabilities.

Among the inefficient clubs in both leagues, Everton and Aston Villa, as well as Śląsk Wrocław and Zagłębie Lubin, stand out. Previous studies on club efficiency highlighted the importance of managerial quality [Haas et al., 2004; Miragaia et al., 2019]. As shown by Narita et al. [2024], poor managerial appointments have significantly negatively impacted Everton's performance. Beyond managerial choices, overall governance quality is also crucial. In clubs based on public capital, such as Śląsk, whose majority owner is the city of Wrocław, and Zagłębie, whose majority owner is the state-controlled company KGHM, structural inefficiencies tend to be greater compared with competitors managed under private ownership [Nessel et al., 2022; Wyszynski, 2021]. In the case of Aston Villa, recent changes in ownership [Financial Times, 2024] may also have contributed to organisational instability, which is generally not conducive to efficiency. All four clubs could improve substantially in terms of both inputs (and, in the case of the two Polish clubs, sporting results), based on Model 1 and Model 2.

These findings have some research, methodological and practical implications. In the research area, the existing literature consistently points to the advantage of the Big Five leagues over peripheral leagues, largely stemming from resource superiority, primarily higher revenue and access to more talented players [Peeters, Szymanski, 2014; Plumley et al., 2017]. At the same time, it has not been directly examined whether other factors, such as technological lag or lower technical efficiency in peripheral leagues, contribute to sustaining this advantage. Our study shows that in the analysed period, differences between the Premier League and the Ekstraklasa can be explained solely by resource advantages, with no evidence of significant differences in technical efficiency or operating technology.

The average efficiency levels in both leagues are similar, indicating that improving managerial efficiency in the Ekstraklasa, while desirable, would not, on its own, close the gap with the Premier League. In practice, better utilisation of existing resources can improve performance, but it cannot substitute for an increase in the resource base if the goal is to achieve comparable sporting and financial results. Higher efficiency may be a competitive advantage within a given league, but it will not enable a substantial "leap" in the international hierarchy.

From a methodological standpoint, our contribution lies in using Elo ratings as the measure of sporting performance within the efficiency framework, paired with Transfermarkt valuations as the proxy for resource endowment. While both metrics are often used interchangeably as indicators of team strength [Peeters, 2018;

[Csató, 2024](#)], they capture different dimensions: Transfermarkt reflects the perceived potential of the squad, whereas Elo is based solely on realised results, adjusted for opponent strength, home advantage and margin of victory. In this setup, Transfermarkt represents the input and Elo the output, aligning with the logic of the specific “production process” taking place in sport. As expected, the two measures were highly correlated in our data, suggesting that when used as proxies for team strength they would likely yield similar results.

Finally, the practical implications are twofold. First, in the absence of significant technological differences, transferring managerial practices between clubs and leagues is relatively feasible, with football associations playing a key role as intermediaries and coordinators in this process. Second, the findings of this paper could enable each club to identify its areas of inefficiency (slacks) and select appropriate benchmark clubs from which to learn and implement measures to improve efficiency. This approach enables optimising existing resources without the immediate need to increase financial expenditure.

These implications are not without limitations. The principal limitation of our empirical strategy is the inability to establish the causal direction between revenue and wage expenditure, as the relationship may involve reverse causality and partially predetermined revenue components. Several additional methodological constraints should also be acknowledged. First, the analysis covers a relatively short period, which may limit the ability to capture long-term trends and changes in managerial efficiency, and which might not fully reflect the dynamic nature of sports clubs’ operations. Moreover, the study concludes in 2023 due to data availability, meaning that the current situation of many clubs may already differ substantially. Second, excluding clubs that experienced promotion or relegation during the studied period reduces the sample’s representativeness and may affect the generalisability of the results. This approach was necessary to maintain comparability but overlooks the specific challenges and management dynamics faced by teams moving between league levels. Third, limitations also arise from data availability and quality. For example, the measures of players’ market value and national all-time ranking may not fully capture the complexity of clubs’ resources and activities. In particular, the I2 measure may overstate the potential of long-standing but moderately successful clubs while underestimating those that have achieved strong results over a shorter period of top-tier participation. Fourth, the composition of the sample of two groups, which are so clearly differentiated by the resource endowments, may force the shape of the meta-frontier to retrace the shapes of the league frontiers. The reasoning around the shape of the meta-frontier, and hence the TGR and technology gap, may thus be biased. It should be verified by including more leagues of comparable resources to the Polish and English leagues, respectively. Finally, although the efficiency frontier in the EPL is at a similar level to that in other Top 5 leagues [\[Boto-García et al., 2023\]](#), it cannot be ruled out that one of the second-tier leagues may be more efficient, and that it is there that one should look for the best benchmarks for clubs from leagues such as Poland.

Therefore, future studies should extend the analysis over longer periods to capture trends and changes in managerial efficiency over time. They should also broaden comparisons by including both leagues with similar market potential and resource availability to the Polish Ekstraklasa and other top-tier leagues from the Big Five, as these may each contribute differently to the shape of the meta-frontier. Furthermore, future research could distinguish between operating and transfer-related revenue to examine how the inclusion or exclusion of transfer activity influences measured efficiency and financial outcomes. This distinction is particularly relevant in football, where transfer operations significantly affect clubs’ financial performance.

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