



# The impact of foreign players in the English premier league: a mathematical analysis

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## Abstract

We undertake extensive analysis of English Premier League data over the period 2009/10 to 2017/18 to identify and rank key factors affecting the economic and footballing performances of the teams. Alternative end-of-season league tables are generated by re-ranking the teams based on five different descriptors—total expenditure, total funds spent on players, total funds spent on foreign players, the ratio of foreign to British players and the overall profit. The unequal distribution of resources and expenditure between the clubs is analyzed through Lorenz curves. A comparative analysis of the differences between the alternative tables and the conventional end-of-season league table establishes the most likely factors to influence the performances of the teams that we also rank using Principal Component Analysis. We find that the top teams in the league are also those that tend to have the highest expenditure overall, for all players, including foreign players; they also have the highest ratios of foreign to British players. Our statistical and machine learning study also indicates that successful performance on the field may not guarantee healthy profits at the end of the season.

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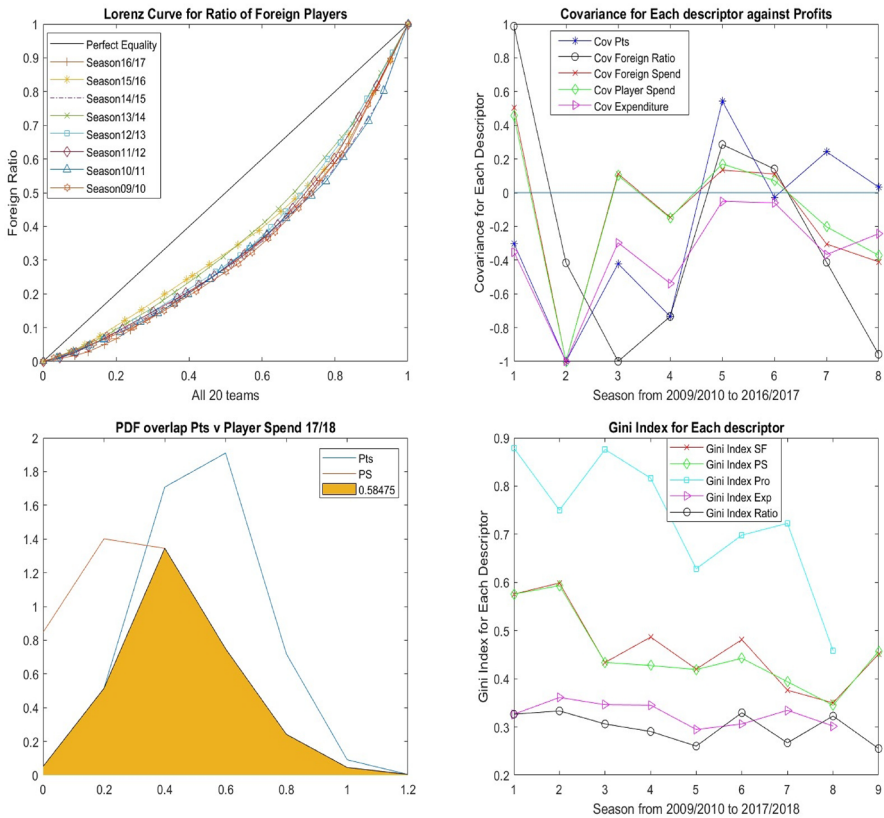
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## Graphical abstract



**Keywords** English premier league · Correlation coefficients · Lorenz curve · PDF

## 1 Introduction

From its humble beginnings in England in the middle of the 19th century, modern football (also known as ‘soccer’) has evolved into a major world wide sport. Indeed, it involves substantial investments both financially and in the form of human capital (players and spectators). In spite of this, a systematic analytical investigation of the impact of the players and the funding on the outcomes of the tournaments is lacking in the literature. We address this absence by performing a comprehensive study of the impact of foreign players in the English Premier League (EPL). We chose to study the EPL as, apart from being the historical birthplace of football, it’s arguably

the most ‘successful’ league in the world and it has a very highest percentage of foreign players. To avoid any distortions, we worked with data prior to the pandemic. A key aspect of this study is the consideration of a multidimensional model to address multiple interconnected factors affecting the decision-making logistics that makes this a highly complex system.

The English Premier League (EPL) was founded in 1992 and, over time, has built up a reputation for being one of the most competitive leagues in European soccer [1]. As a consequence, the EPL has attracted numerous sponsors who wish to benefit from its global reach and appeal, for example through kit sponsorship shown in Fig. 1. The sponsorship and, in addition, the increased funding resulting from broadcasting rights, have permitted the clubs to invest in the best players and other assets. As is well known, the ‘better’ perceived players tend to cost more.

Considerable financial activity surrounds the movement of players (and, hence, funds) between clubs during the two annual transfer windows. The underlying motivation behind the activity is usually either to reinforce a club’s challenge at the top of the table or a rearguard action in the dangerous relegation zone [2]. The transfer of players takes place in a global market. As a consequence, the composition of the EPL teams we see today is very different to what it was when the league was first



**Fig. 1** An illustration of some of the different sponsors of teams in the premier league for the 2016/17 season

launched in 1992. Indeed, it has been described as the Premier League's worldwide pool of talent [3]. As far back as the 2012/13 season, only 32 Premier League starts were by players qualified to play for England, compared to 69 twenty years ago [4]. Nowadays, the EPL has one of the highest percentages of foreign players when compared to other European football leagues at 69.2 [5] and 65 different nationalities are represented in the competition with French and Spanish being the most common [5]. Data analysis has played a key role in this as clubs are now able to draw up a short-list of players whose playing statistics match the profile of their ideal target signing [6]. The low percentage of players in the EPL eligible to play for England led the former FA Chairman Greg Dyke to call a commission to address the issue as it was felt that there could be consequences if the selection pool for the national team contained insufficient numbers of players participating in the sport at the highest level.

First, we explain how performance in the football field is quantified in the EPL structure. Points determine the position of a team in the EPL table. Three points are awarded for a win, one point for a draw and none for a loss. At the end of a season, the total number of points for each team determines the winner of the league and also those to be relegated. The three teams with the fewest points are relegated to the Championship; their places are taken by three teams promoted from the Championship. If the number of total points is the same between two teams, then the teams are ranked by goal difference which is the number of goals scored minus the number of goals conceded. The higher the goal difference, the higher the ranking of the team. If the rank of the two teams still cannot be separated by total points or goal difference, then goals scored by the teams are used to separate them, with the team with more goals ranking higher. If that cannot separate the teams, then they receive the same rank. There are 20 teams in the EPL and they play each other twice in a season from August to May, one home fixture and one away. As a result, each team plays 38 games in the full season.

The main purpose of the present work is to examine the impact of foreign players on the EPL. We want to investigate whether foreign players improve the performance of their clubs and/or generate sufficient additional income to justify the initial expenditure. It has been argued that the uncertain outcome of investment in players, influences the amount of revenue that the club can generate and therefore the capacity to recoup the investment cost [7].

Although the main indicator of a team's success over a given season is the club's position in the end-of-season league table, numerous studies have been undertaken in an attempt to quantify the full or true measure of achievement [8]. Oberstone [9], for example, has developed a regression model to study five independent criteria in addition to the end-of-season points in an attempt to differentiate the various teams at the top of the table: individual performance of the players on the pitch; quality of defence; number of goal attempts; discipline of players; and the consistency of passes made during matches. Each individual descriptor was further refined in order to extract additional information. Somewhat unsurprisingly, the conclusion was that the success of a team was most likely to be determined by the collective performance of its players throughout the season. A key variable in this model relates to the quality of the defence

of a team. This observation is supported by the belief of many commentators that the number of goals conceded during a season by a team is probably one of the most important aspects [10] that should be considered. The importance of an organized and effective defence is also discussed by [11] in a rather limited study restricted to just a single season's data [12]. Hence, there is growing quantitative evidence that a team's overall performance is determined by the contributions of individual players on the field.

The significance of the international transfer market and its effects on the EPL were studied by Madichie [13] who argued that foreign players have contributed positively to the development of top league football teams. However, Madichie [13] refers only to high-profile players who have an additional marketing appeal which can make a substantial financial contribution to a club's balance sheet [14]. For example, the purchase of Cristiano Ronaldo by Juventus for over \$ 100 million enabled his new club to sell \$ 60 million worth of his jerseys within 24 h [15] in 2018.

Other authors have attempted to re-rank the EPL table based on new criteria in order to obtain a league table which captures additional relevant information. Firth [16] re-ranked the table by incorporating the schedule strength of each team. The resulting table takes into account the opportunity to gain points by considering whether a team is playing at home or away and also the difficulty of the matches played.

Several authors have also studied related problems in football. For example, an empirical study of the distribution of goals in football leagues in Italy, England, Spain and Brazil was undertaken by Malacarne and Mendes [17]. Surprisingly, they found distributions not too dissimilar to those that emerge within non-extensive statistical mechanics. Hidden power laws have also been discovered in the European football leagues [18] as well as a power law distribution for the tenure length of sports managers [19].

In the next section, we describe the methodology used in our work. We first discuss the data and then the re-ranking technique used to re-rank the teams according to five different criteria employed. This is followed by an analysis of the distributions of the resources and expenditures throughout the EPL; each criterion is discussed in detail. In the subsequent section, we discuss the results from a multivariate investigation of the data. We conclude with a summary of our findings, especially those relating to the impact of foreign players in the EPL.

## 2 Methods

### 2.1 Problem statement

In this article, we re-rank the final EPL table from 2010 to 2017 using five different criteria: proportion of foreign to British players; expenditure on foreign players; expenditure on all players; overall profits; and overall expenditure. This re-ranked structure is then compared against the official rankings based purely on the performance of the teams throughout the season. Our objective is to statistically analyze key optimization factors balancing and affecting sporting performance against the

econometrics involved in purchasing (or selling) players as well as other monetary incentives like television rights and advertisements. As a result, we specifically address the question: ‘Do teams with a higher proportion of foreign to British payers outperform those with a lower figure?’ An associated question to this is if teams spending more on all players outperform those spending less. We then focus on the key question of monitoring the expenditure of foreign players. Is it statistically true that teams spending more on foreign players outperform those spending less, or in a similar vein, do teams with more profits outperform less profitable ones? Overall, how does total expenditure contribute to the sporting performance graph? What we do not explicitly address are auxiliary questions like the sustainability of the expenditure graphics and the overall loss of local face in the money-dominated leagues.

The above questions are investigated statistically to answer how each criterion correlates with the performance of the teams as measured by the conventional league table. The unequal distribution of the players, wealth and expenditure amongst the clubs is then measured via Gini coefficients or, equivalently, Lorenz curves [26] and also by evaluating the overlaps between probability distribution curves. Finally, we carry out a principal component analysis.

## 2.2 Data collection

The empirical data analyzed in this work were acquired from a number of football and general sports-related websites over a period from 2010 to 2017. Although the information is available in tabulated form on the web pages, it had to be parsed into Matlab for further reformatting and manipulation. Data for the conventional end-of-season EPL standings were obtained from [21]. Information regarding the other criteria of interest in the present study was extracted from various different sources. For example, the nationalities of the players in each squad were downloaded from [21] and the price paid (in millions of pounds) by the teams for players during the transfer windows from [23]. Profit and expenditure details for the teams were obtained from the data held by Companies House [24].

## 2.3 Re-ranking the English premier league

As mentioned above, we employed five different criteria to re-rank the league tables. We will use the data at the end of the 2009/10 season to illustrate our procedure. Table 1 below contains 13 columns of data from 2009/10. The ones in the middle (columns 6–8) contain the conventional information as found in a standard EPL table at the end of the season. Columns 9–13 contain the data as discussed below for our 5 different criteria. Finally, in columns 1–5 we re-rank the teams using the additional data. We discuss each of the criteria below in detail before performing the re-ranking process.

**Table 1** Re-rank table for 2009/10 season. Total player spend, total foreign spend, profits and expenditure are in millions of pounds. Negative profit means a loss

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	Foreign British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
20	2	12	14	17	1	Chelsea	86	2.4444	21.8	21.8	-70.437	257.727
17	18	13	15	10	2	Man U	85	1.1111	22	22	13.544	191.568
16	20	10	10	18	3	Arsenal	75	3.25	11.2	11.2	92.32	179.496
15	10	14	11	6	4	Tottenham	70	0.8	22.6	12.1	-5.163	134.517
19	1	20	20	14	5	Man C	67	1.5833	89.3	61.8	-117.793	253.801
14	4	18	13	3	6	Aston V	64	0.66667	35.6	21.6	-27.712	117.198
18	7	19	17	19	7	Liverpool	63	3.4286	44.8	23.3	-19.935	227.683
13	12	15	16	7	8	Everton	61	0.9375	23	23	-3.093	101.26
5	16	5	1	1	9	Birmingham	50	0.52632	3.4	0	0.199	56.515
8	13	2	4	20	10	Blackburn	50	3.5	2.3	2.3	-1.896	70.425
7	11	11	12	8	11	Stoke	47	1	18	14.5	-4.517	66.532
11	8	7	7	13	12	Fullham	46	1.5	4.7	4.7	-16.942	97.02
12	5	17	18	4	13	Sunderland	44	0.6875	33.3	26.3	-26.179	97.149
9	3	16	19	12	14	Bolton	39	1.4615	27.1	27.1	-35.443	90.461
4	19	9	9	5	15	Wolves	38	0.77778	10.5	10.5	16.29	44.354
1	15	4	6	16	16	Wigan	36	2	2.9	2.9	0.075	3.677
10	6	3	5	11	17	West Ham	35	1.1429	2.5	2.5	-21.485	94.262
3	17	6	2	2	18	Burnley	30	0.52632	3.5	0	10.247	40.372
6	9	8	8	9	19	Hull	30	1	5.8	5.8	-6.831	58.154
2	14	1	3	15	20	Portsmouth	19	1.8	2	0	0	5.4

## 2.4 Ratio of foreign to British players

Here we are interested in the ratio of foreign players to those with British nationality (English, Scottish, Welsh and Northern Irish) in each squad. For example, this is shown in column 9 of Table 1 for the 2009/10 season. The teams are then re-ranked using this data in column 5 in order of an increasing ratio i.e. the team with the lowest ratio (Birmingham) is ranked first.

## 2.5 Total expenditure on all players

The total expenditure on all players refers to the spending undertaken by the clubs for players during the two annual transfer windows. This is displayed in column 10 of Table 1 for 2009/10. The teams are then re-ranked in column 3 in order of increased spending, with the lower-spending teams at the top. One would expect to see the teams that have spent the most in transfer windows to be also placed the highest according to the official rank based on points (columns 6 and 8) as financial performance has become one of the key features of football [14].

## 2.6 Total expenditure on foreign players

The total expenditure on all foreign players purchased by the clubs is obviously a subset of the expenditure on all players. This is shown in column 11 for the 2009/10 season. The re-ranking of the teams is performed in order of increased spending and is displayed in column 4. Once again, one expects to see teams that have spent the most on foreign players achieve more points in a season and, thereby, finish higher up in the official league table. This is clearly a consequence of wealthier clubs being able to purchase high-profile players instead of having to develop talent [25].

## 2.7 Total expenditure

The total amount of expenditure by teams in the EPL each season includes all employee costs (players, groundsman, maintenance, etc.), auditor's remuneration, tangible and intangible assets and investments; this is displayed in column 13. In our re-ranking scheme, we rank the teams in order of increasing expenditure, with the team spending the least at the top. This is shown in column 1 of Table 1.

## 2.8 Total profit

The total profit for each team for a season is the difference between the total income and the total expenditure. We display this in column 12 and the re-ranked data in column 2 where we rank the teams in order of increasing profit, with the team making the smallest profit at the top.

The complete data for the re-ranked tables for the eight seasons from 2009/10 to 2016/17 can be found in Appendix 1. There are clear trends to be discerned from these tables: teams finishing higher up in the EPL at the end of a season tend to be at the lower end of all of our re-ranked tables apart from the one relating to the total profit. Hence, the top teams in the EPL are also those that have the highest total expenditure for the three criteria studied (all players, foreign players and overall), as well as the highest ratio of foreign to British players. An obvious exception to our overall observation occurred in 2015/16 when Leicester City were crowned the winners against all odds. We explore this point in more detail later.

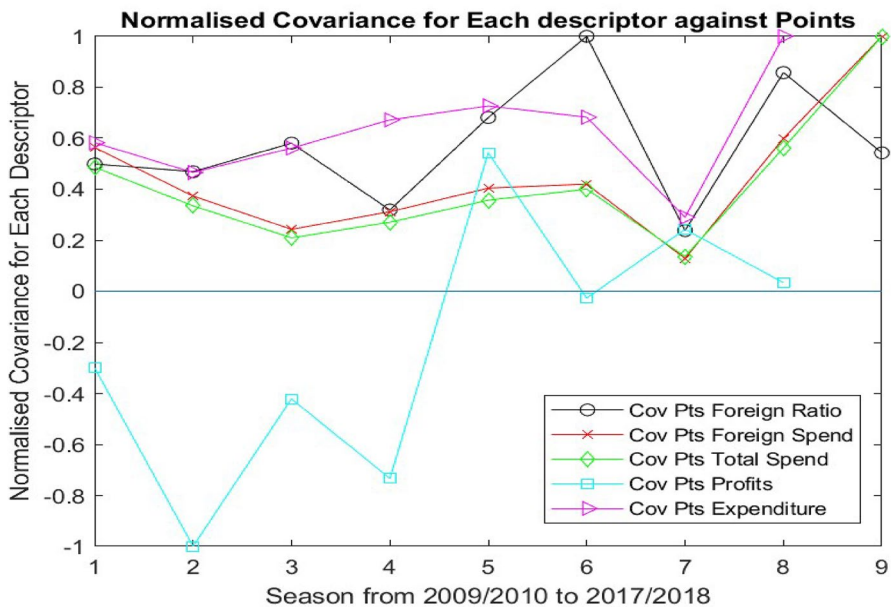
In Fig. 2, we plot the correlation coefficients for each descriptor (our criterion) against the number of points obtained for all of the seasons studied. It is evident that all of the descriptors, apart from the total profit, are correlated with each other.

In the next section, we discuss the results of an extensive analysis of the data.

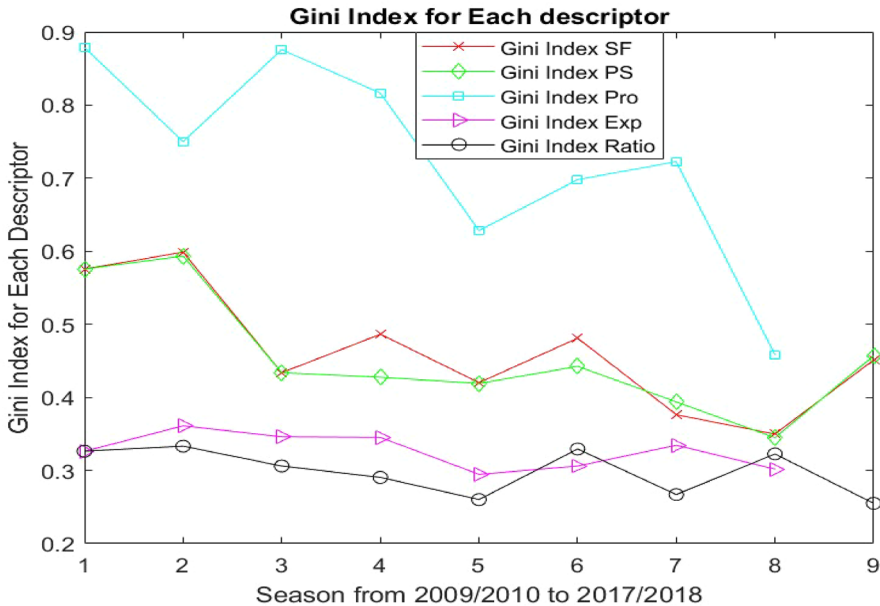
### 3 Results and discussions

#### 3.1 Measures of inequality

The funds available to the teams in the EPL are not distributed evenly and, therefore, neither is the expenditure of the clubs. We estimate the unequal distribution of the resources and the performances of the teams by evaluating several different measures of



**Fig. 2** Correlation coefficients for each descriptor against the number of points. Note that although complete data is displayed for the seasons from 2009/10 to 2016/17, we have only partial data for 2017/18; the data for profits and expenditure for this season was unavailable when this study was undertaken



**Fig. 3** Gini indices for all 5 descriptors spanning years 2009/10 to 2017/18

inequality. The robustness of any given measure should be confirmed by an alternative technique. In order to measure the inequality of the distribution of our five descriptors we first evaluated the relevant Gini coefficients and Lorenz curves for the data [26].

In all figures, we have consistently used circles to indicate “ratio of foreign to British players”, crosses to indicate “spending on foreign players”, inverse ellipses to indicate “total spend”, squares to indicate “total economic profit” and forward triangles to indicate “total expenditure”. As can be clearly seen from Fig. 3, the profit margin shows the highest values with maximum unevenness in distribution over the years while the ratio of foreign to British players (stipulated to 4 maximum) is the most steady profile. The greater inequality in the profit margin is not unexpected though, especially in the context of investment in foreign players that is often much larger than that for the local players.

Figure 4 shows comparative Theil indices for the same descriptor data as in Fig. 3. Clearly, both inequality indices, Gini and Theil, mostly track the inequality baseline but the absolute values are different. Due to the multivariate nature of the data and their interdependence, we tend to rely more on the inequality information from the Theil indices than from Gini indices.

The curves for all five descriptors for all of the seasons investigated are shown in Fig. 5a–e. Note that curves 5a, b display additional data for the 2017/18 season. The deviation from the line of perfect equality (the straight line at  $45^\circ$  in each plot) is an

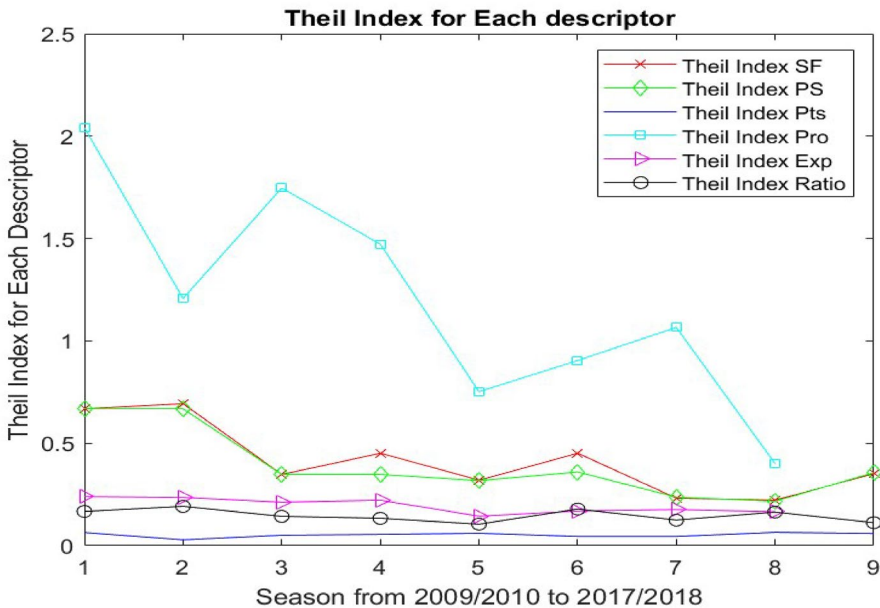


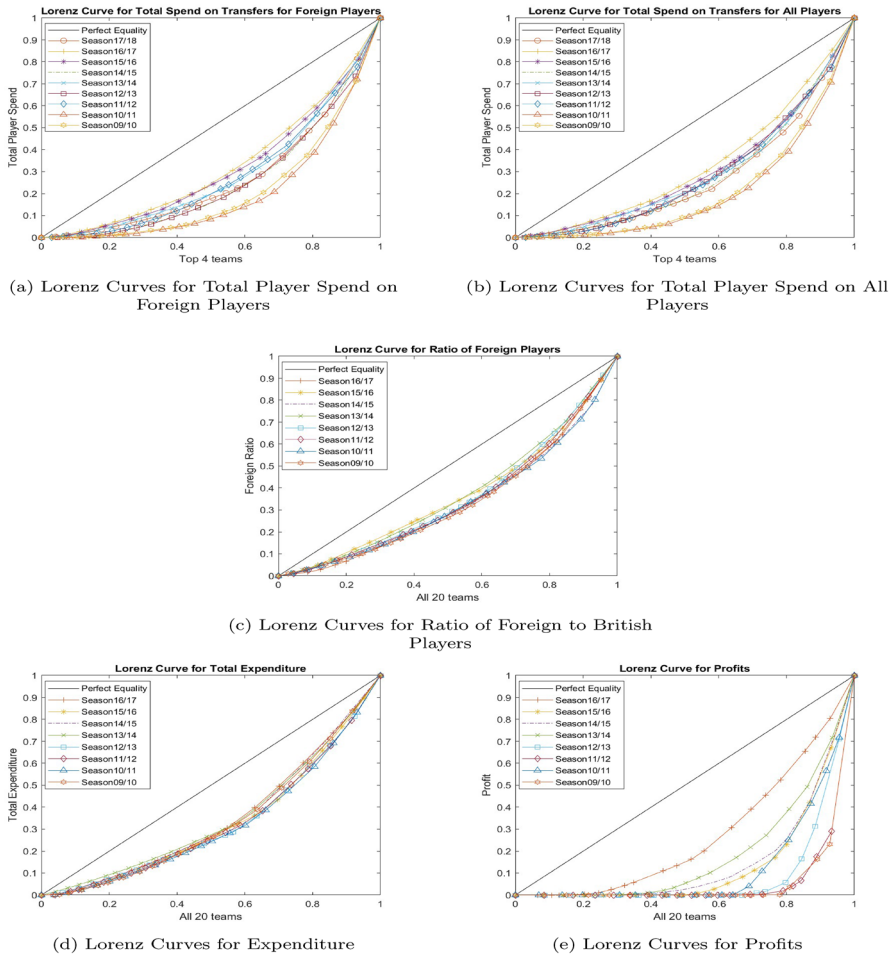
Fig. 4 Theil indices for all 5 descriptors spanning years 2009/10 to 2017/18

indication of the amount of unequal distribution of the quantity of interest. We remind the reader that the Gini coefficient in any particular scenario is simply the ratio of the area between the line of equality and a given curve to the total area under the straight line.

### 3.2 Probability distribution function overlap

The overlapping area of any two given probability distribution curves is an estimate of the agreement of the two descriptors concerned. The numerical value can range from zero (total disagreement) to one (total agreement). In Table 2 we display the values for the non-overlapping areas of the probability distribution curves for the points and the five descriptors of interest. (Note: non-overlapping areas can range from zero (total agreement) to one (total disagreement)).

An examination of Table 2 reveals that the greatest disagreement, over the time period considered, is between the profits and points achieved by a team. This is also clearly evident from Fig. 4 where we re-plot the data against the seasons. Note that in Fig. 4 the seasons run from right to left, with the data for 2009/10 displayed on the extreme right. We notice that the curve for the disagreement between the points and the profits is consistently above all others. (There was no data available for the profits and expenditure for the season 2017/18 when we undertook the analysis. Hence we disregard all entries for the season 2017/18 in Table 2 above.)



**Fig. 5** Lorenz curves for each descriptor against points

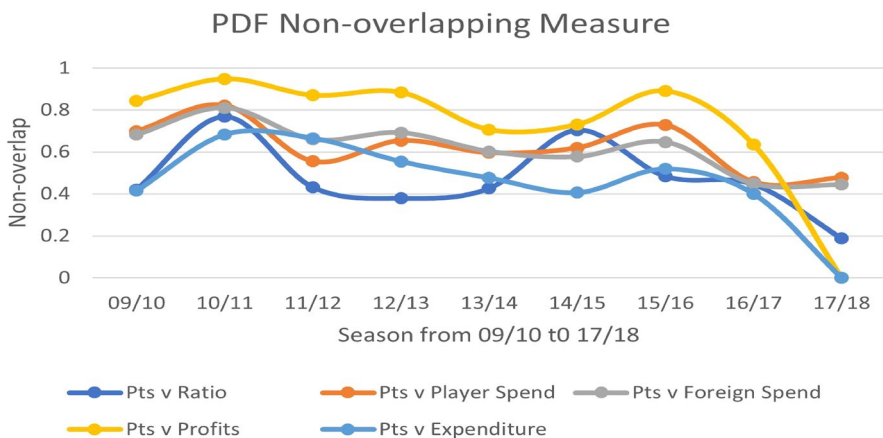
Hence, the achievements of the teams on the playing fields are not translated into profits on the balance sheets for the clubs. In Fig. 6, we can also see that the peaks in all of the inequality curves occurred during the 2010/11 season. It's interesting to note that rules regarding financial fair play to encourage responsible spending for the long-term benefit of football were introduced in the 2011/12 season [30].

### 3.3 Principle component analysis

Finally, we perform a Principal Component Analysis (PCA) [27] of the data in order to determine the most influential descriptors. Principal component analysis

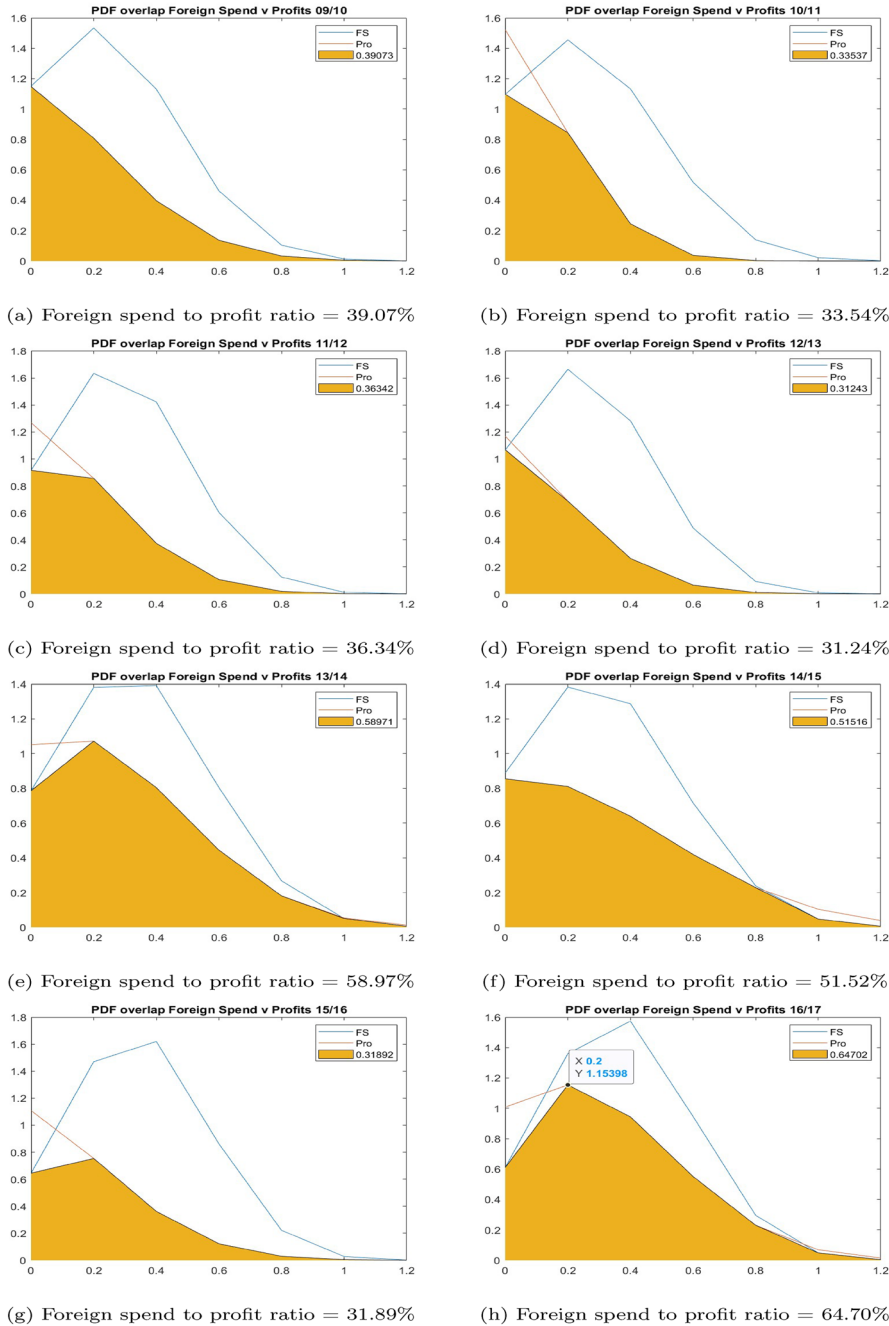
**Table 2** Probability distribution function non-overlap values between points and the five descriptors. Note that higher values imply higher disagreement between the two distributions

Season	Pts versus Ratio	Pts versus Player spend	Pts versus Foreign spend	Pts versus Profits	Pts versus Expenditure
2016/17	0.4451	0.4554	0.4485	0.6346	0.3995
2015/16	0.4829	0.7280	0.6474	0.8905	0.5191
2014/15	0.7037	0.6196	0.5775	0.7307	0.4058
2013/14	0.4259	0.5958	0.6023	0.7062	0.4762
2012/13	0.3782	0.6538	0.6918	0.8838	0.5543
2011/12	0.4312	0.5549	0.6599	0.8703	0.6657
2010/11	0.7679	0.8221	0.8108	0.9484	0.6827
2009/10	0.4208	0.6990	0.6823	0.8437	0.4149

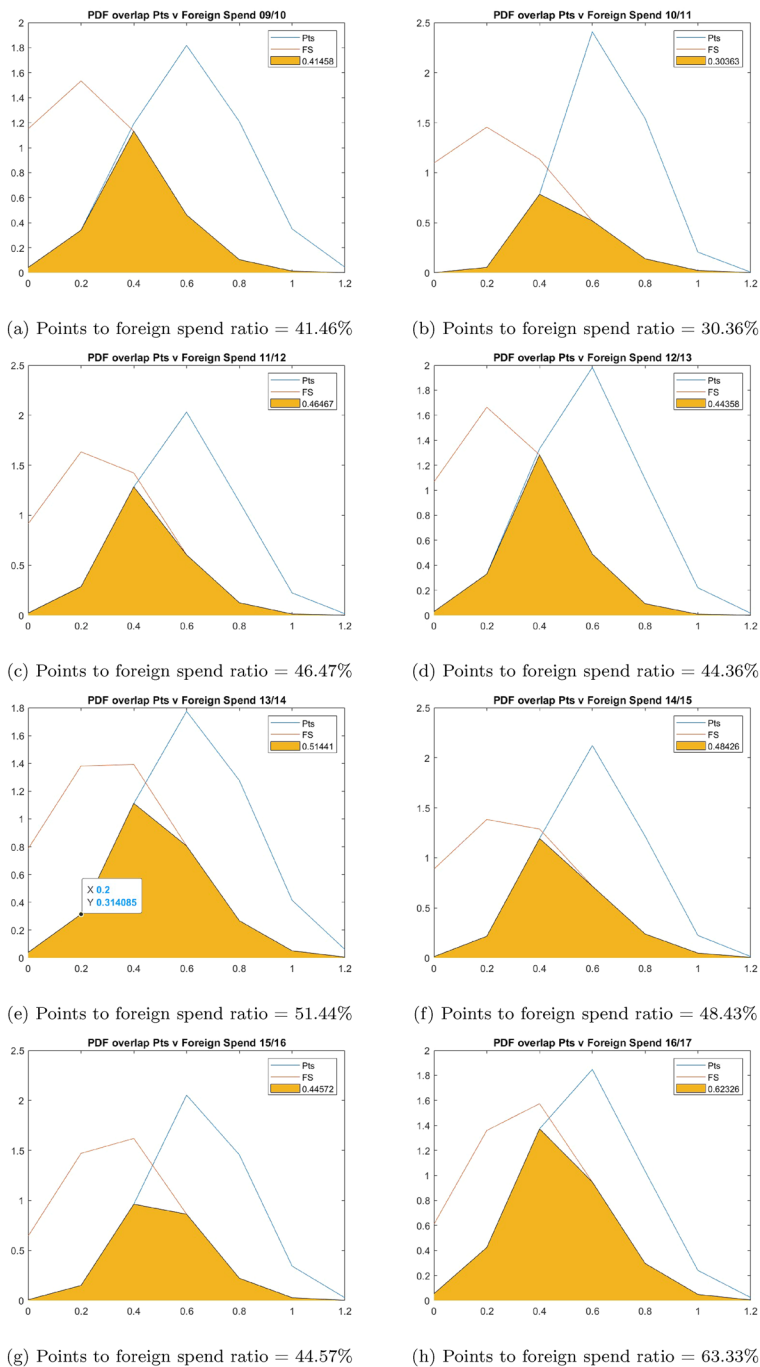
**Fig. 6** A plot of the non-overlapping measure of disagreement between points and the other descriptors spanning 2009/10 to 2017/18

is a statistical procedure that uses an orthogonal transformation to convert a set of observations of correlated variables such as the ones we are dealing with into a set of values of linearly uncorrelated variables called principal components. The PCA was carried out using the standard inbuilt facility available in MATLAB 2023a [31].

The outcomes from the PCA are tabulated in Appendix 2 (see Tables 11, 12, 13, 14, 15, 16, 17 and 18) for all of the seasons studied. The majority of the variation in the data is explained by the columns headed PCA 1. We can see that the expenditure has the highest coefficient in all of the cases tabulated, followed by



**Fig. 7** Percentage of spends on foreign players that translated into economic profit



**Fig. 8** Correlation between footballing performance, measured as number of points scored, against economic profit

expenditure on all players and foreign players. Hence, the majority of the variation between the teams can be described by these three descriptors. The results are consistent over all seasons considered.

### 3.4 Impact of descriptors on economic profit

To analyze the quantitative impact on profit, the first of the indicators that we focused on evaluates the fraction of investment on foreign players that translated into eventual economic profit. To understand this, we calculate the overlapping regions of the probability density functions (PDFs) of the investment on foreign players to economic profits. Note, this is a complex question to answer as the 5 descriptors considered are interlinked and hence the impacts are difficult to untangle. Nevertheless, as Fig. 7 clearly shows, 2015/16 was a remarkable year that contributed to a higher profit margin in the year following, compared to previous years. This is indicative of the impact of Leicester City unexpectedly winning the Premier League against all odds in that season.

A correlated indicator would be measuring the overlapping regimes of the probability density functions for the points scored against the investment on foreign players. This specific indicator is meant to understand how much of the investment on foreign players actually translate into performance on the field. As Fig. 8 shows, the correlation is clearly positive, an observation that follows the trend previously demonstrated in Fig. 7.

Three other indicators have also been measured. These are as follows: correlations between total investment on all players against profit, points acquired by the teams against investment on all players, and net economic profit against total expenditure. The trends are consistent with those from Figs. 7 and 8.

## 4 Conclusion

To conclude, we have undertaken an extensive analysis of the data for the English Premier League over the period covered from 2009/10 to 2016/17 (with some additional data from the 2017/18 season). Our analysis is structured on a multivariate assessment of five key descriptors, total expenditure, funds on all players, funds on foreign players, the ratio of the number of British to foreign players and overall monetary profit. The complexity of the mutual relationship between these factors is demonstrated in the mutual covariance matrix as shown in Fig. 2. Clearly, there is no indicative pattern that can demonstrably comment on the impact trend. By re-ranking the teams using these five descriptors, we are able to establish alternative league tables to the conventional ones, ranking that could optimize investment against points procurement by the teams concerned.

A comparative analysis of the differences between the tables permits us to establish the most likely factors to influence the performance of the clubs. We find that the top teams in the conventional league are also those that tend to have the highest expenditure overall as well as for all players and foreign players; they also have the highest ratios of foreign to British players, as clearly evidenced by the Gini coefficients calculated from the Lorenz curves shown in Fig. 3 as also from the Theil indices as shown in Fig. 4. While the respective profiles for the ratio of British to foreign players and that for expenditure are closely matched over the years considered, the other three descriptors clearly show distinctive time dependence. Clearly, the impact from foreign players cannot be immediate. A certain minimal time would be required for investment on foreign players to mature into tangible productivity in the form of performance and profits. An open question here is a club-specific timeline for such productivity. However, we also find that a successful performance on the field by a team is not a guarantee for healthy profits at the end of the season.

It is interesting to note that the season of 2015/16, when Leicester City triumphed, is an exception to our overall conclusions. Indeed, it could be argued that 2015/16 has been the most successful season for British football over the period considered as the correlations for the ratio of foreign to British players, the spend on foreign players, the total spend and the total expenditure were all at their lowest. Furthermore, the correlation for the profits was positive. All such details can be found in the 3 Appendices.

Our analysis indicates that on-field performances do not necessarily reflect as economic profits or losses. It would be interesting to investigate whether our findings are replicated in other football leagues around the world. We are also planning an extension of this analysis to incorporate additional strategic factors at granular levels, that would be club-specific and targeted towards optimizing footballing and economic performance focusing on sustainability while still being competitive. Furthermore, our study can in principle be used by the football club owners to target either glory on the field or a healthy balance sheet.

## **Appendix 1: Re-ranked tables for all twenty teams over eight seasons (2017/18 data are only partially available)**

See (Tables 3, 4, 5, 6, 7, 8, 9 and 10)

**Table 3** Re-rank table for 2016/17 Season. Total player spend, total foreign spend, profits and expenditure are in millions

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	Foreign British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
18	9	18	19	20	1	Chelsea	93	3.8	143	143	12.97	389.927
15	13	15	13	10	2	Tottenham	86	1.3077	91.9	80.9	28.063	283.953
20	4	20	18	19	3	Manchester City	78	3.6667	194.3	138.8	1.088	512.375
17	17	12	14	6	4	Liverpool	76	1	82.1	82.1	38.917	365.246
16	20	14	16	15	5	Arsenal	75	1.75	88.4	86	58.897	345.305
19	1	19	20	8	6	Manchester United	69	1.0625	173.3	173.3	-85.701	414.172
14	14	13	12	9	7	Everton	61	1.0714	84.15	70.15	30.617	194.466
13	16	11	11	5	8	Southampton	46	0.83333	65.5	52	34.632	187.471
5	11	5	5	3	9	Bournemouth	46	0.375	35.1	28.1	13.991	125.028
4	15	2	2	1	10	West Bromwich	45	0.35294	21.7	15.2	32.289	119.751
11	19	10	10	14	11	West Ham	45	1.6154	52.2	40.2	43.041	170.895
1	3	17	17	16	12	Leicester	44	2	97	97	-0.593	20.928
7	5	6	7	17	13	Stoke	44	2.1111	35.9	34.4	3.574	136.169
12	7	16	15	7	14	Crystal Palace	41	1	96.9	84.9	10.073	171.417
9	10	7	6	12	15	Swansea	41	1.3846	39.2	34	12.996	152.291
2	12	4	3	2	16	Burnley	40	0.36842	29.9	24.1	22.134	101.025
8	6	8	9	18	17	Watford	40	2.2	39.25	39.25	8.141	142.322
3	18	1	1	4	18	Hull	34	0.77778	9	9	42.46	112.593
6	8	9	8	13	19	Middlesbrough	28	1.5	43.55	37.2	11.486	125.906
10	2	3	4	11	20	Sunderland	24	1.3333	25.5	25.5	-10.248	170.616

**Table 4** Re-rank table for 2015/16 season. Total player spend, total foreign spend, profits and expenditure are in millions

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
1	10	7	7	5	1	Leicester	81	0.8125	34.6	29.6	-0.828	19.848
16	20	3	4	17	2	Arsenal	71	2.2	20.6	20.6	25.496	315.946
15	18	16	15	11	3	Tottenham	70	1	69.7	64.8	15.051	207.843
19	19	20	19	19	4	Manchester City	66	2.7778	201.9	132.5	20.483	395.336
17	1	19	20	10	5	Manchester United	66	0.95	145	145	-82.72	344.393
12	16	10	10	14	6	Southampton	63	1.3333	43.75	38.5	4.972	152.514
13	9	12	13	9	7	West Ham	62	0.94737	49.3	44.5	-4.876	152.85
18	6	18	18	8	8	Liverpool	60	0.91304	110	92.4	-21.391	366.914
6	12	5	6	20	9	Stoke	51	2.8571	25	25	2.055	116.566
20	2	15	16	18	10	Chelsea	50	2.75	69.65	69.65	-72.347	423.13
14	5	8	8	6	11	Everton	47	0.83333	37.3	37.3	-24.333	155.043
7	7	1	2	7	12	Swansea	47	0.88235	10.5	10.5	-13.081	118.407
3	14	4	5	16	13	Watford	45	1.7692	22.5	22.5	3.613	96.472
4	11	9	11	1	14	West Bromwich	43	0.57895	42.95	38.65	0.999	100.296
8	8	6	3	4	15	Crystal Palace	42	0.8	26.8	14	-5.567	118.425
2	13	13	9	2	16	Bournemouth	42	0.6087	49.71	38.41	3.395	95.988
11	3	11	12	13	17	Sunderland	39	1.2857	46.6	43.8	-33.785	142.913
9	15	17	17	15	18	Newcastle	37	1.5385	87.7	71.7	4.597	124.852
5	17	2	1	3	19	Norwich	34	0.63158	13.2	3	9.415	112.983
10	4	14	14	12	20	Aston Villa	17	1.0588	61.3	57.9	-29.654	137.709

**Table 5** Re-rank table for 2014/15 season. Total player spend, total foreign spend, profits and expenditure are in millions

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	Foreign British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
19	4	19	19	19	1	Chelsea	87	2.5	140.3	140.3	-26.279	353
20	14	17	17	20	2	Manchester City	79	4.4	113	113	10.54	355.781
18	19	16	16	15	3	Arsenal	75	1.6429	107.7	87.7	51.833	305.871
17	1	20	20	14	4	Manchester United	70	1.2308	182.5	148.5	-65.712	295.78
15	10	10	9	16	5	Tottenham	64	1.6667	23.8	18.8	2.544	198.627
16	20	18	18	13	6	Liverpool	62	1.0588	133.3	128.3	58.762	295.223
13	15	15	13	8	7	Southampton	60	0.875	49	36.5	12.257	143.808
9	7	6	8	3	8	Swansea	56	0.7	17.75	15.5	0.685	121.746
4	12	2	3	18	9	Stoke	54	2.25	3.8	3.8	5.246	96.116
5	13	5	4	4	10	Crystal Palace	48	0.7	13	4	6.352	98.512
12	5	13	15	9	11	Everton	47	0.88889	40.3	40.3	-4.607	133.507
10	11	11	11	10	12	West Ham	47	1	24.9	22.4	4.053	122.68
6	9	7	7	2	13	West Bromwich	44	0.625	19	12.6	1.344	100.334
1	8	9	10	6	14	Leicester	41	0.76471	21.7	21.7	0.982	22.529
8	18	12	12	17	15	Newcastle	39	1.6667	27.2	27.2	32.528	114.295
11	3	4	2	5	16	Sunderland	38	0.72222	12.6	0	-26.677	127.559
14	2	3	6	11	17	Aston Villa	38	1	12.5	12.5	-57.346	169.796
3	16	14	14	12	18	Hull	35	1	45	37	20.395	88.129
2	17	1	1	1	19	Burnley	33	0.3	3.8	0	29.932	49.508
7	6	8	5	7	20	QPR	30	0.84211	20	10	0.467	113.549

**Table 6** Re-rank table for 2013/14 season. Total player spend, total foreign spend, profits and expenditure are in millions

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	Foreign British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
20	3	18	18	16	1	Manchester City	86	1.9	80.6	80.6	-22,929	371,465
16	6	14	14	12	2	Liverpool	84	1.3846	38.5	38.5	0,413	255,25
19	14	19	19	19	3	Chelsea	82	3	82.7	82.7	14,301	342,276
17	19	16	16	20	4	Arsenal	79	3	50	50	48,397	261,465
11	17	10	13	7	5	Everton	72	1	22.8	22.8	28,232	120,49
15	20	20	20	10	6	Tottenham	69	1.0556	111.6	111.6	69,666	201,008
18	2	17	17	8	7	Manchester United	64	1	79.5	79.5	-32,033	280,124
10	18	15	15	3	8	Southampton	56	0.70588	42.5	42.5	30,973	111,296
5	9	1	1	17	9	Stoke	50	2	3.5	3.5	3,786	94,557
13	16	4	4	15	10	Newcastle	49	1.7273	13	13	18,752	125,008
1	15	3	3	1	11	Crystal Palace	45	0.45455	11.9	8.25	17,939	72,652
7	8	11	6	6	12	Swansea	42	0.95	23.3	17.4	1,733	97,431
8	12	12	9	4	13	West Ham	40	0.71429	25	18	10,345	107,733
12	4	8	7	13	14	Sunderland	38	1.3846	21.45	17.8	-16,313	122,137
9	7	6	10	14	15	Aston Villa	38	1.4615	19.3	19.3	1,577	108,991
2	11	5	5	11	16	Hull	37	1.1429	17.6	15.6	9,409	81,409
3	13	2	2	9	17	West Bromwich	36	1	6	6	10,761	85,705
4	10	9	11	5	18	Norwich	33	0.82353	21.8	19.3	6,74	90,576
14	1	7	12	18	19	Fulham	32	2	21.1	21.1	-33,306	125,701
6	5	13	8	2	20	Cardiff	30	0.61905	27.9	17.9	-11,718	96,035

**Table 7** Re-rank table for 2012/13 season. Total player spend, total foreign spend, profits and expenditure are in millions

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	Foreign British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
16	7	18	18	6	1	Manchester United	89	0.82353	53.75	50	-11.372	227.483
20	1	11	12	16	2	Manchester City	78	2	26.6	18.8	-79.368	404.201
19	2	20	20	19	3	Chelsea	75	2.5	108.9	108.9	-56.068	298.975
17	19	19	19	18	4	Arsenal	73	2.3636	58	58	13.216	251.812
15	8	16	17	7	5	Tottenham	72	0.82353	35.8	35.8	-8.938	167.736
13	16	9	9	13	6	Everton	63	1.2308	18.35	14.85	1.597	100.453
18	3	17	15	11	7	Liverpool	61	0.94444	46	27	-46.85	255.979
3	17	4	1	10	8	West Bromwich	49	0.86667	5	0	5.333	67.54
4	20	3	3	4	9	Swansea	46	0.68421	3.8	2.5	15.277	73.326
7	10	10	7	5	10	West Ham	46	0.78947	22.7	9.2	-3.511	94.536
6	14	7	8	2	11	Norwich	44	0.47059	11.9	11.9	0.523	80.089
12	11	5	6	20	12	Fulham	43	2.875	8.5	6	-2.71	98.509
11	4	6	5	8	13	Stoke	42	0.85714	9.9	4.9	-31.119	97.826
5	9	15	13	3	14	Southampton	41	0.55	35.1	26.3	-5.303	75.549
9	5	8	10	14	15	Aston Villa	41	1.6667	16.13	15.5	-15.331	97.016
10	18	13	16	15	16	Newcastle	41	1.6923	29.8	29.8	8.814	97.64
8	6	14	11	1	17	Sunderland	39	0.43478	33.3	18.3	-13.144	96.397
1	13	2	4	17	18	Wigan	36	2	3.5	3.5	-0.684	4.03
2	12	1	2	9	19	Reading	28	0.85714	1.11	0.74	-2.339	63.077
14	15	12	14	12	20	QPR	25	1.2	26.7	26.7	0.616	104.849

**Table 8** Re-rank table for 2011/12 season. Total player spend, total foreign spend, profits and expenditure are in millions

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	Foreign British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
20	1	20	20	20	1	Manchester City	89	3	78.8	78.8	-95.296	352.546
16	10	17	17	5	2	Manchester United	89	0.72222	55.7	37	-2.278	206.774
18	20	16	15	19	3	Arsenal	70	2.875	44.4	27.1	59.509	230.758
15	9	2	1	3	4	Tottenham	69	0.71429	5.7	0	-4.805	151.032
10	15	13	14	13	5	Newcastle	65	1.3077	25.7	25.7	1.401	98.39
19	13	19	19	16	6	Chelsea	64	1.8	60.5	52	0.2	277.201
13	8	6	9	17	7	Everton	56	1.8	6.6	6.6	-9.106	103.89
17	2	18	18	6	8	Liverpool	52	0.76471	59.7	37.2	-40.522	209.579
12	6	11	12	18	9	Fulham	52	2.6667	15.6	15.6	-18.755	102.201
6	11	7	6	10	10	West Bromwich	47	0.9375	8.1	5.1	-0.367	73.08
2	19	8	8	2	11	Swansea	47	0.47826	8.58	6.28	14.632	50.735
4	18	3	3	1	12	Norwich	47	0.30435	5.8	2.2	13.467	62.599
14	3	12	10	9	13	Sunderland	45	0.8125	15.9	9.3	-31.013	108.06
8	7	14	13	8	14	Stoke	45	0.8	27.1	15.8	-9.529	82.363
1	12	5	7	15	15	Wigan	43	1.7	6.6	5.5	-0.24	3.603
11	5	15	16	11	16	Aston Villa	38	0.9375	29.8	29.8	-19.944	99.7
7	14	10	11	12	17	QPR	37	1	12.8	9.8	0.273	74.629
9	4	4	5	4	18	Bolton	36	0.71429	6.6	3	-22.117	91.274
5	16	9	4	14	19	Blackburn	31	1.4286	11	2.3	4.289	72.832
3	17	1	2	7	20	Wolverhampton	25	0.78947	5.6	0	5.76	56.979

**Table 9** Re-rank table for 2010/11 season. Total player spend, total foreign spend, profits and expenditure are in millions

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	Foreign British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
17	16	11	11	11	1	Manchester United	80	1.1765	9	9	9.457	208.172
19	2	19	19	18	2	Chelsea	71	2.375	110	110	-71.962	295.62
20	1	20	20	13	3	Manchester City	71	1.3333	172.5	153	-194.805	353.423
16	17	8	8	20	4	Arsenal	68	4.6	5.7	5.7	12.971	189.004
15	10	13	15	10	5	Tottenham	62	1.0667	22.5	22.5	-6.154	167.724
18	3	18	18	7	6	Liverpool	58	0.84211	91.4	89.4	-49.408	276.545
13	12	9	9	15	7	Everton	54	1.4167	6.6	6.6	-5.413	103.305
8	14	12	12	17	8	Fulham	49	2.3333	9.3	9.3	4.406	86.369
11	8	17	13	5	9	Aston Villa	48	0.76471	38.2	16.7	-9.744	98.564
14	9	14	16	2	10	Sunderland	47	0.55	23	23	-6.234	111.154
4	18	10	10	14	11	West Bromwich	47	1.3571	8.58	8.58	17.049	62.777
10	20	6	6	6	12	Newcastle	46	0.78947	4.2	4.2	32.768	92.434
6	11	3	2	9	13	Stoke	46	1	1.9	0	-5.558	74.534
9	4	16	17	4	14	Bolton	46	0.73684	27.1	27.1	-26.055	87.81
7	5	5	5	19	15	Blackburn	43	3.3333	4	4	-18.615	76.173
1	13	4	4	16	16	Wigan	42	1.6364	3.5	3.5	-0.199	3.486
3	15	2	3	8	17	Wolverhampton	40	0.9	0.68	0.09	9.163	55.238
5	7	15	14	3	18	Birmingham	39	0.61905	23.2	19.2	-12.342	74.383
2	19	1	1	1	19	Blackpool	39	0.34483	0.395	0	20.783	30.893
12	6	7	7	12	20	West Ham	33	1.2778	4.5	4.5	-18.565	99.528

**Table 10** Re-rank table for 2009/10 season. Total player spend, total foreign spend, profits and expenditure are in millions

Expense (£m)	Profit (£m)	Total spend (£m)	Foreign spend (£m)	Foreign British	Position	Team	Pts	Ratio	Total spend (£m)	Foreign spend (£m)	Profits (£m)	Exp (£m)
20	2	12	14	17	1	Chelsea	86	2.4444	21.8	21.8	-70.437	257.727
17	18	13	15	10	2	Manchester United	85	1.1111	22	22	13.544	191.568
16	20	10	10	18	3	Arsenal	75	3.25	11.2	11.2	92.32	179.496
15	10	14	11	6	4	Tottenham	70	0.8	22.6	12.1	-5.163	134.517
19	1	20	20	14	5	Manchester City	67	1.5833	89.3	61.8	-117.793	253.801
14	4	18	13	3	6	Aston Villa	64	0.66667	35.6	21.6	-27.712	117.198
18	7	19	17	19	7	Liverpool	63	3.4286	44.8	23.3	-19.935	227.683
13	12	15	16	7	8	Everton	61	0.9375	23	23	-3.093	101.26
5	16	5	1	1	9	Birmingham	50	0.52632	3.4	0	0.199	56.515
8	13	2	4	20	10	Blackburn	50	3.5	2.3	2.3	-1.896	70.425
7	11	11	12	8	11	Stoke	47	1	18	14.5	-4.517	66.532
11	8	7	7	13	12	Fulham	46	1.5	4.7	4.7	-16.942	97.02
12	5	17	18	4	13	Sunderland	44	0.6875	33.3	26.3	-26.179	97.149
9	3	16	19	12	14	Bolton	39	1.4615	27.1	27.1	-35.443	90.461
4	19	9	9	5	15	Wolverhampton	38	0.77778	10.5	10.5	16.29	44.354
1	15	4	6	16	16	Wigan	36	2	2.9	2.9	0.075	3.677
10	6	3	5	11	17	West Ham	35	1.1429	2.5	2.5	-21.485	94.262
3	17	6	2	2	18	Burnley	30	0.52632	3.5	0	10.247	40.372
6	9	8	8	9	19	Hull	30	1	5.8	5.8	-6.831	58.154
2	14	1	3	15	20	Portsmouth	19	1.8	2	0	0	5.4

## Appendix 2: Principal component analysis (PCA)

See Tables 11,12,13,14,15,16,17 and 18

**Table 11** PCA for 2016/17 season

Variable	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Pts	0.117	−0.0283	0.316	0.736	−0.586	0.00643
Ratio	0.00363	0.00345	0.00765	−0.0133	−0.00104	0.999
Player spend	0.315	0.533	0.361	−0.537	−0.443	−0.0134
Foreign spend	0.276	0.551	0.277	0.367	0.640	0.000523
Profits	−0.0590	−0.512	0.808	−0.181	0.221	−0.00639
Exp	0.898	−0.386	−0.200	−0.0322	0.0498	−0.000767

**Table 12** PCA for 2015/16 season

Variable	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Pts	0.0420	0.00439	0.221	0.958	−0.178	0.000951
Ratio	0.00284	−0.00357	0.00645	−0.00468	−0.0113	0.999
Player spend	0.292	0.741	0.168	−0.159	−0.560	−0.00631
Foreign spend	0.239	0.554	−0.152	0.164	0.766	0.0117
Profits	−0.0888	−0.0162	0.946	−0.165	0.263	−0.00372
Exp	0.921	−0.380	0.0675	−0.0520	0.0119	−0.00452

**Table 13** PCA for 2014/15 season

Variable	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Pts	0.116	0.0271	−0.0653	0.985	−0.103	−0.0186
Ratio	0.00468	0.00226	−0.0103	0.0232	0.0542	0.998
Player spend	0.412	−0.0254	0.631	−0.0733	−0.652	0.0417
Foreign spend	0.388	0.0323	0.531	0.0657	0.748	−0.0385
Profits	−0.0175	0.999	0.00906	−0.0288	−0.0380	0.000639
Exp	0.816	0.0149	−0.562	−0.136	−0.0136	−0.00576

**Table 14** PCA for 2013/14 season

Variable	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Pts	0.117	−0.0283	0.316	0.736	−0.586	0.00643
Ratio	0.00363	0.00345	0.00765	−0.0133	−0.00104	0.999
Player spend	0.315	0.533	0.361	−0.537	−0.443	−0.0134
Foreign spend	0.276	0.551	0.277	0.367	0.640	0.000523
Profits	−0.0590	−0.512	0.808	−0.181	0.221	−0.00639
Exp	0.898	−0.386	−0.200	−0.0322	0.0498	−0.000767

**Table 15** PCA for 2012/13 season

Variable	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Pts	0.138	0.0928	0.377	0.911	-0.00759	0.0128
Ratio	0.00256	0.00331	$6.5275e^{-05}$	-0.0155	-0.0874	0.996
Player spend	0.174	0.636	-0.214	0.00266	0.718	0.0605
Foreign spend	0.165	0.695	-0.118	-0.0516	-0.685	-0.0636
Profits	-0.175	0.248	0.878	-0.361	0.0857	0.00148
Exp	0.945	-0.206	0.168	-0.191	0.00396	-0.00438

**Table 16** PCA for 2011/12 season

Variable	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Pts	0.146	0.105	0.00416	0.981	-0.0766	0.00344
Ratio	0.00440	0.00245	0.00132	0.00255	0.0891	0.996
Player spend	0.226	-0.0306	0.710	-0.0851	-0.658	0.0572
Foreign spend	0.200	-0.131	0.625	0.0395	0.739	-0.0676
Profits	-0.136	0.972	0.153	-0.0778	0.0825	-0.00918
Exp	0.932	0.161	-0.285	-0.153	0.0252	-0.00600

**Table 17** PCA for 2010/11 season

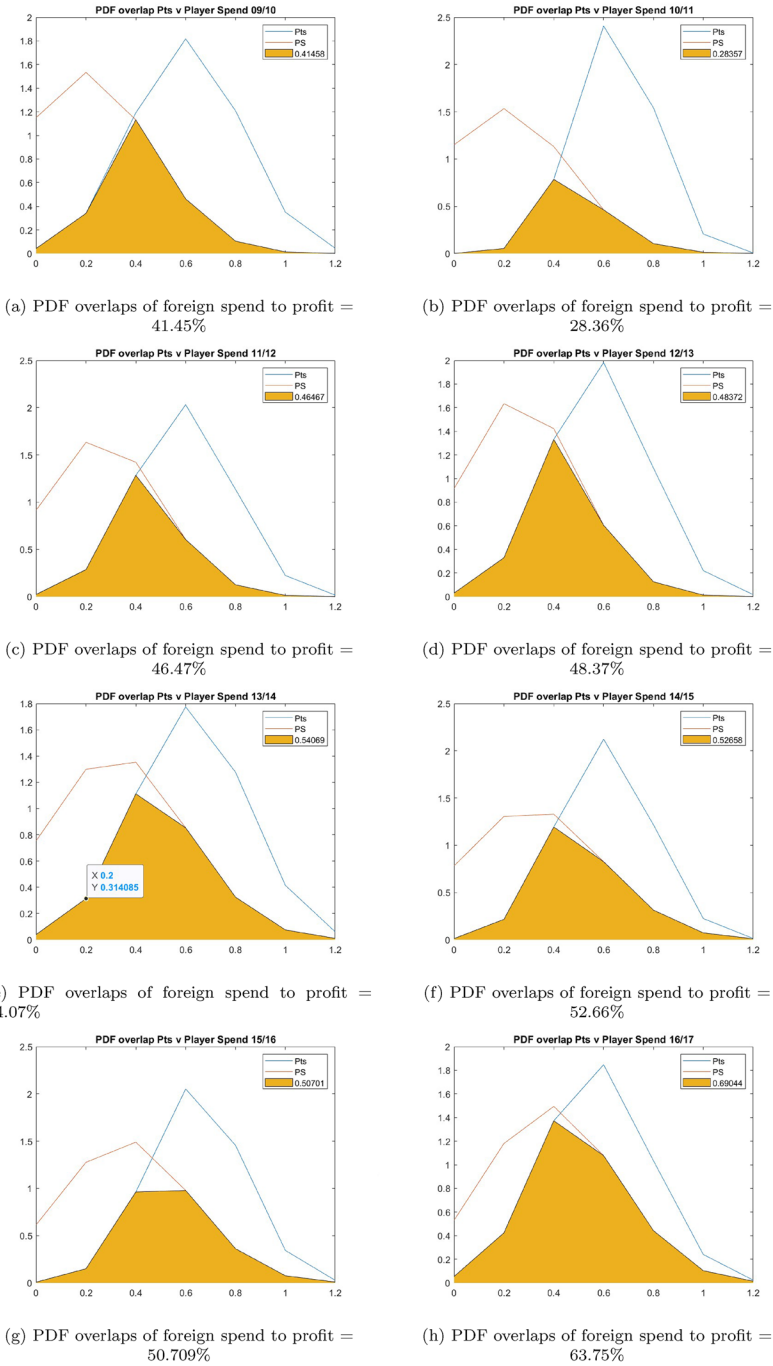
Variable	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Pts	0.0806	0.183	-0.0963	0.969	0.107	-0.0275
Ratio	0.00109	0.00916	-0.0259	0.0176	0.0571	0.998
Player spend	0.367	-0.374	0.485	0.165	-0.679	0.0515
Foreign spend	0.343	-0.301	0.521	-0.000471	0.721	-0.0253
Profits	-0.363	0.630	0.684	-0.0138	-0.0574	0.0159
Exp	0.781	0.582	-0.129	-0.184	-0.0357	-0.004245

**Table 18** PCA for 2009/10 season

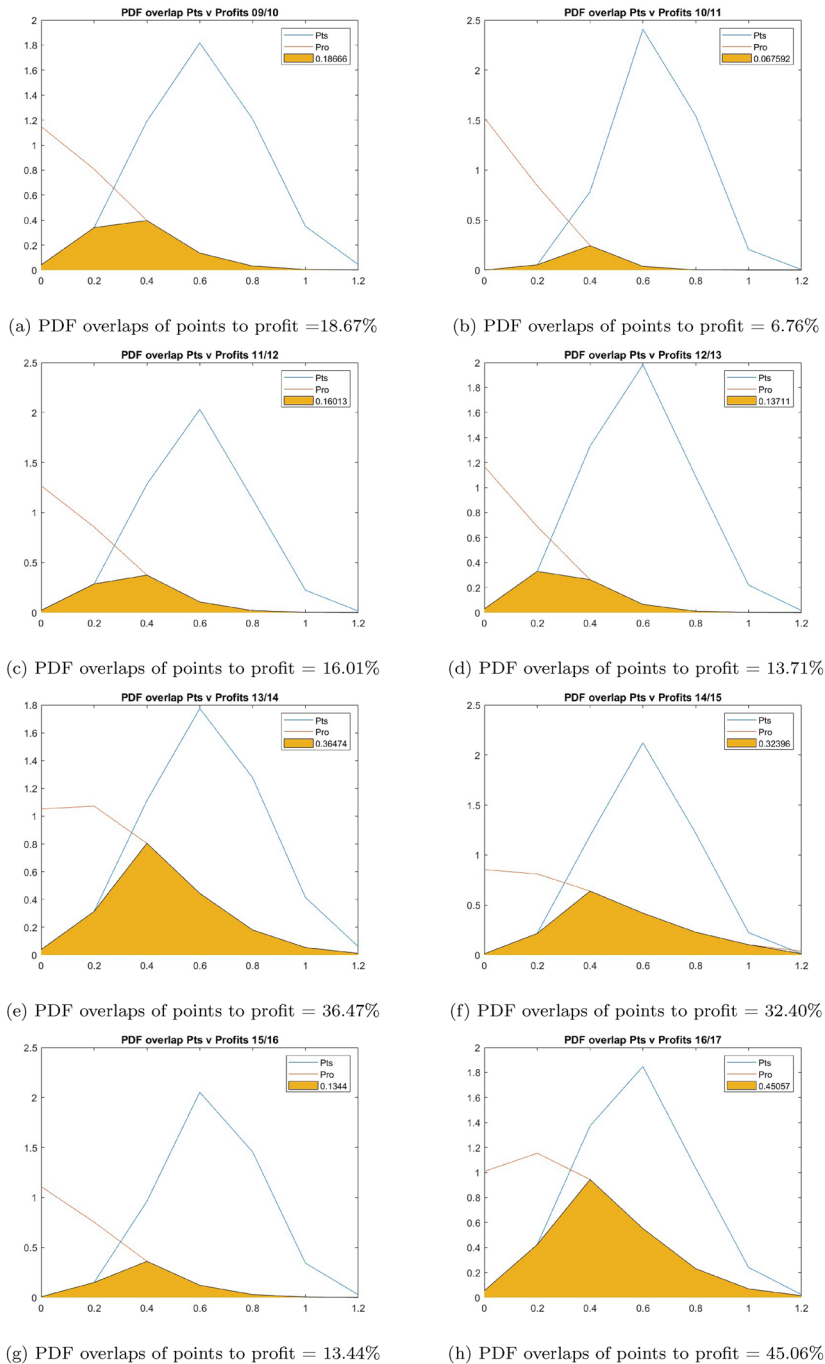
Variable	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Pts	0.188	0.192	-0.0375	0.958	-0.0945	0.0258
Ratio	0.00377	0.00868	-0.0111	-0.0317	-0.0184	0.999
Player spend	0.195	-0.220	0.773	-0.0194	-0.562	-0.00118
Foreign spend	0.138	-0.145	0.524	0.103	0.821	0.0249
Profits	-0.243	0.907	0.323	-0.120	0.00956	-0.00699
Exp	0.921	0.268	-0.149	-0.238	0.0177	-0.0147

### Appendix 3: Indicators comparing footballing performance against sectorial investments on players, including foreign players

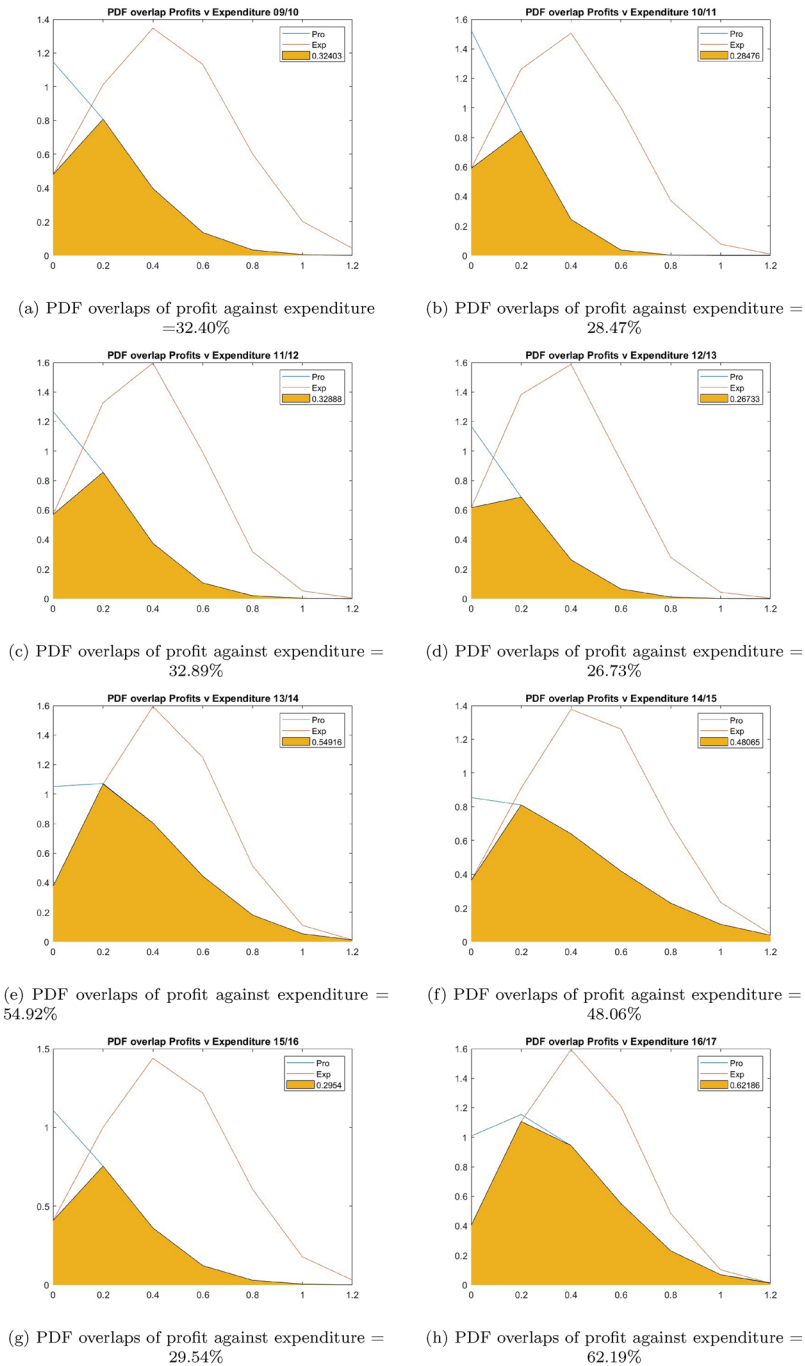
See (Figs. 9, 10 and 11)



**Fig. 9** Percentage of spends on foreign players that translated into economic profit



**Fig. 10** Correlation between on-field performance measured as points scored against economic profits



**Fig. 11** Correlation between economic profit against total expenditure

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**Data availability** Most data are available from links provided in the article. Data not available there could be provided on request for non-commercial use.

## Declarations

**Conflict of interest** No Conflict of interest.

**Ethical approval** The study uses footballing data available from the internet and other published literature. No human or animal data have been used, neither have any participant-based questionnaire study been involved. As such, no ethics approval is required.

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