ΧΟΡΗΓΙΑ _ Sport Management International Journal
CHOREGIA Scientific Forum in Sport Management
SMIJ – VOL. 4, Number 1, 2008

Comparative Analysis of Football Efficiency Among Two Small European Countries: Portugal and Greece

Ioannis Douvis[1], Carlos Pestana Barros[2]

[1] *Department of Physical Education and Sport Science, University of Athens*
[2] *Instituto Superior de Economia e Gestão, Technical University of Lisbon*

Abstract

This paper estimates changes in total productivity, breaking this down into technically efficient change and technological change by means of data envelopment analysis (DEA) applied to a representative sample of football clubs operating in the two small European countries: Portugal and Greece. The aim of this procedure is to seek out those best practices that will lead to improved performance in the market. We rank the football clubs according to their change in total productivity for the period 1999/2000 to 2002/2003, concluding that some clubs experienced productivity growth while others experienced a decrease in productivity. The implications arising from the study are considered in terms of managerial policy.

Key Words: *Football clubs, Portugal, Greece, productivity change, Malmquist index.*

Efficiency at the level of the enterprise is a major issue in contemporary European economics, due to the ever more intense pressure that competition has exerted on prices since the adoption of the EU's Single Market Programme (SMP). This was established in 1992 with the aim of facilitating the free movement of goods and services throughout the Member States. In the football industry, this pressure has resulted from the increase importance of European football cups. However, all of this strategic activity requires a sound, efficient basis if it is to yield successful results. Efficiency in football has been analysed by Fizel & D'Itry (1996,1997), Haas (2003A,B), Barros & Santos (2005), Barros (2003) among others.

This current research is based on our observation of the threats confronting the football clubs of the small countries at European level. First, the small clubs base their activity in a small national internal market, which affects the economies of scale with a reflection in earnings. Second, the historically low levels of purchasing power of the population as a whole, when compared to those of the larger European countries, affect the clubs earnings. Although much progress has been made since joining European Union, particularly in the large urban centres, this indicator shows that the European small countries are still substantial lagging behind the richer EU countries. These characteristics forces the leagues of small countries to use second level foreign players, because first level national players are bought by the clubs of the bigger countries. This result affects the performance of the European small countries leagues.

The Portuguese and Greek football industry reacts to these threats by attempting to increase the efficient use of inputs. One procedure adopted for improving competitiveness is benchmarking. These results from research carried out into an industry's best practices, based on the idea that the widespread application of these can lead to improved performance throughout the whole industry (Barros & Leach, 2005; Haas, 2003A and Fizel & D'Itry, 1997).

The efficiency of sport clubs is a major theme in contemporary research, viz. Fizel & D'Itry (1996), Barros & Santos (1993). Among the benchmarking techniques, DEA, a non-parametric technique, has been the one most commonly used in previous research into insurance, for example in Haas (2003A,B) and Barros & Santos (2005, 2003). In this paper, we analyse the comparative efficiency of major Portuguese and Greek football clubs, assessing the sector's efficiency by using a variety of metrics to measure inputs and outputs that combine financial, as well as operational, dimensions. Moreover, we evaluate total productivity with the Malmquist index.

From an academic perspective, the particular contribution of this paper lies in the comparison of two football leagues clubs: Portugal and Greece. The Malmquist index has been previously used in sports by Barros & Santos (2003), but we are not aware of any previous published paper analysing two national football leagues.

The paper is organised as follows: in section 2, we describe the contextual setting, considering the Portuguese and Greek football clubs in order to shed some light on the threats mentioned above; in section 3, we survey the existing literature on the topic, with the aim of highlighting the contribution that the present paper seeks to make; in section 4, we explain the theoretical framework supporting the model used; in section 5, we present the data and results; in section 6, we estimate the determinants of the efficient scores; in section 7, we discuss the results; in section 8, we put forward the limitations and possible extensions of the study; and finally, in section 9, we make our concluding remarks.

Institutional Setting

In this section, we display the characteristics of Greek and Portuguese first league football clubs in order to establish the institutional background against which the paper is set.

Greece

Despite the enormous success of the Greek national team in Euro 2004, Greece's professional football remains in the shadow of at least eight other European premier leagues in terms of its competitive, organizational, financial and managerial effectiveness. Similarly to Portugal, Greece holds one of the lowest positions among other European countries in terms of its market size, GDP and income. Almost 55% of the total population (11 million) resides in two major urban areas, the capital city of Athens and Thessaloniki. Considering the fact that 12 out of the 16 teams participating in the first division of the Greek league are from these two cities, one can easily understand the highly centralized structure and nature of Greek professional football. The three most dominant clubs Olympiakos, Panathinaikos and AEK are from the city of Athens. The last time that a team residing outside of the greater metropolitan area of Athens, won a championship title, was almost two decades ago. Even the teams from Thessaloniki, the second largest city in the country, possessing a long history and a solid fan base do not seem to have what it takes to challenge seriously the powerhouses of Olympiakos and Panathinaikos for the title. The last decade Olympiakos won 7 consecutive titles in Greece and Panathinaikos reached the quarterfinals and semi-finals of the UEFA Champions League. With the exception of Skoda Xanthi, a model club from the northern part of the country (the only football club in Greece possessing an ISO 9001 certificate of quality), the remaining smaller clubs struggle to stay in the division facing enormous financial problems due to mismanagement and lack of appropriate organization. In terms of its financial magnitude, Greek professional football stands very low in the European football market, which is estimated to be approximately 10.4 billion euros (Deloitte & Touche, 2004). The total revenue generated by the league the 2002-2003

season amounts to 115 million euros (gate receipts, TV coverage, sponsors and government support through the state lottery company), while Manchester United alone received almost 180 million for that same period (Deloitte & Touche, 2003). A recent incident, which harmed the financial situation and undermined the reliability of the league, was the bankruptcy of one of the two cable TV companies, after having invested disproportional amounts of money, into the league of a country with such a small market. On top of this, there are several issues which need to be stated in order to provide a clear illustration of the institutional setting of professional football in Greece. There are clubs which receive indirect support from state agencies for political reasons. In addition to that, there are 6 smaller clubs from Athens and Thessaloniki, which have very limited fan bases and whose revenues come for the most part from non-gate receipts. Ticket sales make up only 8.7% of the total income for these clubs (*Table 1*).

Table 1. *Revenues of smaller football clubs, 2002-2003 Season (units: Euro).*

Club	Total Revenue	Gate Receipts	Percentage	Other Revenue	Percentage
Aigaleo	3302000	368000	11%	2934000	89%
Akratitos	2643000	147000	6%	2496000	94%
Ionikos	3921000	179000	5%	3742000	95%
Paniliakos	1669000	59000	4%	1610000	96%
Proodeutiki	984000	235000	24%	749000	76%
Xalkidona	741000	13000	2%	728000	98%
TOTAL	13260000	1001000	8.7%	12259000	91.3%

Finally, there are clubs which face severe financial problems and should be relegated according to the state's legislation. Popular clubs tend to avoid this enforcement through legal manipulations due to the political cost that such an implementation of the law may have for the government. This entire situation makes it very difficult for clubs to keep the young and extremely talented players, who basically came out of nowhere to win the Euro 2004 in Portugal. Over the last two seasons most of the starting 11 of last summer's triumphant Greek national team, secured lucrative transfers in big European clubs. Giourkas was transferred from Panathinaikos to Porto, Charisteas went to Ajax, Karagounis to Inter, Giannakopoulos to Bolton, Dellas to Roma ect. Greece has become a destination for ex-football superstars (Rivaldo, Giovanni, Paulo Souza) and second tear players who receive most of the money from the abovementioned transfers. *Table 2* illustrates the total spending of the clubs used in the analysis for the season 2002-2003, which are those which maintained their presence in the First Division

throughout the four consecutive years analysed. It is evident that 77.4% of the league's total spending go to player salaries. On the other hand, player salaries of the league most of the times exceed by far the league's total revenue.

Table 2. *Spending and Player Salaries by Football Club, 2002-2003 Season (units: Euro).*

Club	Total Spending	Player Salaries	Percentage
AEK	40071000	17561000	44%
Aris	11834000	10804000	915
Ionikos	3900000	3587000	92%
Iraklis	8993000	7760000	86%
OFI	5194000	4249000	82%
Olympiakos	60552000	41446000	68%
Panathinaikos	30919000	21367000	69%
Panionios	2684000	2295000	86%
PAOK	14745000	10666000	72%
Skoda Xanthi	4858000	4064000	84%
TOTAL	183750000	123799000	77.4%

This has as result the accumulation of gigantic losses, especially in the three dominating clubs. As of June 2003 the accumulated losses of all Greek football clubs reached 275 million euros (Papanikos, 2004). While this is the case for big clubs, smaller clubs can only afford to buy cheap players of low quality. This diminishes fan loyalty and deteriorates the game's popularity, resulting into decline of attendances, lack of sponsors and limited opportunities for commercial exploitation. Another big concern for the Greek league, are the increasingly frequent incidents of hooliganism, which harm the general image of the game and keep true football fans away from the stadiums. In order for Greek professional football to address its issues, overcome the obstacles and advance to the level of counties like the Netherlands, Portugal and Denmark, the management of the clubs must optimise its practices, find innovative income generating strategies (match day income, sponsorship) and ultimately relate football success and the clubs' financial management and performance.

Portugal

It is fair to say that Portuguese professional football lags far behind the European powerhouse premier leagues of England, Spain and Italy, in terms

of spectacle, consumer satisfaction, attendances, and financial power measured by most indicators. The market is small, GDP, measured by purchasing power is lower than most European countries and the population of a little over 10 million is concentrated on the Atlantic coast, principally in the country's two largest urban conurbations, Lisbon in the centre and Oporto in the north. This explains the fact that three clubs –Benfica and Sporting in Lisbon and FC Porto– dominate the domestic game to such an extent that they are universally known as the Big Three. The Superliga presently has 18 clubs. It is rare indeed for any usurper from among the lesser clubs to challenge for the league championship and even less common to actually win it. As evidence, when the second, smaller team in Oporto, Boavista, won the title in 2001, it was the first time that one of the Big Three had not taken the championship since 1946. Outside of these two cities, the fan base is small and financial weakness allows little scope to buy the quality or number of players necessary to amount a serious championship assault, or to keep any players of sufficient talent to play on a more glamorous stage.

With reference to the financial dimension of the sport in Portugal, and as an indication of how far behind giants such as Real Madrid, Manchester United or Juventus the Big Three are in organisational and commercial terms, comparative figures published for the 2000/2001 season show that the total income receipts generated by the Portuguese First Division fell a little short of 13% of those in the English Premiership and 15% of Italy's Serie A. At club level, the total income of FC Porto was approximately 25 million euros, while Manchester United received almost 180 million euros in the same season. (Deloitte & Touche, 2001). The clubs in financial deficit are in abundance, with total First Division costs which rose by 38% in 2000/2001 (to 246 million euros) from the figure accumulated in 1997/98. In the area of costs, Benfica were the champions in 2001, registering net losses of more than 37 million euros, which was more than 40% of the total for the entire First Division. Costs for the season were the double of the club's income. This is a vivid illustration of the financial difficulties and weak economic performance and management, which the sport must confront in Portugal. Furthermore, Benfica has not won the First Division title since 1993/94 and its last major trophy was the Portuguese Cup in 1996. However, it should also be emphasised that examples of financial equilibrium in football clubs around the world are few.

Clubs have tended to have squads of players which are much too large for the club's requirements and too expensive a cost, given that players' salaries represent the largest single item of expenditure on the balance sheet. The biggest clubs must pay salaries in line with those in England or Spain to their star players, if they are to persuade them not to move elsewhere in Europe. This is a severe managerial weakness, as was revealed by the example of Boavista, who became champions in 2001 with a total monthly salary bill of

only 20 thousand euros. Thanks to the sound, wise financial management of Boavista PLC, the club is a rare case of financial equilibrium.

It is therefore naturally understandable that Portugal is not a destination for the best known, most talented players in their prime in Europe or Latin America. On the contrary, it is economically obliged to be an exporter of talent. This appears to be a rising trend, with increasingly young Portuguese players of outstanding ability –but still unfinished products– being sold on to rich and hungry giants to the east and north of their home country. Between June 2002 and August 2003 Sporting sold three teenagers (Viana to Newcastle, Quaresma to Barcelona and Cristiano Ronaldo to Msanchester United) for a combined total of approximately 28 million euros, while FC Porto sold the 20 year-old Postiga to Tottenham Hotspur for 8.75 million euros in June 2003. Whilst this may constitute astute business for the selling clubs, it is a fooballing loss to the Portuguese League. It remains to be seen whether such a lucrative form of income can become a staple of the sport's sustainability, whether the game's popularity, or fan loyalty, suffer as a result, or whether it is only a temporary phase. Whatever the outcome will be, this strategy must raise searching questions that relate football success and the clubs' financial management and performance.

In *Table 3*, we present the structure of costs of the clubs used in the analysis, which are those which maintained their presence in the First Division throughout the three consecutive years analysed.

Table 3. *Structure of the costs in 2001/2002 season.*

Football clubs	Wages/ total cost	Amortisation/ total cost	Supplies/ total cost	Total cost (Euro)/ points won in the season
FC Porto	0.518	0.290	0.101	775842.4
Sporting	0.467	0.353	0.109	728421.4
Benfica	0.338	0.369	0.126	1028544
Boavista	0.448	0.258	0.100	218704.1
Alverca	0.312	0.486	0.166	232435.6
Victoria Guimarães	0.532	0.094	0.095	177939
Salgueiros	0.647	0.018	0.174	147427.9
Leiria	0.815	0.002	0.159	70216.33
Sporting Braga	0.653	0.121	0.124	154939.9
Maritimo	0.330	0.169	0.464	117576.5
Belenenses	0.573	0.244	0.122	95928.89
Farense	0.628	0.055	0.165	123305
Gil Vicente	0.758	0.052	0.092	59845.61
Mean	0.539	0.193	0.153	302394.4

We verify that the cost per point is dispersed, with the Big Three presenting a very high value compared with the rest of the division, confirming the dominant role of the these three clubs. The average value of the cost of points is 302.389,00 euros per point; the leading clubs attain this value, with the other clubs depicting less than average value. The ratio wages/total cost shows that the salaries in the total of costs is 53.9% a value smaller than the average value in the economy, which amounts to 60%. We also verify that amortisation is on average 19.3%, but this small value includes some clubs which play in municipally-owned stadiums, and therefore have a small amortisation cost. The supplies and services on total cost average 15%.

In *Table 4*, we present the structure of receipts by club.

Table 4. *Structure of receipts.*

	Tickets/ total	Member sybscriptions/ total	Sponsorship/ total	TV total	Gains-players sold/ total	Finance/ total
FC Porto	0.318	0.055	0.149	0.120	0.264	0.036
Sporting	0.216	0.094	0.050	0.185	0.351	0.032
Benfica	0.209	0.103	0.067	0.222	0.207	0.004
Boavista	0.468	0.000	0.043	0.227	0.219	0.024
Alverca	0.051	0.000	0.081	0.287	0.541	0.016
Guimar´es	0.145	0.100	0.030	0.348	0.210	0.022
Salgueiros	0.100	0.041	0.098	0.208	0.131	0.000
Leiria	0.094	0.019	0.332	0.480	0.000	0.000
Sport Braga	0.074	0.078	0.061	0.289	0.470	0.003
Maritimo	0.081	0.054	0.140	0.204	0.000	0.004
Belenenses	0.422	0.000	0.065	0.220	0.281	0.0003
Farense	0.105	0.073	0.082	0.385	0.116	0.011
Gil Vicente	0.058	0.046	0.140	0.478	0.000	0.0004
Mean	0.180	0.05	0.103	0.281	0.215	0.012

We verify that the mean match ticket receipts amount to 18%, club membership subscriptions are worth only 5% (three clubs do not have a membership scheme), sponsorship accounts for 10.3%, TV receipts are 28.1% and gains from the transfer of players are 21.5%. Financial income has a residual value of 1.2%. This table shows that there are different management strategies among the clubs. Some do not ask their supporters to pay a membership fee, while others appear to make no profits from players' added value in the transfer market.

Overall, it can be observed that the Big Three clubs, which have a scale dimension much higher than the average, dominate Portuguese football, in financial as well as sporting terms.

Literature Survey

The analysis of sports efficiency is scarce, due to the lack of adequate data for this purpose (Slack, T., 1997). There are two contemporary approaches to measure efficiency: firstly, the econometric or parametric approach and second, the non-parametric. Besides these two approaches, we observe other papers relying on ratio analysis which address the same issue.

Among the papers which have taken the non-parametric approach, which are, thus, of particular interest for the present paper, we mention Fizel & D' Itri (1996,1997), who applied the DEA analysis to measure the managerial efficiency of college basketball teams to assess the conflicting theses concerning the impact of managerial succession on organisational performance and Porter and Scully (1982), who analysed the managerial efficiency of baseball managers with a non-parametric approach. Barros (2002) analysed the incentive regulation on sports organisational training activities disentangling technical and allocative efficiency with DEA. Haas (2003A) analyses the efficiency of the USA Major Soccer League with plain DEA and Barros & Santos (2003) estimate a Malmquist index for Portuguese sports organisational training activities.

Among the papers which have used the econometric frontier, Zak, Huang & Siegfried (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 American 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, Hadley & Gustafson (1996) analysed the efficiency of baseball teams with panel data. Hoeffler & Payne (1997) analysed the stochastic frontier of American basketball with cross-section data. Audas, Dobson & Goddard (2000) analysed involuntary and voluntary managerial job-termination, with hazard functions for English professional football. Hadley, Poitras, Ruggiero & Knowles (2000) analysed the performance of the American NFL, using a Poisson regression model. Dawson, Dobson & Gerrard (2000) analysed the managerial efficiency of English soccer managers with an econometric stochastic frontier and Carmichael, Thomas & Ward (2001) analysed the efficiency of the English Premiership clubs with residuals. Gerrard (2001) analyses the production function of coaches working in the English Premier League with win-ratios for the period of 1992 to1998. Barros & Leach (2005) analyse the technical efficiency of the English Premier League with a cost function.

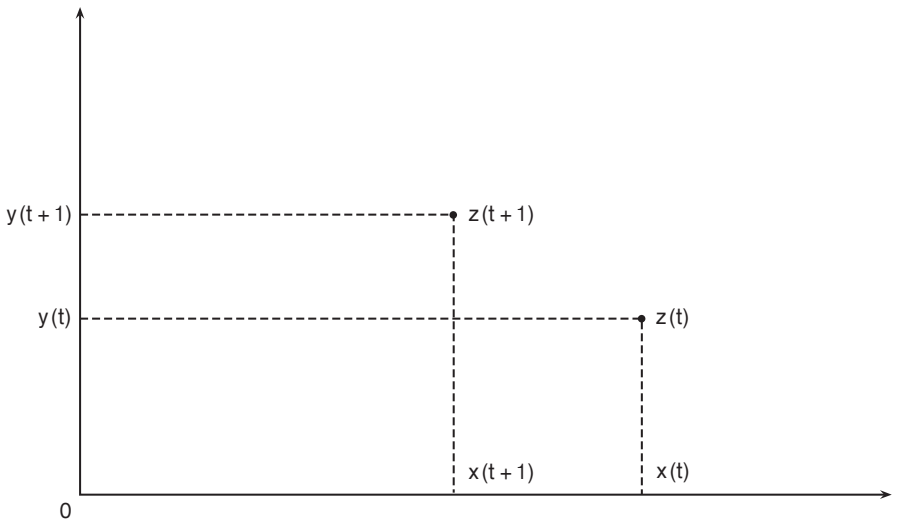
The non-parametric approach papers mentioned above are clearly insufficient for such an important management technique as DEA, which is being increasingly used elsewhere in management and economic fields, and should be a focus of sport management research. DEA is particularly useful when the data set is small and prevents an econometric frontier being established, as is the case in the present paper.

Theoretical Framework

In this paper, we adopt the efficient frontier approach, using the Malmquist productivity index based on data envelopment analysis (DEA).

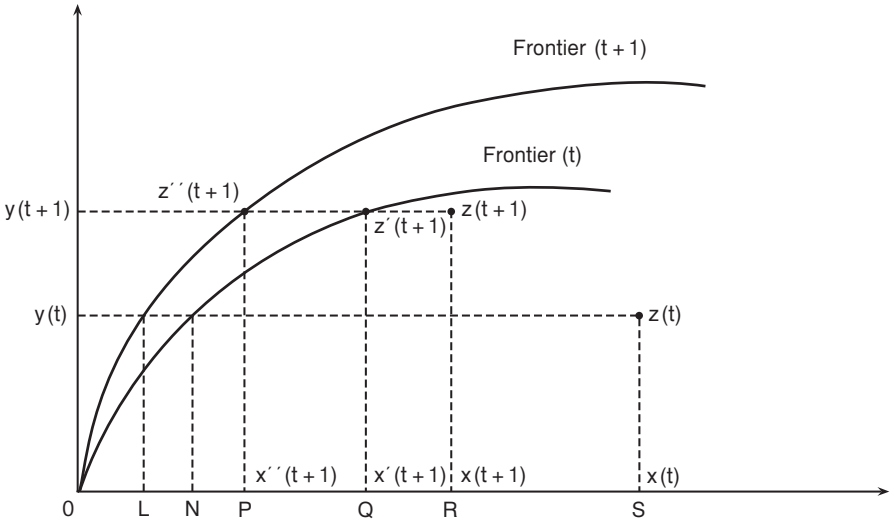
The Malmquist productivity index allows for changes in productivity to be broken down into changes in technical efficiency and changes in technological efficiency.

To set the scene for our productivity measurement, we adopt the framework presented in *Figure 1* below, which shows two observations of the input (x) and output (y) bundles used by a firm in an industry at time t and t + 1. The aim is to measure the productivity growth between t and t+1 in terms of the change from input-output bundle z (t) to input-output bundle z (t + 1).



Productivity is measured through the potential production frontier that is imposed on the production bundle in *Figure 2*. The production frontier represents the efficient levels of maximum output (y) that can be produced from a given level of input (x). If the firm is technically efficient in period t, it produces along

the frontier the maximum output attainable, y (t). Point $z(t) = [x(t), y(t)]$ corresponds to a technically inefficient firm, which uses more than the minimal amount of input to produce a given level of output. The input x(t) should be multiplied by the horizontal distance ratio, ON/OS, in order to make production of y(t) technically efficient. By analogy, and assuming frontier t as reference, the input $x(t+1)$ should be multiplied by the horizontal distance ratio, OQ/OR, in order to achieve technical efficiency in the production of output $y(t+1)$, that is bundle $z(t+1)$. Since the frontier has shifted in the meantime, $z(t+1)$ is technically inefficient in $t+1$. In order for the firm to be efficient in period $t+1$, input $x(t+1)$ must be reduced by the horizontal distance ratio, OP/OQ, resulting in bundle $z'(t+1)$. Globally, the input ratio inefficiency in $t+1$ is OP/OR.



The relative movement of a production observation over time may result from firms catching up with the frontier (technical efficiency change) or may result from the frontier shifting upwards over time (technological efficiency change).

The Malmquist index of productivity growth (M) is the ratio of the input inefficiencies at $t+1$ and t.

$$M = \left[\frac{OP}{OR} \div \frac{ON}{OS}\right] = \left[\frac{OQ}{OR} \div \frac{ON}{OS}\right] \times \frac{OP}{OQ} = MC \times MF \qquad (1)$$

We can see that the relative efficiency distances of each observation from the original frontier measures the catching-up effect. The frontier shift effect is measured by the relative distance between the frontiers at output level

$y(t+1)$, e.g. (OP/OQ). This is the benchmark used by Hjalmarsson & Veiderpass (1992) and Price & Weyman-Jones (1996). Another benchmark used by Fare et al. (1990) measures the frontier shift as the relative distance between the frontiers at t and $t+1$, at output level $y(t)$, e.g. (OL/ON). An alternative is to determine the shift effect as the geometric mean of these two benchmarks, $\left[\frac{OP}{OQ} \times \frac{OL}{ON}\right]^{1/2}$. Using this last alternative, we have,

$$M = \left[\frac{OQ}{OR} \div \frac{ON}{OS}\right] \times \left[\frac{OP}{OQ} \times \frac{OL}{ON}\right]^{1/2} = MC \times MF \tag{2}$$

Formally, the Malmquist index is based on the output distance function defined as:

$$d^T(x^t, y^t) \equiv \inf\left[\theta : (x^t, \frac{1}{\theta} y^t) \varepsilon S^t\right] \tag{3}$$

where x denotes a vector of inputs, y is the vector of outputs, S is the technology set, and superscript T denotes the technology reference period, usually $T = t$ or $T = t+1$, and $1/\theta$ defines the amount by which outputs in year t could have been increased, given the inputs used, if technology for year T had been fully utilised.

Caves, Christensen & Diewert (1982) showed that productivity movements can be measured by a multi-input, multi-output Malmquist index when input and output data are available in physical units, so that no price index problems arise. They argue that the distance function $d(x, y)$ can be used in the construction of the Malmquist index and measure the Malmquist index of change between t and $t+1$ as the ratio:

$$d^T(x^{t+1}, y^{t+1}) / d^T(x^t, y^t) \tag{4}$$

Fare et al. (1994) sought to measure the Malmquist index as the geometric mean of such indices calculated both for year t and year $t+1$ reference technologies as:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{d^t(x^{t+1}, y^{t+1})}{d^t(x^t, y^t)} \cdot \frac{d^{t+1}(x^{t+1}, y^{t+1})}{d^{t+1}(x^t, y^t)}\right] \tag{5}$$

Fare et al. (1994) factor this expression into the product of technological change and technical efficiency change as:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{d^{t+1}(x^{t+1}, y^{t+1})}{d^t(x^t, y^t)} \times \left[\frac{d^t(x^{t+1}, y^{t+1})}{d^{t+1}(x^{t+1}, y^{t+1})} \frac{d^t(x^t, y^t)}{d^{t+1}(x^t, y^t)}\right]^{1/2} \tag{6}$$

The ratio outside the brackets is the index of change in technical efficiency (i.e. the change in the distance of the observed production from the current maximum feasible production) between years t and t + 1, while the bracketed term is the index of change in technology (or technological change) between two periods evaluated at x^t and x^{t+1}.

The Malmquist index is measured either with the distance function or, alternatively, with the reciprocal of the input distance function $\theta(x, y) = [1/d(x, y)]$. This reciprocal of the input distance function $\theta(x, y)$ is the smallest ratio by which an input bundle can be multiplied and still be capable of achieving a given level of output. The reciprocal distance function is equivalent to the measure of technical efficiency proposed by Farrell (1957) and is the basis of the efficiency distance ratios used in analysing *Figure 2*.

When the Farrell measurement of technical efficiency (the reciprocal of the input or output distance) is used in constructing the Malmquist index, we obtain productivity growth if $M > 1$ and productivity regression if $M < 1$.

The Malmquist index (Malmquist, 1953) allows for changes in productivity to be broken down into changes in efficiency and technological changes. Unlike the econometric stochastic frontier approach, it offers a different rate of technological change for each individual, which is more appropriate for the purposes of this section, i.e. the analysis of technological change by clubs. Moreover, since it is estimated with a non-parametric methodology (DEA), it needs neither to impose any functional form on the data, nor to make any distributional assumptions for the inefficiency term.

Additional, the technical efficiency change can be broken down into pure technical change and scale technical change. The break down of the technical efficiency change into its components is based in the variable return to scale (VRS) hypothesis, (Fare et al., 1994). The VRS scores measure pure technical efficiency only, while the constant return to scale (CRS) index is composed of a non-additive combination of pure technical and scale efficiencies. A ratio of the overall efficiency (CRS) scores to pure technical efficiency scores (VRS) provides us with a measurement of scale efficiency and therefore the estimation of pure technical change. The difference between the CRS scores and the scale efficient change allow us to obtain the pure efficiency change.

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{d^{t+1}_{VRS}(x^{t+1}, y^{t+1})}{d^t_{VRS}(x^t, y^t)} \times \left[\frac{d^{t+1}_{CRS}(x^{t+1}, y^{t+1})}{d^{t+1}_{VRS}(x^{t+1}, y^{t+1})} \div \frac{d^t_{CRS}(x^t, y^t)}{d^t_{VRS}(x^t, y^t)} \right] \times \left[\frac{d^t_{CRS}(x^t, y^t)}{d^{t+1}_{CRS}(x^{t+1}, y^{t+1})} \times \frac{d^t_{CRS}(x^t, y^t)}{d^{t+1}_{CRS}(x^t, y)} \right]^{1/2} \quad (7)$$

This efficiency measurement assumes that the production function of the fully efficient club is known. In practice, this is not the case, and the efficient

frontier must be estimated from the sample data. Under such conditions, the frontier is relative to the sample considered in the analysis. We developed a Malmquist productivity estimate from mathematical programming models of the frontier production function. For recent surveys, see Fare, Grosskopf & Lovell (1994), Charnes et al. (1995), Coelli (1996), Coelli, Rao & Battese (1998), Cooper et al. (2000) and Thanassoulis (2001).

Data and Results

To estimate the production frontier, we used balanced panel data on Greek and Portuguese football clubs in the seasons 1999/2000 to 2002/2003 (4 years?20 clubs=80 observations), published by Deloitte & Touche. A sample of the clubs that played consecutively in the league in the years under analysis (1999/2000 to 2002/2003) is used. The use of such clubs ensures balanced panel data and is needed to obtain similar average scores over the period at club level.

The clubs considered in the analysis are listed in *Table 5* above, being those which maintained their presence in the First Division in the consecutive years under analysis, listed in *Table 5*. This small data set precludes the use of econometrics, but is suitable for DEA.

Frontier models require the identification of inputs (resources) and outputs (transformation of resources). It is important for the applicability of the model results and the Football Federation's ÏÏbuy in`` to the process that the measures of inputs and outputs be relevant, adequately measurable, that appropriate archival data is available and that ÏÏmore is better`` in the case of outputs.

Several criteria can be applied to the selection of inputs and outputs. First, the available archival data criterion is used. Second, the literature survey is a way to ensure the validity of the research and therefore, another criterion to take into account. Finally, the last criterion for measurement selection is the professional opinion of managers in the area concerned. In this paper, we follow the first two criteria.

We measured output by 3 indicators: first, financial indicators, namely, total receipt; then, sports indicators, i.e., championship points won, and the total number of attendances measured by the total number of tickets sold.

We measured inputs by two indicators: number of players and total costs.

All the monetary variables are expressed in euros, and were deflated by the GDP deflator and denoted at constant 2001 prices. We ensured the DEA convention that the minimum number of DMUs is greater than three times the number of inputs plus output $\left(38 \geqslant 3\,(7 + 5)\right)$, Raab & Lichty (2002).

Table 5. *Descriptive statistics of the logarithm of the variables used, 1999/2000 to 2001/2002.*

Items	Nobs	Minimum	Maximum	Mean	Std. Deviation
			Outputs		
Total receipt (euro)	80	4048	545203	89727	92364
Points won	80	22	92	52.725	14.893
Total attendance (number)	80	767844	80586755	13042943	15737976
			Inputs		
Number of players	80	22	36	27	2.907
Total cost (euro)	80	1146219	183489875	25566707	34112033

We verify that the for total receipts and total attendance the standard deviation is higher than the mean, signifying a high level of heterogeneity in the sample.

Results

The Malmquist index can be calculated in several ways (Caves et al., 1982). In this study, we estimate an output-oriented Malmquist productivity index, based on DEA. Output-oriented efficiency measurements are appropriate if we assume that football clubs act in a competitive market (Khumbhakar, 1987; Zellner et al., 1966). In output-oriented models, such as the one adopted in this paper, DEA seeks to identify technical inefficiency as a proportional decrease in input usage. However, it is possible to measure an input-oriented model of technical inefficiency as a proportional increase in output use. As far as football clubs are concerned, output orientation seems to be the natural choice, due to their competitive position in the market. However, since the input and output Malmquist indices are equal (Thanassoulis, 2001, p. 182), this specification is more of a theoretical issue rather than a practical one.

DEA allows for the estimation of total productivity change in the form of a Malmquist index. The results are presented in Table 5, with the Malmquist index, denoted total productivity change, broken down into technical efficient change (the diffusion or catch-up component) and technological efficient

change (the innovation or frontier-shift component). Moreover, we break down technical efficient change into pure efficient change and scale-efficient change. The football clubs are ranked according to the results of column 5.

Table 6: *Average Technically Efficient Change and Technological Change Observed in Portuguese and Greek Football Clubs 1999/2000 to 2002/2003.*

	Football Clubs	MC-Technically efficient change (1)	MF-Technological change (2)	MC(a) Pure technical efficiency change (3)	MC(b) Scale efficiency change (4)	M-Total productivity change (5)
			Greek football clubs			
1	Panathinaikos	0.933	1.113	1.000	0.933	1.038
2	Skoda Xanthi	0.933	1.083	0.930	1.003	1.010
3	Iraklis	1.018	0.988	1.040	0.978	1.006
4	Olympiakos	0.947	1.054	0.954	0.993	0.998
5	PAOK	0.962	1.028	0.973	0.988	0.985
6	Ionikos	0.980	0.985	0.947	1.035	0.965
7	Panionios	1.027	0.933	1.021	1.006	0.959
8	AEK	0.982	0.916	0.992	0.989	0.899
9	OFI	0.958	0.890	0.968	0.990	0.853
10	Aris	0.907	0.903	0.956	0.949	0.819
—	Mean	0.964	0.989	0.978	0.986	0.953
—	Median	0.960	0.986	0.970	0.989	0.975
—	Std. Dev	0.037	0.078	0.034	0.028	0.072
			Portuguese football clubs			
1	Porto	1.021	1.162	1.018	1.004	1.187
2	Braga	1.109	1.035	1.120	0.990	1.148
3	Belenenses	1.028	1.069	1.000	1.028	1.098
4	Guimarães	1.145	0.957	1.136	1.008	1.096
5	Maritimo	0.992	1.082	1.000	0.992	1.074
6	Boavista	1.008	1.057	0.963	1.046	1.065
7	Benfica	1.000	1.040	1.000	1.000	1.040
8	Gil Vicente	1.027	1.012	1.000	1.027	1.040
9	Sporting	0.912	1.124	0.920	0.991	1.025
10	Leiria	1.032	0.974	1.000	1.032	1.005
—	Mean	1.027	1.051	1.015	1.011	1.077
—	Median	1.024	1.048	1.000	1.006	1.069
—	Std. Dev	0.063	0.062	0.065	0.019	0.056

In *Table 6*, we can see that the total productivity change score (the Malmquist index presented in column 5) is one or higher than one for all Portuguese football clubs and for two Greek football clubs, out of ten. This result shows that a large proportion of the Portuguese football clubs experienced gains in total productivity in the period considered, while for Greece only a small proportion of the clubs analysed experienced productivity gains in the period. The mean score of the Malmquist index is 1.077 for the Portuguese football clubs and 0.953 for the Greek football clubs. Therefore, there are eight Greek football clubs with a Malmquist index lower than the mean.

The change in the technical efficiency score (column 1) is defined as the diffusion of best-practice technology in the management of the activity and is attributed to investment planning, technical experience and management and organisation in the football clubs. For the period under analysis, we can see that it is higher than one for all Portuguese football clubs, with the exception of two. Moreover, it is higher than one only for two Greek football clubs. For a proportion of football clubs, the change in technical efficiency is lower than one, signifying that there was a recession in technical efficiency in the period.

The breakdown of the score for the change in technical efficiency into pure technical efficiency change (column 3) and scale efficiency change (column 4) shows mixed results, with some football clubs obtaining simultaneous gains in both areas and others obtaining gains in one, but losses in the other. The improvement in pure technical efficiency, which signifies an improvement in managerial skills, shows that there was investment in organisational factors associated with the management of some football clubs, such as a better balance between inputs and outputs, best-practice initiatives, more accurate reporting, an improvement in quality, and so on. The scale efficiency, which is the consequence of size, increases in the period for many Portuguese football clubs and for a minority of the Greek football clubs.

Technological change (column 2) is the consequence of innovation, i.e. the adoption of new technologies, by best-practice football clubs. We can see that this index is higher than one for many football clubs. This indicates that innovation improved in the period for these, best practice, clubs, meaning that there was investment in new technologies (methodologies, procedures and techniques) and in the commensurate skills upgrades related to this. However, for the clubs showing a downward movement in terms of technological change this is a primary area of concern.

Overall, we observe four combinations of technical efficiency change and technological change:

(i) In the first group, we find twelve clubs in which improvements in technical efficiency co-exist with improvements in technology change. These are the best-performing football clubs in the period, with improvements

registered in technical efficiency, denoting upgraded organisational factors associated with the use of inputs, outputs and the relationship between inputs and outputs. No Greek football club displays this combination of efficient scores, while six Portuguese football clubs display this result (Porto, Braga, Belenenses, Boavista, Benfica and Gil Vicente).

(ii) In the second group, we find football clubs in which improvements in technical efficiency co-exist with deteriorations in technology. Two Greek football clubs (Irakils and Panionios) display this combination. In 2002 Panionios was on the verge of bankruptcy having to deal with an immense amount of debts. The management of the team, by taking advantage of several legal loopholes, managed to erase the debt by changing the name of the club into New Panionios. During the period under investigation Iraklis was owned by one of the most successful businessmen in Greece. Several experienced managers from the owner's corporate group of firms got involved in the management of the club. Investment in new technologies and innovation in management was not a priority for both clubs. The short term success of the management of both teams, came to an end in 2002 for Iraklis and in 2004 for Panionios when both clubs passed into new ownership. Two Portuguese football clubs also display this combination (Guimar´es and Leiria). These are the football clubs with upgraded organisational factors, but without the innovation inherent in investment in new technology, which would provide leverage for the organisational factors. These football clubs need to acquire new technology and the necessary commensurate skills upgrades in order to improve their performance.

(iii) In the third group, we find the football clubs in which improvements in technological efficiency co-exists with deterioration of technical efficiency. These clubs need to upgrade their managerial skills and scale to improve their performance. This group includes for Greece (Panathinaikos, Skoda Xanthi, Olympiakos and PAOK) and for Portugal (Mar£timo and Sporting). All four Greek clubs have solid fan bases and infrastructure, using at the same time new technologies. Two of these teams were in the process of building new state of the art stadiums and the other two renovating their existing ones. It is evident that a higher level of organizational efficiency, could do miracles for these clubs financially and competitively.

(iv) In the fourth possibility, in which deteriorating technical efficiency co-exists with deteriorating technology, we have four Greek clubs (Ionikos, AEK, OFI and Aris).

Hence, our findings encompass several combinations of efficiency change, signifying that there is room for adjustment in almost all of the above-men-

tioned inefficient football clubs in order to achieve best-practice procedures in football management. One of the most representative examples of this statement is the case of AEK. Prior to the beginning of the 2004-2005 season, the club came very close to complete destruction. With a debt amounting over 100 million euros, the final strike came when the temporary management of the club, based on promises for support by the government, decided to demolish the existing historical stadium of the club in order to build a new modern one. Of course this never happened and the club not only lost the significant revenue of gate receipts, but also had to rent other stadiums in order to compete. The complete turn around was based on the efforts of Demis Nikolaidis, one of the players who won the Euro 2004 in Portugal and former player of AEK. Nikolaidis a true leader and hero for fans of the club, decided to buy the club together with a group of young successful and wealthy businessmen. By hiring experienced managers and adopting effective techniques and best-practice procedures in the management of the club, Nikolaidis managed to capitalize on the teams fan base and moved the team to the brand new Olympic Stadium of Athens, providing first class services and a completely new athletic experience to the fans. After achieving an arrangement of the debts, the management of AEK looks with confidence into the future. The first priority lies in the improvement of the technological efficiency of its managerial procedures in order to improve the financial position of the club. The ultimate goal is the building a state of the art stadium for AEK.

Discussion

The present paper analyses changes in total productivity in a representative sample of Portuguese and Greek football clubs between 1999/2000 and 2002/2003, a period of intense instability in the sector, due to the combination of several factors.

We emphasise two implications of our findings for managerial policy. Firstly, the management of the clubs with the poorest performances should change their managerial procedures in order to adopt an efficient, enhanced-incentive policy, which would enable these inefficient football clubs to catch up with the efficient frontier. Secondly, the adjustment must be based on the improvement of technical efficiency, as well as technological change.

Technical efficiency is characterised, in a dynamic way, as efficiency change (diffusion), relating to changes between two successive technical-efficiency frontiers, and is explained by management skills and scale. Due to any of these attributes, many football clubs do not display technical efficiency change in the period. This is a particular area of concern for Greece, since many of the clubs displaying technical inefficiency change are Greek.

Other possible reasons for inefficiencies are resource-based strategic factors. These include technological change (innovation), which, in a broad economic sense, is related to investment that would improve the total productivity of a productive unit. This arises from capital accumulation, which determines the adoption of technology by best-practice decision-making units, thereby shifting the efficient frontier. In the football activity, technological change means investing in new methods, procedures and techniques with the aim of improving results. The results of such investment only take effect in the long term and are not attributable to current management practices. Examples of such strategic factors are the dimensional factors associated with scale and scope, meaning that the profitability of clubs with an inappropriate scale and scope is inevitably restricted.

The general conclusion is that there is room for improvement in the management of those clubs that are performing badly.

What should the managers of inefficient football clubs do to improve efficiency? Firstly, they should adopt a benchmark management procedure in order to evaluate their relative position and to adopt appropriate managerial procedures for catching up with the frontier of "best practices". This results from the fact that sports are benchmarked in the pit, but financial activity is not benchmarked. Secondly, they should upgrade the quality of their management practices.

How do we explain the different strategies adopted by the analysed football clubs? The Portuguese league is clearly more competitive than the Greek league, in the football pit, as the results in the European cups reveal. This competitiveness is displayed in either sport or financial efficiency, balancing sporting and financial success to some extent, in order to be successful in the league. Second, the main reason of the inefficiency in the Greek clubs is scale, signifying that an appropriate upgrading strategy starts from the analysis of the scale of activities and progresses to the adoption of an appropriate managerial strategy. Population and income in the club area is a main determinant of efficiency (El-Hodiri & Quirk, 1971; Forth & Quirk, 1995). Third, pure technical change, which measures managerial skills is a main area of concern in Greece and Portugal. Finally the elite clubs, display technical efficiency change in the Portuguese league, but not in the Greek league.

For the inefficient football clubs to achieve upward mobility requires a superior insight into the rules of the game within this industry. In football, leaders usually outperform their competitors. However, if the leader is always the same, a hierarchical system is imposed on the game and in this case, there is no way to escape the industry trap.

Considering the results, we draw the following managerial implications from this study. In a league with clubs defined in a hierarchical ranking which includes sporting and financial results, the margin for the management of the

subordinated clubs to improve the position of the club in the ranking, without an exogenous chock, is limited. What is an exogenous chock? Chelsea's Abramovich money observed in the English league, Barros & Leach (2005), or the adoption of an innovative managerial strategy? The adoption of a managerial strategy is first, not to allow the conventional gloom within the industry to deter the manager from creating value; second, to change the rules of the game in its favour, which will allow some to out-perform the less insightful rivals. Therefore the primary managerial implication of the paper is that the inefficient club's management must upgrade its managerial procedure regarding sporting and financial activities, in order to provide more explicitly-binding incentives for increasing economic efficiency. Directors can try to change the club strategy and performance in ways that will allow it to rise above the average. Moreover, an appropriate upgrading strategy starts from the analysis of the scale of activities and progresses to the adoption of an appropriate managerial strategy (El-Hodiri & Quirk, 1971; Fort & Quirk, 1995).

The results indicated that the majority of the Greek clubs face severe problems in terms of their productivity gains, while all Portuguese clubs experienced gains in total productivity in the period under investigation. It was also indicated that in many cases in the Greek league, deteriorating technical efficiency co-exists with deteriorating technology. Only a few months after the «Golden Greek Summer» (successful organization of the Olympic Games in Athens and the unbelievable winning of the Euro 2004 by the Greek national team), what remains to be seen is if Greek professional football will capitalize on these two fortunate incidents in order to overcome its organizational, managerial and financial weaknesses. The infrastructure which comes as a legacy of the 2004 Olympic Games (Five state of the art new stadiums in five different cities and complete renovation of at least another eight) together with the acquisition of the know-how of the most innovative and effective managerial techniques and strategies, used by the state's sports agencies and the organizing committee, provide a whole new perspective for Greek football clubs and a first class opportunity to optimise their managerial and financial situation. The success of the Greek national team in Euro 2004 is expected to provide a further stimulus for Greek football, in terms of increasing the general interest of all the constituents around the domestic professional league.

Contributions, Limitations and Possible Extensions of this Study

At this juncture, it is appropriate to consider the contribution of our paper to the economics literature on insurance, as well as its limitations and possible extensions. The key contribution is its application of the Malmquist DEA model to this football clubs, supported by a theoretical model of economic be-

haviour. Moreover, we present an extensive literature survey which serves to clarify our paper's contribution. We also undertake an external benchmark analysis, focusing on Portuguese clubs and Greek clubs together.

This paper has two sets of limitations: firstly, those relating to the data set, and, secondly, those arising as a result of the DEA method.

As far as the data set is concerned, the homogeneity of the football clubs used in the analysis is questionable, since we compare clubs with different sizes and locations, which may face different restrictions and are not therefore directly comparable. However, we can always claim that the units are not comparable and that therefore a ratio analysis could not be carried out either. Moreover, the data set is short, so that the conclusions are limited. In order for the latter to be more generalised, we would need to have a larger 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).

We have also combined Portuguese and Greek football clubs, which can be criticised since they clearly do not face the same restrictions.

The limitations of the DEA model are as follows: DEA does not impose any functional form on the data nor make any distributional assumptions for the inefficiency term. Nor does it make a priori distinctions between the relative importance of any combination of inputs and outputs. These limitations are precisely the most distinctive and appealing 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. Under such conditions, the frontier is relative to the sample considered in the analysis (Bessent & Bessent, 1980). A less appealing characteristic of DEA is that, without statistical distribution hypotheses, DEA does not allow for random errors in the data, assuming away measurement error and chance as factors affecting outcomes (Seiford & Thrall, 1990).

A variety of extensions can be undertaken in relation to this paper. Firstly, in this analysis, the DEA model allowed for complete weight flexibility. In situations in which some measurements are likely to be more important than others, DEA allows for the restriction of factor weights through linear constraints. These linear constraints represent ranges for relative preferences among factors based on managerial input. Such an analysis allows for the effective incorporation of managerial input into the DEA evaluations. Secondly, the input and output dimensions that are considered are context-specific. More comprehensive input and output measurements need to be taken into consideration, namely ones that do not allow for any discretionary factors, such as environmental, socio-economic and quality inputs and outputs. The influence of non-discretionary variables, which are excluded from the analysis, amounts to an assumption that these factors are constant across the sample.

Thirdly, non-parametric, or alternatively parametric, free disposal hull analysis, can be used to assess the efficiency scores. However, previous research has shown that the DEA scores are inferior in value to econometric scores, even though the same ranking is still preserved (Bauer et al., 1998).

Conclusion

In this paper, we have analysed total productivity change in a representative sample of Portuguese and Greek football clubs between 1999/2000 and 2002/2003, a period of volatility in the sector, due to the combination of several factors. The analysis is based on a DEA model that allows for the incorporation of multiple inputs and outputs in determining relative efficiencies. Benchmarks are provided for improving the operations of poorly performing football clubs.

We conclude that increasing the governance and transparency of the clubs in question would increase their efficiency.

More investigation is needed to address the limitations mentioned.

References

Audas, R., Dobson, S. & Goddard, J. (2000). Organizational Performance and Managerial Turnover. Managerial and Decision Economics, 20, 305-318

Banker, R.D. (1993). Maximum likelihood, consistency and data envelopment analysis, Management Science, 39 (10), pp. 1265-1273

Barros, C.P. (2003). Incentive Regulation and Efficiency in Sports Organisational Training Activities. Sport Management Review, 6, 1, 33-52

Barros, C.P. & Santos, A. (2003). Productivity in Sports Organisational Training Activities: A DEA Study. European Journal of Sport Management Quarterly, 1, 46-65

Barros, C.P. & Santos, A. (2005). Les relations entre performance sportive et la performance financiere: application au cas du football Portugais. In Bolle, G. and Desbordes M. (eds.), Marketing et Football: une perspective internationale. Presses Universitaires du Sport, Voiron, France, (forthcoming)

Barros, C.P. & Leach, S. (2005). Analyzing the Performance of the English Football League with an Econometric Frontier Model. Journal of Sport Economics, (forthcoming)

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

Bessent, A.M. & Bessent, E.W. (1980). Determining the Comparative Efficiency of Schools Through Data Envelopment Analysis, Educational Administration Quarterly, 16, pp. 57-75

Carmichael, F., Thomas, D. & Ward, R. (2001). Production and efficiency in association football. Journal of Sports Economics, 2, 3:228-243

Caves D.W., Christensen, L.R. & Diewert, W.E. (1982). The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity, Econometrica, 50, pp. 1393-1414

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

Coelli, T.J. (1996). A Guide to DEAP version 2.1: A Data Envelopment Analysis (Computer) Program. Working Paper No. 8/96, Centre for Efficiency and Productivity Analysis. University of New England. Armidale, Australia

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

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

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, 341-362

Deloitte & Touche: Reports for Portugal 1999/2000 to 2002/2003

Deloitte & Touche: Reports for Greece 1999/2000 to 2002/2003

El-Hodiri, M. & Quirk, J. (1971). An Economic Model of a Professional Sports League. Journal of Political Economy, 79, 1302-1319

Fare, R.S., Grosskopf, S. & Lovell, C.A.K. (1994). Production Frontiers. Cambridge University Press

Farrell, M.J. (1957). The Measurement of Productive Efficiency. Journal of the Royal Statistical Society, Series A, 120 (3), pp. 253-290

Fizel, J.L. & D'Itri, M.P. (1996). Estimating Managerial Efficiency: The case of college basketball coaches. Journal of Sport Management, 10, 435-445

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

Fort, R. & Quirk, J. (1995). Cross-Subsidization, Incentives, and Outcomes in Professional Team Sports Leagues. Journal of Economic Literature, 33, 1265-1299

Haas, D.J. (2003B). Productive Efficiency of English Football Teams - A Data Envelopment Approach. Managerial and Decision Economics, 24, 403-410

Haas, D.J. (2003A). Technical Efficiency in the Major League Soccer. Journal of Sport Economics, 4, 3, 203- 215

Hadley, L., Poitras, M., Ruggiero, J. & Knowles, S. (2000). Performance evaluation of National Football League teams. Managerial and Decision Economics, 21, 63-70

Hjalmarsson, L. & Veiderpass, A. (1992). Productivity in Swedish Electricity Retail Distribution, Scandinavian Journal of Economics, 94, supplement, 193-205

Hoeffler, R.A. & Payne, J.E. (1997). Measuring efficiency in the National Basketball Association. Economic Letters, 55, 293-299

Khumabhakar, S.C. (1987). Production frontiers and panel data: an application to US class 1 railroads. Journal of Business and Economic Statistics, 5 (2), 249-255

Malmquist, S. (1953). Index Numbers and Indifference Surfaces. Trabajos de Estatistica, 4, 209-42

Papanikos, G. (2004). Greek Football at a financial Crossroad. Paper prepared for presentation in a Roundtable on the Financial Crisis of Football, Faculty of Economics, University of Bologna, Rimini, March, 2004

Porter, P. & Scully, G.W. (1982). Measuring managerial efficiency: The case of baseball. Southern Economic Journal, 48, 642-650

Price, C.W. & Weyman-Jones, T. (1996). Malmquist Indices of Productivity Change in the UK Gas Industry Before and After Privatization, Applied Economics, 28, 29-39

Raab, R. & Lichty, R.W. (2002). Identifying subareas that comprise a greater metropolitan area: the criterion of county relative efficiency, Journal of Regional Science, 42 (3), 579-594

Ruggiero, J., Hadley, L. & Gustafson, E. (1996). Technical efficiency in major League Baseball. In Fizel, E., Gustafson, E. and Hadley, L. (edits). Baseball Economics: Current Research. Praeger publishers: Westport CT, 191-200

Scully, G.W. (1994). Managerial efficiency and survivability in professional team sports. Managerial and Decision Economics, 15, 403-411

Seiford, L. & Thrall, R. (1990). Recent developments in DEA: The Mathematical Programming Approach to Frontier Analysis, Journal of Econometrics, 46, 7-38

Slack, T. (1997). Understanding Sport Organisation: the application of organisational theory. Champaign, IL, Human Kinetics

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

Zak, T.A., Huang, C.J. & Siegfried, J.J. (1979). Production efficiency: The case of professional basketball. Journal of Business, 52, 379-392

Zellner, A., Kmenta, J. & Dréze, J. (1966). Specification and estimation of Cobb-Douglas Functions. Econometrica, 34, 784-795

Address for correspondence:
Ioannis Douvis
61 Nafsikas Str.,
17564, Palaio Faliro
Athens, Greece
e-mail: jdouvis@phed.uoa.gr