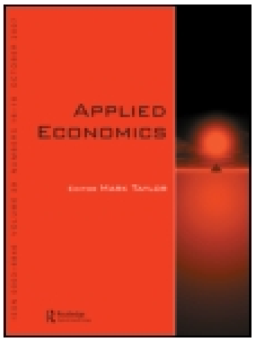

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Performance evaluation of the English Premier Football League with data envelopment analysis

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Performance evaluation of the English Premier Football League with data envelopment analysis

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This paper uses data envelopment analysis (DEA) to evaluate the performance of English Premier League football clubs from 1998/99 to 2002/03 combining sport and financial variables. The paper evaluates how close the clubs are relative to the frontier of best practices, analysing how they manage sport as well as financial results. Managerial implications of the research are devised.

I. Introduction

Football clubs play football with the aim of succeeding on the pitch. However, pitch success does not translate necessarily into financial success, and some clubs run deficits while others obtain positive financial results. Financial deficits strain the sporting performance of the clubs, sometimes resulting in relegation from the league. The link between sporting and financial activities is therefore of paramount importance for the competitiveness of football clubs (Szymanski and Kuypers, 2000, p. 22). Quirk and El Hodiri (1974) consider that sports managers are profit maximizers. Sloane (1971) on the other hand, assumes that sports managers maximize utility in the pursuit of non-profit goals, being organized to consume their resources in order to obtain satisfaction rather than profit. Vrooman (2000) assumes an intermediate position, in which sport managers jointly maximize both profit and utility (performance). Performance analysis of football clubs combining sport and financial variables has been addressed by Barros and Santos (2004) for the Portuguese football league; by Haas (2003b) for the English football league and by Haas (2003a) for the US soccer league. All the above mentioned papers used data envelopment analysis (DEA). DEA was first developed by Farrell (1957) and consolidated by Charnes *et al*. (1978) as a non-parametric procedure that compares a decision unit with an efficient frontier using performance indicators. DEA is particularly appropriate in cases in which the researcher is interested in investigating the efficiency of converting multiple inputs into multiple outputs and has only a small number of observations, which prevents a parametric analysis.

DEA is a popular tool to analyse efficiency in many fields, such as banking (Hauner, 2005); financial services (Fiordelisi and Molyneux, 2004); hospitals (Dervaux *et al*., 2004); agriculture (Latruppe *et al*., 2004); regional development (Leonida *et al*., 2004; Price and Weyman Jones, 1996).

DEA is a linear programming technique that enables management to benchmark the best-practice decision unit (DMU), i.e. the football clubs. Furthermore, DEA provides estimates of potential

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improvement for inefficient DMUs. We shall assume throughout this paper some knowledge of DEA on the reader's part. Readers not familiar with DEA are referred to Charnes *et al*. (1995), Coelli *et al*. (1998), Coelli (1996), Cooper *et al*. (2000) and Thanassoulis (2001).

In this paper, we present an application of DEA to the analysis of two disparate success measures: sporting success and financial success, extending the efficiency research to football clubs, using data on English Premier League clubs obtained from the Deloitte & Touche Annual Report on Professional Football Finance. The paper expands on previous research comparing the efficient scores of the English football clubs with two DEA models, the CCR and BCC, whereas previous research, Haas (2003b) relied on a shorter data set. We address the same issue extending the data set and limiting the paper to the following fundamental questions: are there differences in points awarded at the end of the season caused by differences in technical efficiency? Are the bigger clubs more efficient than the smaller ones? The aim of the paper is thus limited to estimating technical efficient scores for those English Premier League football clubs that played consecutively in the league from 1998/99 to 2002/03, combining sporting and financial issues. Thus explaining all possible differences is beyond the scope of this paper.

The paper is organized as follows: in Section II we describe the institutional setting; in Section III we survey the literature on the topic; in Section IV we present the theoretical framework. Section V details the data and Section VI the results. In Section VII and VIII the managerial implications of the study are considered. In Section IX we discuss the limitations and possible extensions of the study, and finally, Section X concludes.

II. Institutional Setting

England, the country in which football was born, is the European country with the most entrenched tradition in this sport and with the most competitive clubs. Thus, it comes as little surprise that the Premier League is the most profitable, not only in Europe but the world and contains the world's richest club: Manchester United. Prior to 1992 there were four divisions within one league in England; however, during the late 1980s and early 1990s the top teams in England sought to improve their share of television broadcast revenue and became less willing to subsidise smaller teams through redistribution of this television income. During the 1980s English football was plagued with hooliganism and crumbling stadiums and as such attendances suffered a decline. However, after the disasters at Heysel in 1985 (which led to the banning of English clubs in European competitions for 3 years), the fire at Bradford in 1985 and the stampede at Hillsborough in 1989, strict regulations were put into place to combat hooliganism and to force clubs to invest heavily in better equipped stadiums. With the re-creation of football as it were into a more family oriented and entertaining atmosphere along with more lucrative television broadcasting deals, football began to experience a resurrection after the dire period in the 1980s. With more money flowing into the largest English clubs, the 22 clubs of the first division in the Football League broke away and created the Premier League in 1992. The Premier League was comprised of 22 clubs until the 1995/96 season where it limited itself to just 20 clubs. Since the formation of the Premier League one team (Manchester United) has dominated and until recently only Arsenal has mounted a serious challenge to this dominance. However it is not infeasible for other clubs to become champions. Notably in 1995, relatively obscure Blackburn Rovers won the Premiership championship due to Jack Walker's millions pouring into the club for stadium redevelopment, player investment and better managerial leadership. Similarities can now be seen with the emergence of Chelsea and the coffers of Abramovich.

Compared to other European football leagues, England is the richest with revenues of around €1790 million in the 2002/03 season compared with €1162 in Italy.[1] Relative to the European leagues, England also still generates a substantial portion of its revenue via matchday income, around 30%, whereas Italy, Germany and France generate only 15–18% of total revenues through matchday proceeds. This is even more astonishing given that many Premiership clubs are capacity constrained and many clubs could improve their stadia and indeed realize more income on matchdays. However, even though the English Premier League is the most prosperous it is not uncommon to find genuine concern for the financial health of individual clubs. Not only does the threat and subsequent effect of relegation to the smaller and less lucrative

[1] Deloitte & Touche *Annual Review of Football Finance* 2004.

First Division sometimes leave former Premiership clubs (i.e. Derby County and Bradford City) near financial ruin, but also missing out on lucrative European championships such as the Champions League and UEFA Cup can adversely affect a club. Most notably, Leeds United invested heavily in playing talent only to miss qualification for the Champions League in 2002, thus eliminating a large part of their expected income and leading to a sell-off of playing talent. During the turmoil, Leeds was ultimately relegated. So to achieve success requires spending but with that comes risk and it is not uncommon to see many Premiership teams spending heavily and entering into negative operating profits in hopes of achieving a certain position or qualification spot for European competition.

In order to compete with other big teams in Europe (i.e. Real Madrid and Juventus) for playing talent, English teams have had to increase their spending on wages in order to attract the best players. Also, the biggest teams in England, notably Manchester United, Arsenal, Liverpool and more recently Chelsea, have increasingly imported players (and in the case of the latter three, managers) from 'overseas', so that only perhaps a handful of English players have a place in the starting 11. Currently the starting 11 at Arsenal includes two English players, and Arsenal recently broke the club transfer record by purchasing José Antonio Reyes from Seville for £17.6 million. Two of the top ten world transfer records belong to Manchester United and over the past two seasons, Chelsea has spent over £200 million on new players. Not only do these big clubs have to compete in Europe but also in traditional cup competitions (such as the League Cup and the FA Cup) in the domestic leagues, which tends to cause some clubs to field 'reserve' sides in the less glamorous competitions. Thus it appears that some clubs create alternative squads where one set of players competes in less prestigious games whereas the 'superstars' play in the more celebrated and lucrative matches.

Hence the finance and performance of these leading clubs can be very complex indeed. Some clubs have started expanding into new markets and sponsorship deals. Manchester United has entered into a marketing agreement with the New York Yankees and Arsenal has recently signed a deal with Emirates Airlines for £100 million for stadium and shirt sponsorship. Football in England is big business, and vital to the success of the business is success not only on the pitch but also financial success and in development of an efficiently produced product. Below in Table 1 we present the twelve English football clubs that remained in the Premiership throughout the seasons analysed.

Table 1. Figures for 2002/03 season

Football club	Revenues (£m)	Wages (£m)	Position
Arsenal	103801	60569	2
Aston Villa	45447	32310	16
Chelsea	93027	54365	4
Everton	46781	29735	7
Leeds United	64005	56595	15
Liverpool	103981	54431	5
Manchester United	174936	79517	1
Middlesbrough	40229	29428	11
Newcastle United	96689	45195	3
Southampton	48875	26666	8
Tottenham Hotspur	66506	38024	10
West Ham United	51712	33342	18

Source: Deloitte & Touche, 2004.

III. Literature Survey

There are two contemporary approaches to measure efficiency: first, the econometric or parametric approach and, secondly the non-parametric approach. Among the papers which used the non-parametric approach, which are of special interest for the present paper, we mention Fizel and D' Itri (1996, 1997), who applied DEA analysis to measure the managerial efficiency of college basketball teams to assess the conflicting thesis concerning the impact of managerial succession on organizing performance; and Porter and Scully (1982), who analysed the managerial efficiency of baseball managers with a nonparametric approach. Recently Barros and Santos (2004) analysed the Portuguese football first division clubs with a DEA-CCR and BCC model. Haas (2003a) analysed the efficiency of the English first league with a DEA-CCR model, and Haas (2003b) analysed the efficiency of the USA soccer league.

Among the papers which used the econometric frontier, Zak *et al*. (1979) analysed production efficiency in the basketball market with a Cobb–Douglas deterministic frontier. Scully (1994), analysed measures of managerial efficiency for professional baseball, basketball and football coaches, with a deterministic and a stochastic econometric frontier. A survival analysis was used to measure the coaching tenure probability in these sports. Extending the analysis of efficiency in sports, Ruggiero *et al*. (1996) analysed the efficiency of baseball teams with panel data. Hoeffler and Payne (1997) analysed the stochastic frontier with cross-section data. Audas *et al*. (2000) analysed involuntary and voluntary managerial job termination with hazard functions for English professional soccer. Hadley *et al*. (2000) analysed the performance of the NFL league using a Poisson regression model. Dawson *et al.* (2000) analysed the managerial efficiency of English soccer managers with an econometric stochastic frontier and Carmichael et al. (2001) analysed the efficiency of the English Premiership clubs with residuals.

Gerrard (2005) analyses the production function of coaches working in the English Premier League with win-ratios for the period 1992 to1998. Kahane (2005) analyses the efficiency of the USA Hockey League discriminatory hiring practices with a stochastic frontier model.

From the above mentioned literature it is concluded that the papers by Haas (2003a, 2003b) and Barros and Santos (2004) are the most relevant to the present research and therefore will be used in a counterfactual analysis.

IV. Theoretical Framework

Following Farrell (1957), Charnes *et al.* (1978) first introduced the term, DEA (data envelopment analysis) to describe a mathematical programming approach to the construction of production frontiers and the efficiency measurement of the constructed frontiers. The latter authors proposed a model that had an input orientation and assumed constant returns-to-scale (CSR). This model is known as the CCR model in the literature. Later studies have considered alternative sets of assumptions. Banker *et al.* (1984) first introduced the assumption of variable return-to-scale (VRS). This model is known in the literature as BCC model. There are four other basic DEA models, used less frequently in the literature, the additive model of Charnes *et al.* (1985), the multiplicative model of Charnes *et al.* (1982), the cone-ratio DEA model of Charnes *et al.* (1990) and the assurance region DEA model of Thompson *et al.* (1986, 1990). These two latter models include *a priori* information (experts opinion, opportunity costs, rate of transformation or rate of substitution) to restrict the results, to just one best DMU (assurance region DEA model), or linking the DEA with multi-criteria analysis (cone-ratio DEA model).

Extensions of the DEA model are the DEA-Malmquist which disentangles the total productivity change into technical efficiency change and technological efficiency change (Malmquist, 1953), and the DEA-allocative model, that disentangles technical and allocative efficiency.

Since the models are well established and extensively applied in the literature, discussion is limited in this article. A brief description of the model is outlined. For more details on model development, see Fare *et al.* (1994), Charnes *et al.* (1995), Coelli (1996), Coelli *et al.* (1998), and Thanassoulis (2001).

DEA is applied to unit assessment of homogeneous units such as football clubs playing in the same league. The unit of assessment is normally referred to as a decision-making unit (DMU). A DMU converts inputs into outputs. The identification of the inputs and outputs in an assessment is as difficult as it is crucial. The literature review, the availability of data and managers' subjective opinions all play a role in the selection of inputs and outputs. In this paper, we follow the three procedures mentioned above to select the inputs and outputs used in the study.

In the programming method, DEA 'floats' a piece-wise linear surface to rest on the top of the observation (Seiford and Thrall, 1990, p. 8). The facets of the hyperplane define the efficiency frontiers, and the degree of inefficiency is quantified and partitioned by a series of metrics that measures various distance from the hyperplane and its facets.

In order to solve the linear-programming problem, the user must specify three characteristics of the model: the input–output orientation system; the returns-to-scale; and the weights of the evaluation system. In relation to the first of these, the choice of input- or output-oriented DEA is based on the market conditions of the DMU. As a general rule of thumb, in competitive markets, the DMUs are output-oriented, since we assume that inputs are under the control of the DMU, which aims to maximize its output, subject to market demand, outside the control of the DMU. With exogenous inputs, the production function is the natural choice (Kumbhakar, 1987). In monopolist markets, the DMUs are input-oriented, because output is endogenous, while input is exogenous and the cost function is the natural choice. The input-orientation system searches for a linear combination of DMUs that maximizes the excess input usage of DMU*i*, subject to the inequality restraints presented below. With regard to the returns-to-scale, they may be either constant or variable. We calculate both forms (CCR and BCC model) for comparative purposes. In relation to the weights possibly placed on inputs and outputs in the objective function, these are subject to the inequality constraints. Weights are endogenous defined by the algorithm and measure the distance between the DMU and the frontier.

DEA optimizes at each observation for the purpose of constructing the cost frontier (Fig. 1), which consists of a discrete curve formed soled by efficient DMUs, those that minimise cost. The inefficient DMUs are above the cost frontier, since they do not minimize total cost for the production level.

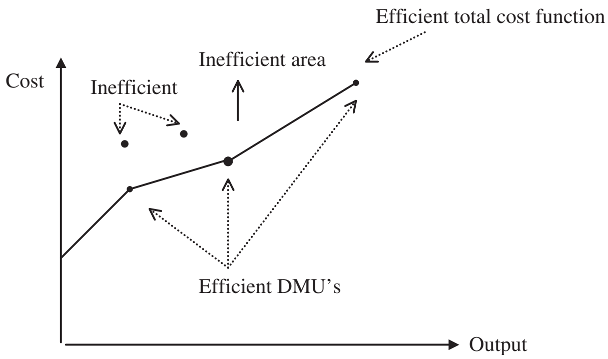

Fig. 1. Data envelopment analysis: cost function

We define a Pareto-efficient or DEA-efficient DMU in cases in which the DMU uses $m \geq 1$ inputs to secure $s \geq 1$ outputs in either an output orientation or an input orientation.

The general-purpose DEA developed by Charnes *et al.* (1978) considers n DMUs ($j = 1, \ldots, n$) using k inputs to secure m outputs. Let us denote x_{ij}, y_{ij} the observed level of the kth input and mth output, respectively, at DMU j. An efficient score for the nth DMU can be obtained by maximizing the ratio of total weighted output over total weighted input for all DMU subject to the constraint on all such ratios of the other DMUs in the sample to be less than or equal to one. Mathematically, this can be written as:

$$\begin{aligned} &\max_{u,v} \frac{uy_i}{vx_i} \\ &s.t. \frac{uy_j}{vxj} - 1 \leq 0 \end{aligned} \tag{1}$$

where u are the output weights and v are the input weights. The system of equations in (1) is a fractional programming model of computing technical efficiency and can be solved with nonlinear programming techniques. To simplify computation, a transformation of the fractional programming model allows the system of equations in (1) to be formulated as a linear programming problem. For the CCR model with constant return-to-scale and strong disposability, the following linear programming is solved to ascertain whether DMU i is DEA-efficient.

$$\begin{aligned} &\min_{z,\lambda} \lambda_i \\ &st \\ &\sum_{i=1}^{n} x_{ij} z_i - \lambda_i x_{ij} \leq 0 \\ &\sum_{i=1}^{n} y_{ij} z_i - \lambda_i y_{ij} \geq 0 \\ &z_i \geq 0, \lambda_i \; free \end{aligned} \tag{2}$$

For the BCC model with variable return-to-scale and strong input disposability, the following linear programming is solved to ascertain whether DMU i is DEA-efficient.

$$\begin{aligned} &\min_{z,\lambda} \lambda_i \\ &st \\ &\sum_{i=1}^{n} x_{ij} z_i - \lambda_i x_{ij} \leq 0 \\ &\sum_{i=1}^{n} y_{ij} z_i - \lambda_i y_{ij} \geq 0 \\ &\sum_{i=1}^{n} z_i - 1 = 0, \lambda_i \; free \end{aligned} \tag{3}$$

where λ is a scalar variable measuring the level of efficiency. The model works as follows. For a given set of feasible λ values, the LHSs of the input- and output-related constraints specify a production point within the production possibility set. The model seeks a production possibility set point which offers at least the output levels of DMU j_0 while using as low a proportion of its input levels as possible. With the superscript $*$ denoting optimal values, the j_0 DMU is DEA-efficient if, and only if, $\lambda_0^* = 1$. If $\lambda_0^* \leq 1$ the j_0 DMU is DEA-inefficient λ_0^* is a measurement of the radial DEA efficiency of DMU j_0.

The model assesses efficiency in a production context and its counterpart assesses efficiency in a value context. By virtue of duality, the primal and dual models yield the same efficiency ratings in respect of DMU j_0 (see Charnes *et al.*, 1978 for details).

V. Data Issues

To estimate the cost frontier, we used balanced panel data on English Premier League Football Clubs in the years 1998/99 to 2002/2003 (12 clubs $\times$ 5 years $=$ 60 observations). We measured output using three indicators: points obtained in the season, attendance and turnover. We measured inputs using four indicators: number of players, wages, net assets and stadium facilities expenditure. All the monetary variables (turnover, wages, net assets and stadium facilities) are in English Pounds (£'000) and were deflated by the GDP deflator and denoted at constant 2000 prices. The combination of indicators measured ensured the DEA convention that the minimum number of DMUs is greater than three times the number of inputs plus output $(60 \geq 3(3+4)]$ (Raab and Lichty, 2002). By using an input orientation, one can determine whether a football club can produce the same level of output with less input.

The characteristics of the variables for UK football clubs are depicted in Table 2:

We verify that the standard deviation is higher than the mean for turnover and net assets, signifying that different levels of wealth correspond to similar sport levels on the pitch. The aim of this work is to determine if wealth affects sport performance.

VI. Results

The DEA index can be calculated in several ways. In this study, we estimated an output-oriented, technically efficient (TE) DEA index, assuming that football clubs aim to maximize sporting and financial results simultaneously. In this context inputs are exogenous and the outputs endogenous because of the competitive environment in which the clubs compete (Kumbhakar, 1987).

The variable return-to-scale (VRS) hypothesis was chosen, because we assume strong disposability of inputs and outputs. The use of VRS reference technology needs to be motivated. If strong disposability of inputs and outputs is assumed, technical efficiency can be decomposed into two different components: pure technical efficiency and scale efficiency (Fare *et al.*, 1994). The VRS scores measure pure technical efficiency only. However, the constant return-to-scale (CRS) index is composed of a non-additive combination of pure technical and scales efficiencies. A ratio of the overall efficiency scores to pure technical efficiency scores provides a scale efficiency measurement.

The relative efficiency of the English football clubs is presented in Table 3.

A number of points emerge from the present study. First, the best-practice calculations indicate that almost all clubs operated at a high level of pure technical efficiency in the period. Second, all technically efficient CRS clubs are also technically efficient in VRS, signifying that the dominant source of efficiency is scale. Third, on the basis of BCC results, which measures pure technical efficiency, due to management skills, all clubs are efficient in the period. Fourth, according to the scale efficiency, some clubs are efficient while others are not. Those clubs with DRS (decreasing returns to scale) are too large in size. Scale size should be decreased if decreasing returns to scale prevail. Fifth, the efficient scores presented in Table 3 are average values for the period, but whenever we

Table 2. Characteristics of the variables for 1998/99 and 2002/03

	Definition	Minimum	Maximum	Mean	Std. Deviation
Points	Points obtained in the league at the end of each season	41,00	91,00	58,96	13,28
Attendance	Number of tickets sold	15132,00	67630,00	37464,90	10682,43
Turnover	Turnover in the season	13448,00	1013981,00	75214,40	127437,32
Players	Number of players	20,00	35,00	27,03	3,19
Wages	Wages of players	8511,00	79517,00	33753,7667	15439,71
Net Assets	Balance sheet Net assets and liabilities value	−44268,00	156833,00	39956,53	40164,09
Stadium Facilities	Stadium facilities expenditures	247,00	80226,00	8597,341	12840,02

Table 3. DEA technically efficient scores for English Football Clubs, average values for the period 1998/99–2002/03

Designation	Technically efficient, constant return-to-scale CCR model	Technically efficient, variable return-to-scale BCC model	Technically efficient scale	Position of the port in frontier
Arsenal	1.000	1.000	1.000	–
Aston Villa	1.000	1.000	1.000	–
Chelsea	1.000	1.000	1.000	–
Everton	0.836	1.000	0.836	Drs
Leeds United	1.000	1.000	1.000	–
Liverpool	0.978	1.000	0.978	Drs
Manchester United	1.000	1.000	1.000	–
Middlesbrough Newcastle United	0.946	1.000	0.946	Drs
Southampton	0.796	1.000	0.796	Drs
Tottenham Hotspur	1.000	1.000	1.000	–
West Ham United	0.962	1.000	0.962	Drs
Mean	1.000	1.000	1.000	–

analyse the football clubs for all years, the result is the same: All clubs display pure technical efficiency, but some of them do not display scale efficiency. Therefore the overall conclusion is that English Premier League football clubs are well managed as depicted by pure technical efficiency, but dimension makes a difference, and therefore some of them have decreasing returns to scale (DRS).

Although DEA identifies inefficient football clubs in the sample, it does not identify the cause of the inefficiency. DEA identifies the slack for the inefficient club and gives to it a reference set (peer group) which allows for specific recommendations to improve efficiency. Adjustments for the inefficient clubs can be identified for outputs and inputs in order for them to join the efficient frontier.

VII. Efficiency for Different Types of Clubs

The first question to be answered is if clubs with more points awarded at the end of the season are more efficient than those with less sport success. In Table 4 we present the Mann–Whitney U-test, between efficiency scores obtained using the CCR model for all clubs in all years and points obtained at the end of the season (Newson, 2002). The Mann–Whitney test is recommended for non-parametric analysis of DEA results by Brockett and Golany (1996), and Grosskopf and Valdamanis (1987). It is used here because the efficient score results do not fit within a standard normal distribution.

The second question is if wealthier clubs, measured by turnover, are more efficient than poorer clubs. In Table 4 we present results of a Mann–Whitney Z test of differences of efficient scores between clubs awarded high points and clubs awarded low points, as well as the differences of efficient scores of higher turnover clubs and low turnover clubs.

The minus sign of the Z score indicates that clubs achieving a high points score tend to have higher efficiency scores than clubs achieving only a small points score, which validates the first question. Moreover, clubs with a large turnover tend to have higher efficiency scores than clubs with a smaller turnover. Finally, clubs with a large population base tend to have higher efficiency scores than clubs from smaller cities.

VIII. Discussion

The overall conclusion is that the English football clubs are managed with pure technical efficiency, displaying similar managerial skills. However, scale effects differentiate the clubs, with some displaying scale efficiency and others not. Therefore, scale is the main issue in football club management. In this context the competitive imbalance may result from different scales among clubs.

How do our results compare with the other papers? First, we find that all the clubs are efficient with VRS, as in Barros and Santos (2004), concluding that contrary to common allegations in the media, football clubs are well managed, therefore competitive imbalance is based on different scale effects. Second, comparing our results with Haas (2003b) we conclude that this author presents several VRS scores lower than one, but since he uses a very short data set (just one season) we cannot use his results with confidence for comparative purposes.

Based on this result the overall conclusion is that scale is paramount to football clubs, and therefore DEA-CCR models should not be used alone in the evaluation of performance. Moreover we verify that that large clubs with a higher points tally tend to have higher efficiency scores than clubs with fewer points; clubs with high turnover tend to have higher efficiency scores than clubs with smaller turnover. Finally, clubs with a large population base tend to have higher efficiency scores than clubs in smaller cities. From this result it emerges that population base and richer areas enable some clubs to have a high turnover, and the clubs tend to obtain more points. The general conclusion is that scale is a main driver in sporting efficiency, confirming the importance of the local fan base and high turnover. Sporting success results from the local base, confirming theoretical results, where the population in the

Table 4. Mann–Whitney test of differences in efficiency

Reference	Mann–Whitney U test	Z	Asymptotic significance (two-tailed)
High points awarded versus low points awarded	199.00	–1.40	0.030*
Large turnover versus small turnover	153.00	–1.58	0.042*
Large population basis versus small population basis	148.00	–1.89	0.025*

Notes: * Indicates significance at 5% level. Population of the clubs hometown was obtained in www.statistics.gov.uk team area is a main driver of economic performance (El-Hodiri and Quirk, 1971; Fort and Quirk, 1995). Differential managerial styles may explain part of the behaviour observed, but the DEA results show that there is an equivalence in managerial skills among the clubs analysed. A policy to overcome the identified inefficiencies should start from an analysis of the scale of activities and the adoption of a competitive sporting strategy. Naturally, the local base can restrict the competitive strategy, as the example of Leeds has shown.

IX. Limitations and Extensions of this Study

This paper has two limitations, the first being related to the data set and the second to the DEA method.

With reference to the data set, the homogeneity of the English football clubs used in the analysis is questionable, since we compare clubs with different dimensions and locations, and facing different restrictions: they may, therefore, not be considered directly comparable. However, one can always claim that the units are not comparable, and therefore a ratio analysis could not be carried out. Moreover, the data set is short, thus the conclusions are limited. In order for the conclusions to be generalized, we would need to have a more extensive panel data set. Reducing the number of observations in DEA variables increases the likelihood that a given observation will be judged relatively efficient (Banker, 1993). Despite this recommendation, we must stress that the data used in the paper has a larger span than the data sets used by Barros and Santos (2004) and by Haas (2003a, 2003b).

The limitations of the DEA model are the following: the DEA does not impose any functional form on the data, neither does it make distributional assumptions for the inefficiency term, nor does it make a prior distinction between the relative importance of any combination of inputs and outputs. These limitations are precisely the most distinctive and attractive characteristics of DEA. This efficiency measurement assumes that the production function of the fully efficient football club is known. In practice, this is not the case and the efficient isoquant must be estimated from the sample data. In these conditions, the frontier is relative to the sample considered in the analysis. The least attractive characteristic of DEA is that without statistical distribution hypotheses, the DEA does not allow for random errors in the data, assuming away measurement error and chance as factors affecting outcomes (Seiford and Thrall, 1990).

A variety of extensions to this paper can be undertaken. First, in this analysis, the DEA model allowed for complete weight flexibility. In situations in which some of the measures are likely to be more important than others, DEA allows for restricting factor weights through linear constraints. These linear constraints represent ranges for relative preferences among factors based on managerial input. Such analysis enables effective incorporation of managerial input into the DEA evaluations. Second, the input and output dimensions considered, are context-specific. More comprehensive input and output measurements, namely, allowing for no discretionary factors, such as environmental, socio-economic and quality inputs and outputs, need to be taken into consideration. The influence of no discretionary variables, excluded from the analysis, amounts to an assumption that these factors are constant across the sample. Third, non-parametric, free-disposal hull analysis or alternatively, parametric, can be used to assess the efficiency scores. However, previous research has shown that the DEA scores are inferior in value to econometric scores, but the ranking is preserved (Bauer *et al*., 1998).

X. Conclusions

This article has proposed a simple framework for the comparative evaluation of English Premier League Football clubs which play consecutively in the years 1998/99 to 2002/03 and the rationalisation of their operational activities. The analysis is based on a DEA model that allows for the incorporation of multiple inputs and outputs in determining the relative efficiencies. Benchmarks are provided for improving the operations of poorly performing football clubs. Several interesting and useful managerial insights and implications arising from the study are discussed. The general conclusion is that the English football clubs display equivalent managerial skills, being VRS efficient. However, they do not display equivalent scale efficiency, signifying that dimension is a restriction to the performance of the small clubs. A statistical correlation test between dimension (measured by turnover) and the CCR efficient scores does not support a statistical positive correlation between them. However, a statistical correlation test between points awarded and the CCR efficient scores is statistically supported. More research is needed to confirm this result.

References

Audas, R., Dobson, S. and Goddard, J. (2000) Organizational perfomance and managerial turnover, *Managerial and Decision Economics*, **20**, 305–18.

Banker, R. D. (1993) Maximum likelihood, consistency and data envelopment analysis, *Management Science*, **39**, 1265–73.

Banker, R. D., Charnes, A. and Cooper, W. W. (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis, *Management Science*, **30**, 1078–92.

Barros, C. P. and Santos, A. (2004) Les relations entre performance sportive et la performance financière dans le football: application au cas du football Portugais, in *Marketing et Football: Une Prespective Internationale* (Eds) G. Bolle and M. Desbordes, Presses Universitaires du Sport, Voiron, France.

Bauer, P. W., Berger, A. N., Ferrier, G. D. and Humphrey, D. B. (1998) Consistency conditions for regulatory analysis of financial institutions: a comparison of frontier efficiency methods, *Journal of Economics and Business*, **50**, 85–114.

Brockett, P. L. and Golany, B. (1996) Using rank statistics for determining programming efficiency differences in data envelopment analysis, *Management Science*, **42**, 466–72.

Carmichael, F., Thomas, D. and Ward, R. (2001) Production and efficiency in Association Football, *Journal of Sports Economics*, **2**, 228–43.

Charnes, A., Cooper, W. W. and Rhodes, E. (1978) Measuring the efficiency of decision-making units, *European Journal of Operations Research*, **2**, 429–44.

Charnes, A., Cooper, W. W., Seiford, L. and Stutz, J. A. (1982) Multiplicative model of efficiency analysis, *Socio-Economic Planning Sciences*, **16**, 223–4.

Charnes, A., Cooper, W. W., Gollany, B., Seiford, L. and Stutz, J. (1985) Foundations of data envelopment analysis for Pareto-Koopmans efficient empirical productions functions, *Journal of Econometrics*, **30**, 91–107.

Charnes, A., Cooper, W. W. and Huang, Z. M. (1990) Polyhedral cone-ratio DEA with an illustrative application to large commercial banks, *Journal of Econometrics*, **46**, 73–91.

Charnes, A., Cooper, W. W., Lewin, A. Y. and Seiford, L. M. (1995) *Data Envelopment Analysis: Theory, Methodology and Applications*, Kluwer, Academic Press, Boston.

Coelli, T. J. (1996) A guide to DEAP version 2.1: a data envelopment analysis (computer) program, Working Paper n°8/96, Centre for Efficiency and Productivity Analysis. University of New England, Armidale, Australia.

Coelli, T. J., Rao, P. and Battese, G. E. (1998) *An Introduction to Efficiency and Productivity Analysis*, Kluwer Academic Press, Boston.

Cooper, W. W., Seiford, L. M. and Tone, K. (2000) *Data Envelopment Analysis*, Kluwer, Boston, MA.

Dawson, P., Dobson, S. and Gerrard, B. (2000) Stochastic frontier and the temporal structure of managerial efficiency in English Soccer, *Journal of Sports Economics*, **1**, 341–62.

Deloitte & Touche. Annual Review of Football Finance. Reports for UK (several years).

Dervaux, B., Ferrier, G. D., Leleu, H. and Valdmanis, V. (2004) Comparing French and US hospitals technology: a directional input function approach, *Applied Economics*, **36**, 1065–81.

El-Hodiri, M. and Quirk, J. (1971) An economic model of professional sport league, *Journal of Political Economy*, **79**, 1302–19.

Fare, R. S., Grosskopf, S. and Lovel, C. A. K. (1994) *Production Frontiers*, Cambridge University Press, Cambridge.

Farrell, M. J. (1957) The measurement of productive efficiency, *Journal of the Royal Statistical Society*, **120**, 253–90.

Fiordelisi, F. and Molyneux, P. (2004) Efficiency in the factoring industry, *Applied Economics*, **36**, 947–59.

Fizel, J. L. and D'Itri, M. P. (1996) Estimating managerial efficiency: the case of college basketball coaches, *Journal of Sport Management*, **10**, 435–45.

Fizel, J. L. and D'Itri, M. P. (1997) Managerial efficiency, managerial succession and organizational performance, *Managerial and Decision Economics*, **18**, 295–308.

Fort, R. and Quirk, J. (1995) Cross-subsidiation, incentives and outcomes in professional leagues, *Journal of Economic Literature*, **33**, 1265–99.

Gerrard, B. (2005) A resource-utilization model of organisational efficiency in professional sport teams, *Journal of Sport Management*, **19**, 143–69.

Grosskopf, S. and Valdamanis, A. (1987) Measuring hospital performance: a non-parametric approach, *Journal of Health Economics*, **6**, 89–107.

Haas, D. J. (2003a) Financial efficiency in Major League Soccer, *Journal of Sport Economics*, **4**, 203–15.

Haas, D. J. (2003b) Productive efficiency of English football teams- a data envelopment approach, *Managerial and Decision Economics*, **24**, 403–10.

Hadley, L., Poitras, M., Ruggiero, J. and Knowles, S. (2000) Performance evaluation of national Football League Teams, *Managerial and Decision Economics*, **21**, 63–70.

Hauner, D. (2005) Explaining efficiency differences among large German and Austrian banks, *Applied Economics*, **37**, 969–80.

Hoeffler, R. A. and Payne, J. E. (1997) Measuring efficiency in the National Basketball Association, *Economic Letters*, **55**, 293–99.

Kahane, L. H. (2005) Production efficiency and discriminatory hiring practices in the National Hockey League: a stochastic frontier approach, Review of Industrial, *Organisation*, **27**, 47–71.

Kumbhakar, S. C. (1987) Production frontiers and panel data: an application to U.S. Class 1 railroads, *Journal of Business and Economics Statistics*, **5**, 249–55.

Latruppe, L., Balcombe, K., Davidova, S. and Zawalinska, K. (2004) Determinants of technical efficiency of crop and livestock farms in Poland, *Applied Economics*, **36**, 1255–63.

Leonida, L., Petraglia, C. and Murillo Zamorano, L. (2004) Total factor productivity and convergence hypothesis in Italian regions, *Applied Economics*, **36**, 2187–93.

Malmquist, S. (1953) Index numbers and indifference surfaces, *Trabajos de Estatistica*, **4**, 209–42.

Newson, R. (2002) Parameters behind "Nonparametric" statistics: Kendall's tau Somers' D and median differences, *The Stata Journal*, **2**, 45–64.

Porter, P. and Scully, G. W. (1982) Measuring managerial efficiency: the case of baseball, *Southern Economic Journal*, **48**, 642–50.

Price, C. W. and Weyman-Jones, T. (1996) Malmquist indices of productivity change in the UK gas industry before and after privatisation, *Applied Economics*, **28**, 29–39.

Quirk, J. and El-Hodiri, M. (1974) The economic theory of professional sport league, in *Government and Sport Business* (Ed.) R. Noll, Brookings Institution, Washington, DC, pp. 33–80.

Raab, R. and Lichty, R. (2002) Identifying sub-areas that comprise a greater metropolitan area: the criterion of county relative efficiency, *Journal of Regional Science*, **42**, 579–94.

Ruggiero, J., Hadley, L. and Gustafson, E. (1996) Technical efficiency in Major League Baseball, in *Baseball Economics: Current Research* (Eds) E. Fizel, E. Gustafson and L. Hadley, Praeger, New York.

Scully, G. W. (1994) Managerial efficiency and survivability in professional team sports, *Managerial and Decision Economics*, **15**, 403–11.

Seiford, L. M. and Thrall, R. (1990) Recent developments in DEA: the mathematical programming approach to frontier analysis, *Journal of Econometrics*, **46**, 7–38.

Sloane, P. (1971) The economics of professional football: the football club as a utility maximizer, *Scottish Journal of Economy*, **17**, 121–45.

Szymanski, S. and Kuipers, T. (2000) *Winners and Losers*, Penguin Books, London.

Thanassoulis E. (2001) *Introduction to the Theory and Application of Data Envelopment Analysis: A Foundation Text with Integrated Software*, Kluwer Academic Publishers, Dordrecht.

Thompson, R. G., Langemeier, L. N., Lee, C. and Thrall, R. M. (1990) The role of multiplier bounds in efficiency analysis with application to Kansas farming, *Journal of Econometrics*, **46**, 93–108.

Thompson, R. G., Singleton, F. D., Thrall, R. M. and Smith, B. A. (1986) Comparative site evaluation for locating a high-energy physics lab in Texas, *Interfaces*, **16**, 35–49.

Vrooman, J. (2000) The economics of American Sport Leagues, Scottish Journal of, *Political Economy*, **47**, 364–98.

Zak, T. A., Huang, C. J. and Siegfried, J. J. (1979) Production efficiency: the case of professional basketball, *Journal of Business*, **52**, 379–92.