Efficiency of French football clubs and its dynamics

Jardin, Mathieu
University of Rennes 1, CREM (UMR CNRS 6211)

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M. Jardin[1]

[1] *University of Rennes 1, Faculty of economic (France) / CNRS-CREM*

7 place Hoche, 35000 Rennes, +33 (0)2 23 23 33 24

mathieu.jardin@univ-rennes1.fr

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Abstract:

In the paper we evaluate the efficiency of French football clubs (Ligue 1) from 2004 to 2007 using Data Envelopment Analysis (DEA) with « Assurance Region ». Then, we study the dynamics of clubs' performances.

Contrary to previous works on other championships, best teams in competition or most profitable clubs are not the most efficient units in our sample. High average scores show that French First League is efficient. The first source of inefficiency in the Ligue 1 is linked to size problems and over-investments. Despite an average club performance stable over the period, we exhibit a deterioration of conditions in which clubs operate.

Keywords: Ligue 1, efficiency scores, Data Envelopment Analysis (DEA), Malmquist index, over-investment

JEL code: C88, L30

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1/Introduction

The French football First League called “Ligue 1” (L1) belongs to the “Big5” that is the English, Spanish, Italian, French and German football championships. Those major leagues are involved in a competitive contest for talent on the players market, a situation institutionalized since 1995 and the Bosman case. In addition, the best clubs of those championships are also directly in competition on the field during European cups.

In that global picture, the L1 has two faces. On one hand, a healthy financial situation with its clubs relatively less put into debt than their European neighbors. As an illustration the L1 global turnover in 2008 was positive for the third consecutive year. The league works with an auditing organism, the “Direction National du Contrôle de Gestion” (DNCG) and professional French clubs are audited each season with the obligation to publish their financial accounts. This particular attention has allowed the league to avoid the European football financial crisis (Gouguet and Primault 2006), at least apparently (Andreff 2007). Moreover this control is one of the factors leading to a high level of competitive balance. The L1 is known indeed to be highly balanced[1]. On the other hand, European performances of French clubs are disappointing; especially in Champion’s League (the most prestigious European cup). The L1 is ranked 5th in the 2009 UEFA ranking, based on national previous years performances in all European cups. Furthermore, only two clubs figure in the Deloitte & Touche 2008 “Football Money League”, the annual study on the top 20 European clubs with the highest revenue (6 of those clubs are English, 4 from Italy and Germany and 3 from Spain).

Taking actively part in this European race, the L1 tries to reach a higher step in the international hierarchy while respecting a certain conception of financial fair play. But in order to obtain greater achievement, the L1 need to know more about itself. What can be said about French football clubs efficiency? A question never investigated while several works have already been performed on English, American, Spanish or Portuguese League. In that context, the aim of this paper is to highlight, first, whether French clubs are efficient or not. Then, where do the inefficiencies come from. Finally, how and why the clubs’ performance do evolve across time.

Table 1 shows some references (from the older to the more recent one) dealing with efficiency of sportive organizations. Authors span a large scope of units from coaches to federations or clubs. Most of these works have been performed on US or English data with a majority studying football. The method of evaluation is either mathematical (namely DEA), or statistical (Stochastic Frontier Analysis for instance). Both methodologies belong to the family of efficiency frontier method, which is the most relevant approach for this range of works. From this quick literature review we notice the lack of study about the French First League, despites that L1 is one of the biggest European championships.

INSERT TABLE 1 (all tables and figures are at the end of the document)

Efficiency measurement in sport and particularly in football is challenging. If efficiency is a simple notion, defined by the ability of reaching objectives with respect to means, the difficulty lies in the identification of a football club objectives and means[2]. Literature on club manager objectives can be split into two different classes of models. First works on sports economics assumed, as for enterprises, that club managers face a classical profit maximization problem. It is the case for example, of Neale in (1964) or Quirk and Fort in (1992), these works both studying American professional leagues. However in 1973, Sloane built a more European fashion model with club managers maximizing their own utility. He introduced a sportive dimension in the manager objectives, this manager being also a sportsman. In 1996, 1999 and 2006, Késenne develops in the same way, a model where victories are more important than profit for club managers. In Rasher (1997) or in Vrooman (2000), the authors propose a situation where profit and the number of victories are maximized at the same time.

Despite empirical test attempts, neither the assumption of profit maximization nor the assumption of utility maximization has been undoubtedly validated; and both assumptions are traditionally used. Nevertheless, it seems that, in Europe, and especially at lower levels of competition, the assumption of utility maximization is the relevant one. Indeed, Szymanski and Smith (1997) or Kesenne (1999) for instance, argue that bad budgetary balances in a majority of clubs go against the profit maximization behavior. We follow this argument here, even if we have to notice a tendency to the “Americanization of European football” (Hoehn and Szymanski 1999 or Andreff and Staudohar 2000).

Data Envelopment Analysis (DEA, initially proposed by Charnes *and al* in 1978) perfectly matches the multi-outputs peculiarities of the problem. Indeed, using no assumption on the objective function of a club manager, we can deal with an efficiency evaluation considering at the same time both sportive and financial issues. The flexibility is one of the DEA quality and also a limit. Letting the method freely choose each objective weight in the maximization can lead to extreme cases (with only one of the two objectives considered). That is why, in order to fit the literature, we use the "Assurance Region" (AR) method. By doing so, we constrain the two dimensions to be considered (sportive and financial). The AR use is one of the extensions proposed in Barros and Leach (2006a). Then it is natural to use Malmquist indexes to obtain information on performance evolutions since we can easily compute those indexes from our previous DEA scores.

Haas (2003b) and Barros and Leach (2006a), both on the English First League and Haas (2003a) on US soccer, are our three main references and we use them as a comparison for our results. We describe efficiency of French football and characterize its evolution using both financial and sportive dimensions. We find that more than one third of French clubs are on the best practice frontier with an average efficiency score of 0.93 (maximum is 1). The first inefficiency source is linked to a size problem, with a majority of clubs over-investing in players. In our sample there is no correlation between efficiency scores and athletic performances contrary to previous studies on English or American First League. We even find a negative correlation between efficiency and financial achievement. This "exception Française" is described in the results section.

The dynamic study of managerial performance emphasizes two different ideas. First, the average efficiency is decreasing across time. Mainly not because of the clubs themselves, but because of the environment in which they operate. It is especially due to total wage inflation. Then, L1 can be split in three clusters, each one with its own dynamic of efficiency evolution. Thus, this article presents different interests. It is, indeed, the first DEA application to the French League. Furthermore, allowing both static and dynamic characterization of efficiency, this work stressed some French professional football peculiarities, giving a new tool for league governance.

Section 2 explains our methodology. Section 3 presents and justifies the data chosen for this paper. Section 4 and 5 are respectively devoted to results and conclusions.

2/Methodology

Besides the methodological interest explained in introduction, the DEA exhibits some other convenient features. Indeed, DEA is a non parametric technique and allows to study cases with relatively few observations (with only 20 clubs per season in the league, a standard parametric approach is difficult to implement). In addition, DEA can easily deal with multi-outputs problems, even if the items used are not valued on a traditional market (for instance the points at the end of the season). Finally, efficiency scores can be used in order to compute Malmquist Index. On the minus side, statistical noise cannot be separated from inefficiency in our scores and as for any non-parametric method, statistic inference is challenging.

The DEA built weighted average ratio of outputs on inputs for each Decision Making Unit (DMU i.e. football club here). Weights are chosen by the method itself during the linear program solving. Those weights vectors are set in order to be the most favorable for the evaluated DMU. Using efficient DMUs in the sample to form an efficiency frontier, we measure other DMUs inefficiency as the distance to this frontier. Efficiency scores are bounded between 0 and 1 with 1 for a fully efficient club.

We have to notice that DEA computes a relative efficiency, each clubs being evaluated in respect to the other DMUs in the sample. For that reason we can only use relatively homogenous DMUs like football clubs of the same championship and at a similar level of competition. All technical aspects of DEA construction and use are given in appendix A. So in that section, we only briefly describe the steps required to the envelopment design. First, considering football clubs as production processes implies considering DMUs as using inputs to produce outputs. In that context, we have to define how to measure achievement (outputs) and how to measure resources (inputs). Our choices are explained in the Data section. Then, the model orientation and return to scale assumption have to be settled. We use here an output oriented model, that is, we measure inefficiency by the potential output expansion for a given input level[3]. Constant and variable returns to scale assumptions are successively used, giving respectively global efficiency (GE) and pure technical efficiency (PTE) scores. Even if the variable return to scale assumption is the likeliest, joint computation allows scale efficiency scores computation (SE with the ratio of GE on PTE). Scale efficiency scores give more precise information on inefficiency sources.

In order to avoid extreme cases, where only one of the two output dimensions would be present in the maximization (thus one of the weights in the weighted average of outputs equal to 0); we use the "Assurance region" method (introduced in Thompson *and al* 1986). By doing so, we constrain the two output dimensions weights ratio to be bounded between an upper and a lower bound[4]. It is equivalent to preventing one dimension from being over-represented (or even the only dimension to be represented). As explained in the introduction, it is relevant in the European case to encompass both sportive and profit dimensions. A more formal explanation of the AR method is given in appendix A.

The study last step is to compute and decompose the Malmquist indexes (as described in Färe and Grosskopf 1992). We can build those indexes using efficiency scores from the DEA first step (all the details are given in appendix B). Computation gives the overall performance evolution for each club, while decomposition splits that evolution into two components: an endogenous and an exogenous one. The interested reader can find more extensive explanations in Barros and Santos (2003).

3/Data

All the data are from the INSEE website (Institut National de la Statistique et des Etudes Economiques) for populations and from the French Professional League annual reports for financial and sportive data. Two inputs and two outputs are used to build the efficiency frontier for French professional clubs from 2004 to 2007. For the purpose of the study, we only focus on clubs playing in the First League during the whole period (14 clubs during 3 seasons or 42 observations). Descriptive statistics of the data are given in appendix C.

Our first input is the club total wage. It is a proxy for the team talent stock[5] (as in Szymanski and Smith 1997). This measure is not perfect since it encompasses some non-player salaries and is not a perfect measure of talent (wage is also a function of player popularity). It is, nevertheless, the most accurate measure we have. First, because we investigate the club's global efficiency, bearing in mind that this club is a Decision Making Unit (DMU) as well as a sportive team, which implies that we also have to consider the talent of all people working with or around the team, even when they are not players (i.e. coach, staff); second, because player's popularity can be considered as one of his qualities and so has to be included in his skills (popularity attracts fans and allows for some merchandising and sponsoring). We use population size of the club city as the second input in our frontier. We, have to consider that clubs are localized in different areas. Those areas are characterized by different population sizes. Our clubs face, incidentally, different potential market sizes. Indeed, a bigger population means a relatively bigger fan-base, and thus a bigger gate receipt and a stronger merchandising. A bigger community is also a synonym for relatively bigger subsidies. The amount of population is, in our design, a non discretionary input (because the population is obviously not under the club manager control), a specification already used in Haas (2003b).

Outputs (or objectives) include number of points at the end of the season and turnover. The number of points is a measure of the sport achievement for DMUs. It allows a ranking at the end of the season, with access to a European cup for the League top teams or relegation for the last three clubs. This output dimension has to be included in the clubs' objectives, according to common sense and literature on owner objectives (Kesenne 1996, 1999 or Szymanski and Smith 1997). But we cannot consider professional clubs only in their athletic function. Part of the literature indeed, considers that football clubs are also profit maximizers (Rasher 97), or sometimes even only profit maximizers. Moreover, football clubs are moving closer[6] to the private sector; a phenomenon emphasized by Andreff and Staudohar (2000). To encompass this, we use annual club turnovers to evaluate each club's financial achievement (turnover includes gates receipts and TV rights both from national championship and European cups participations, merchandising, sponsoring and subsidies). Input and output choices are based on data availability or on previous literature; we use both criteria in this paper.

To summarize we use 4 items[7]: 2 inputs (a discretionary one and a non-discretionary one) - total wage and urban area population - and 2 outputs – number of points and turnover.

4/Results

We organize our results in two parts. The first part answers questions about French club efficiency, inefficiency sources and type of efficient clubs. The second part gives details on the evolution of efficiency and the evolution reasons.

The L1 efficiency scores are reported in Table 2. Here we have each club's average score for the overall period (from 04-05 to 06-07). A comprehensive table with each club score for each season is given in appendix D. In the second column, are the scores computed under the constant returns to scale assumption (measuring the global efficiency: GE). In the third column, are the scores computed under the variable returns to scale assumption (measuring the pure technical efficiency: PTE). Scale efficiency scores (SE, fourth column) are built with the two previous one since it is the ratio of scores under constant and variable returns to scale assumptions. All scores are bounded between 0 and 1 with 1 for a fully efficient club.

Scale efficiency score shows whether the club size is optimal or not, while pure technical efficiency score gives information about the part of inefficiency coming from a bad managerial performance. That is, from an inefficient transformation process of inputs into outputs. By club size, we mean the total amount of resources involved in the activity. For instance, SOCHAUX is on the best practice frontier with all its scores equal to 1. The league average score for the entire period under consideration is high (0.93 and 0.85 for pure technical efficiency and scale efficiency). This average shows the good French clubs performance. Under the variable return to scale assumption (the more realistic one), more than one third of the clubs are indeed on the efficiency frontier.

Scale inefficiency is the main reason for inefficiency in the French championship. SAINT-ETIENNE, AUXERRE and SOCHAUX are the only clubs to be fully efficient whatever the return to scale assumption. LYON and TOULOUSE are the only two clubs for which a non-optimal size is the only source of inefficiency. In that particular context, considering that populations are beyond managerial control, we are focusing on total wages for "size". Therefore a non-optimal size is either an excessive or an insufficient total wage bill. All the other clubs are inefficient both because of their managerial practice and because of their non-optimal size.

The fifth column of Table 2 gives the areas, on or under the frontier, to which a club belongs. Letter "*c*" means an optimal size of club (constant return to scale area), letter "*i*" a too small size (increasing return to scale area) and "*d*" an excessive size of club (decreasing return to scale area). We have three letters per club, one for each season in our sample. In more than half the cases (23/42), French clubs are too big in terms of inputs. In other words, a majority of them often overinvest in players at the beginning of the season. AUXERRE, SAINT-ETIENNE and SOCHAUX have an optimal size for all the seasons while NICE is always too small. Several clubs alternatively over or under invest in players (TOULOUSE, RENNES, NANTES and MONACO). However, the reader must remember that a theoretical optimal club size is impossible to determine with DEA because the efficiency studied here is a relative one.

INSERT TABLE 2

From the last two columns of Table 2, we notice the difficulty to establish any link between efficiency level and athletic performance. It underscores the need of running some statistical tests to study a potential correlation. In order to perform these tests, we use the Mann-Whitney traditional procedure. First, we divide the sample into two subsamples using a different criterion for each comparison (Table 3). In the first comparison, for instance, we split our sample into two parts in respect to the median amount of points. Then we compare the average level of efficiency in each subsample. All the values of the Mann-Whitney Z statistics are positive (Table 3); meaning that for each comparison exposed in the first column, the second subsample is on average more efficient than the first one. It appears that sport achievement and efficiency are not correlated in the L1. In addition to this, financial performance (as well as population or total wage) and efficiency are negatively correlated.

Interestingly and contrary to Barros and Leach's (2006a) study of the English First League or Haas (2003a) on US soccer; we find here, that French sportive or financial "champions" are not the most efficient clubs in the L1. This result emphasizes, again, a general overinvestment with the biggest clubs winning too few matches and generating too little turnover in respect to the resources they engage. We think this major difference between the English and French championship is, at least partly, due to the higher level of competitive balance (CB) in France. More CB means a closer competition and so - ceteris paribus - fewer points for the champions (the corollary is less turnovers from TV rights, the sharing being partly function of the athletic performance). It is furthermore quite intuitive, that the two subgroups with the biggest populations or total wages have a less good efficiency score on average compare to their respective opponent. To sum up with a simple formula: "Small is beautiful" in the French championship.

INSERT TABLE 3

Malmquist index computation for each DMU allows considering efficiency evolution from one season to the next (or for the overall period, i.e. 3 seasons). An index equal to 1 means a perfectly stable performance across time. An index lower (greater) than 1 means that efficiency has decreased (increased). The League average indexes for both sub-periods (from 04-05 to 05-06 and from 05-06 to 06-07) and for the entire period (from 04-05 to 06-07) are reported in Table 4. A table with each club's performance evolution for each period is available in appendix D. On average, the L1 clubs are less efficient at the end of the period than at the beginning since the index on the entire period is equal to 0.76. It is also the case over our two sub-periods (respectively 0.87 and 0.90). The average league performance is decreasing across time.

We can decompose the Malmquist index in order to distinguish two different sources of evolution. The first source is endogenous and due to the managerial change in the club activity. The second source is exogenous and due to all the factors out of the club manager's control but impacting efficiency[8]; in other words, the environment in which the club operates. It is obvious from Table 4 that efficiency decrease is mainly due to deterioration of the environment (0.80), since the endogenous performance level is quite stable during the period (0.95) and even increasing for one sub-period. That result raises the question of the exogenous degradation reason.

Considering the methodology we used to build the efficiency scores, an exogenous degradation of performance could only come from the way the different inputs/outputs evolved across the period. Recall that they are for each club: total wage, urban population, turnover and number of points. Population and number of points have been stable on average between 2004 and 2007, so these two items have not impacted the evolution of efficiency. In addition, the total L1 turnover became even bigger during this length of time. Consequently, all things being equal, efficiency should have been increasing over the period instead of decreasing. But during the same span of time, the total wage bill of French clubs has jumped with a global inflation of 47% in between 2004 and 2007. This inflation has overwhelmed the relative turnover improvement, leading to the deterioration of global performance[9] in the League. A result also pointed out in Andreff (2007).

INSERT TABLE 4

However, those aggregate indexes hide different realities among clubs. We can in fact, distinguish 3 different groups of clubs. Each cluster has its own efficiency dynamics (Figure 1). Cluster 1 (C1) is the closest to the average club of L1, with a stable level of management quality but a decreasing efficiency caused by an exogenous deterioration of the general performance (Total wage inflation). We find SAINT-ETIENNE, NICE, SOCHAUX, TOULOUSE and AUXERRE in C1. It is interesting to note that this cluster is composed by the five first clubs of the efficiency ranking (last column of Table 1). Cluster 2 (C2) is characterized at the same time by an environment degradation and an efficiency improvement. Thus, C2 overall performance is quite stable (RENNES, BORDEAUX, MARSEILLES, and NANTES). The 5 last clubs are finally in cluster 3 (C3) with both efficiency decrease and environment deterioration (PARIS, MONACO, LENS, LILLE and LYON). To summarize, even if all the French clubs have in common an exogenous environmental deterioration, they differ by their proper efficiency dynamics. There are three different dynamics of efficiency - one for each cluster - respectively stable, positive and negative.

INSERT FIGURE 1

5/Concluding remarks

To the best of our knowledge, it is the first time that such a study has been conducted on the French football championship (except for Jardin 2009 or Barros and Andreff 2009). This proves again the lack of analytical and economic studies on the French League despites it belongs to the “Big 5”. Nevertheless, a better understanding of the economical mechanisms involved in a club activity is a necessary condition to professional league governance improvement. In the current context of European race and in addition to the need for transparency required in Andreff (2007), an increasing performance of professional French football goes through this range of work.

Furthermore, this paper presents a methodological interest since it is the first attempt to use the « Assurance Region » method combined with standard DEA in order to constrain weights total flexibility for the study of a professional football league (an extension suggested at the end of Barros and Leach 2006a). By doing so, we are in line with the literature of European professional football, considering that both profit and victory maximization holds at the same time. Moreover, it is also the first time those efficiency scores have been used to build some Malmquist indexes for football clubs; allowing dynamic characterization of efficiency within a professional football League. We propose, using both the financial and sportive dimensions, a comprehensive framework to describe the efficiency of French football and characterize its evolution. We find that more than one third of our DMUs are on the best practice frontier with an average score in the French first league of 0.93 (maximum is 1). The first inefficiency source is linked to a size problem: clubs are too big in majority because of over-investments in players. A similar result has been shown for US soccer in Haas (2003a). In addition, the envelopment shows targets on the best practice frontier for inefficient clubs and gives recommendations for improvements of their efficiency.

Our work stresses some French League peculiarities. The absence of correlation between efficiency scores and sport achievements or the negative correlation between efficiency scores and financial results could seem to be awkward at first glance. Indeed, in previous studies (Barros and Leach 2006a or Haas 2003a), the best clubs, from financial or athletic point of view, are also the most efficient units. The main difference between French football and the other championships is about competitive balance level. It appears that French big clubs over-invest in terms of talent, because they win too few matches considering the resources they engage[10]. And because the sharing of TV rights is partly a function of the athletic performance, big clubs do not generate enough turnovers to be efficient (TV rights are the French clubs first revenue). This relative superiority of small clubs which is an “exception Française” comes directly from the League choice of financial governance. Besides, the dynamic study of managerial performance emphasizes two different ideas. First, the average efficiency is decreasing across time. Mainly not because of the clubs themselves but the environment in which they operate. It is especially due to total wage inflation. Then, L1 can be split into three clusters, each one with its own efficiency evolution dynamics. Those specificities have to be considered in order to design more accurate league policies. So, if the joint work of the League authorities and the DNCG seems to unable a financial control leading to a well balanced championship, it fails to prevent the wage inflation harming the French clubs, especially the biggest ones.

We must keep in mind that efficiency, in our context, is relative. DEA never allows finding an optimal management or how to reach an absolute efficiency. But our results seem to be robust because they are not sensitive to our frontier design (orientation, items choices) except for the use of the "Assurance Region" which impacts upon efficiency ranking and lower mechanically efficiency scores on average. It is certain, however, that further works on a longer span of time will give some better ideas of efficiency dynamics in the French First League. Another direction for further research is the use of econometrical tools in order to explain efficiency differences among clubs.

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Appendix A: Data Envelopment Analysis (DEA)

DEA is directly in line with Farrell's work (1957) but was more precisely developed by Charnes *and al* (1978). It is a mathematical method using a linear programming resolution to build an efficiency frontier from the sample observations. By the way, it measures efficiency of units in respect to that frontier. The first DEA model (CCR model) used constant returns to scale assumption. In 1984, Banker *and al* introduced the variable returns to scale assumption (BCC model). CCR and BCC models are the two basic models used in this paper. The « Assurance Region » (AR), developed by Thompson and *al* (1986) gives us a way to introduce a normative aspect in the score computations and so in the frontier construction. We also use the AR for the purpose of our study. All those models being well known, technical description of the next paragraphs is voluntarily simple. Interested readers can find some more detailed developments in Färe *and al* (1994), Charnes *and al* (1985) or Coelli and *al* (1998).

The method maximizes, for each club and at each season, a virtual output on a virtual input ratio. A virtual output (resp. input) is a weighted average of all the output dimensions (resp. input dimensions) of each club. Weights are chosen by the method itself as a way of having the best unit score in respect to its competitor performances.

More formally, we maximize E_0 (for the club 0) under the constraints:

$E_j \leq 1$ (j= 0,…, n, all the clubs in the sample) for the units in the sample and with all the weights positive (u and v ≥ ε with ε an Archimedean constant)

With $E_0 = \dfrac{u_1.y_{1j_0} + u_2.y_{2j_0} + \ldots + u_k.y_{kj_0}}{v_1.x_{1j_0} + v_2.x_{2j_0} + \ldots + v_i.x_{ij_0}} = \dfrac{\sum_k u_k y_{kj_0}}{\sum_i v_i x_{ij_0}}$, the efficiency of unit 0. (1)

y are the outputs and x the inputs. Full efficient unit efficiency is equal to 1 (by normalization)

For this fractional system to be solved, we have to transform it into a linear one. A quite simple transformation since the more important in such a ratio is the relative magnitude in between numerator and denominator. Thus, we can choose a value for the denominator and rewrite:

$$\text{Max } E_0 = \sum_k u_k y_{kj_0} \qquad \text{j=0 ,…,n}$$

$$\text{st} \quad \sum_i v_i x_{ij_0} = 100 \ \ \text{(for example)}$$

$$\sum_k u_k y_{kj_0} - \sum_i v_i x_{ij_0} \le 0$$

$$-v_i \le -\varepsilon \ , \ -u_k \le -\varepsilon \qquad (2)$$

The output oriented CCR and BCC model:

CCR from Charnes, Cooper and Rhodes uses the constant returns to scale assumption. While BCC from Banker, Charnes and Cooper uses a variable returns to scale assumption.

In Charnes *and al* (1978) and Banker and *al* (1984) we have:

CCR output oriented	BCC output oriented
$\max E_0 = \sum_{k=1}^{K} u_k y_{k0}$	$\max E_0 = \sum_{k=1}^{K} u_k y_{k0}$
St $\sum_{k=1}^{K} u_k y_{kj} - \sum v_i x_{ij} \le 0$	St $\sum_{k=1}^{K} u_k y_{kj} - \sum v_i x_{ij} \le 0$
$\sum_{i=1}^{I} v_i x_{i0} = 1$	$\sum_{i=1}^{I} v_i x_{i0} = 1$
$u_k, v_i \ge \varepsilon \ge 0$	$\sum u_k = 1 \ , \ u_k, v_i \ge \varepsilon \ge 0$ (3)

The only difference between the two models is the additional linear constraint in the BCC model, allowing variable returns to scale.

The « Assurance Region » adjunction leads to a last linear constraint included in the system:

$L_{1,2} \le u_1/u_2 \le U_{1,2}$, with L and U respectively the lower and upper bounds of the ratio of two outputs dimension (here 1 and 2) weights.

Appendix B: Malmquist Index definition and computation.

Let $x^t(x_1^t,..., x_N^t) \in R_+^N$ and $y^t(y_1^t,..., y_M^t) \in R_+^M$ be a producer inputs and outputs vectors in period t (t =1,…, T).

The entire set of production is: $P^t(x^t) = (y^t : x^t \textit{ can produce } y^t) \quad t = 1,\ldots,T$

A functional technology representation for period t is given by the distance function (output oriented):

$$D^t(x^t, y^t) = \min(\theta : (y^t / \theta) \in P^t(x^t)) \quad t = 1,\ldots,T$$

Which is a standard distance function defined for each producer. We can also define some adjacent distance functions as:

$D^t(x^{t+1}, y^{t+1}) = \min(\theta : (y^{t+1} / \theta) \in P^t(x^{t+1}))$ and

$D^{t+1}(x^t, y^t) = \min(\theta : (y^t / \theta) \in P^{t+1}(x^t))$

Standard distance functions are built in respect to the technology derived from observations on all the producers in that period. Adjacent distance functions are defined for each producer in the period in respect to the technology derived from observations on producers of an adjacent period. Two adjacent distance functions and two standard distance functions are required for the Malmquist index computation. (Färe and Grosskopf 1992)

- Definition : The Malmquist productivity Index output oriented between periods t and t+1 is :

$$M^t(x^t, y^t, x^{t+1}, y^{t+1}) = \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} * \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t+1}(x^t, y^t)} \right]^{1/2}$$

It measures the productivity change between t and t+1. To do so, we use a geometrical mean of two indexes, one computed for period t and the other for t+1. The index is respectively higher, equal or lower than 1 if productivity has increased, stagnated, or decreased between t and t+1.

Besides, this index can be decomposed in two factors. The first one is the technical efficiency change (the endogenous part of the performance evolution). The second one is a more general technical change (the exogenous part).

- Decomposition : The Malmquist productivity index between t and t+1 can be decomposed as :

$$M^t(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} * \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})} \bigg/ \frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)} \right]^{1/2}$$

This factorization allows changes in productivity to be broken down into changes in efficiency and technological global change; with each component being less, equal or more than 1 according to its effect on total productivity change.

- Computation: In a DEA framework and following Färe *and al* (1994) methodology, we can use some distance functions to build the index. Four different distance functions are required, and therefore four different linear program resolutions. Under the constant returns to scale assumption and with an output orientation we have :

$\left[D_0^t(y^t, x^t)\right]^{-1} = \max_{\lambda\phi} \phi$ St $-\phi y_i^t + Y^t\lambda \geq 0$ $x_i^t + X^t\lambda \geq 0$ $\lambda \geq 0$	$\left[D_0^{t+1}(y^{t+1}, x^{t+1})\right]^{-1} = \max_{\lambda\phi} \phi$ St $-\phi y_i^{t+1} + Y^{t+1}\lambda \geq 0$ $x_i^{t+1} + X^{t+1}\lambda \geq 0$ $\lambda \geq 0$
$\left[D_0^t(y^{t+1}, x^{t+1})\right]^{-1} = \max_{\lambda\phi} \phi$ St $-\phi y_i^{t+1} + Y^t\lambda \geq 0$ $x_i^{t+1} + X^t\lambda \geq 0$ $\lambda \geq 0$	$\left[D_0^{t+1}(y^t, x^t)\right]^{-1} = \max_{\lambda\phi} \phi$ St $-\phi y_i^t + Y^{t+1}\lambda \geq 0$ $x_i^t + X^{t+1}\lambda \geq 0$ $\lambda \geq 0$

Appendix C: Data

Table a: Data descriptive statistics (number of observations: 42)

	Total wage (in K€/year)	Population (urban area in 1000)	Number of points	Turnover (in K€/year)
Mean	27 866	1 543 605	55	55 877
Maximum	93 469	11 174 743	84	140 553
Minimum	9 609	85 080	34	21 234
Stand- deviation	16 393.23	2 739 863.30	10.41	26 348.69

Appendix D: Results

Table b: Average efficiency scores by season

Seasons	GE	PTE	SE
mean 04-05	0.8229	0.9229	0.8867
mean 05-06	0.8240	0.9600	0.8537
mean 06-07	0.7803	0.9335	0.8320

Table c: Efficiency scores for each club at each season

	Season 2004-2005			Season 2005-2006			Season 2006-2007		
	GE	PTE	SE	GE	PTE	SE	GE	PTE	SE
Auxerre	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Bordeaux	0.6745	0.7608	0.8865	0.7736	1.0000	0.7736	0.8776	1.0000	0.8776
Lens	0.8655	0.9460	0.9149	0.7014	0.9370	0.7486	0.6636	0.9880	0.6717
Lille	0.9590	1.0000	0.9590	0.9422	1.0000	0.9422	0.7561	0.8750	0.8641
Lyon	0.7997	1.0000	0.7997	0.6043	1.0000	0.6043	0.5066	1.0000	0.5066
Marseille	0.5771	0.7190	0.8026	0.8314	1.0000	0.8314	0.7317	1.0000	0.7317
Monaco	0.6901	1.0000	0.6901	0.4579	0.7410	0.6180	0.3892	0.7764	0.5014
Nantes	0.5678	0.7012	0.8098	0.8585	0.8858	0.9692	0.6239	0.6602	0.9450
Nice	0.9824	0.9835	0.9989	1.0000	1.0000	1.0000	0.9942	1.0000	0.9942
PSG	0.6835	0.8675	0.7878	0.7112	0.8983	0.7918	0.5849	0.7937	0.7369
Rennes	0.7205	0.9424	0.7645	0.8508	0.9786	0.8694	0.8514	0.9754	0.8729
St-Etienne	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sochaux	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Toulouse	1.0000	1.0000	1.0000	0.8039	1.0000	0.8039	0.9454	1.0000	0.9454
MEAN	**0.8229**	**0.9229**	**0.8867**	**0.8240**	**0.9600**	**0.8537**	**0.7803**	**0.9335**	**0.8320**
Stand-dev	**0.1619**	**0.1090**	**0.1048**	**0.1587**	**0.0720**	**0.1334**	**0.1963**	**0.1077**	**0.1693**
Minimum	**0.5678**	**0.7012**	**0.6901**	**0.4579**	**0.7410**	**0.6043**	**0.3892**	**0.6602**	**0.5014**
Maximum	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**

(Scores are computed using “DEAFrontier” software)

	On the overall period			Between 04-05 and 05-06			Between 05-06 and 06-07		
Club	***Malmquist Index***	***Efficiency***	***Environment***	***Malmquist Index***	***Efficiency***	***Environment***	***Malmquist Index***	***Efficiency***	***Environment***
Auxerre	0.9808	1.0000	0.9808	1.0935	1.0000	1.0935	0.8993	1.0000	0.8993
Bordeaux	1.1342	1.3010	0.8717	0.9976	1.1468	0.8699	1.0725	1.1345	0.9454
Lens	0.6553	0.7667	0.8546	0.6761	0.8104	0.8342	1.0552	0.9461	1.1154
Lille	0.5858	0.7884	0.7422	0.8444	0.9825	0.8594	0.8277	0.8025	1.0314
Lyon	0.5880	0.6333	0.9284	0.6629	0.7556	0.8773	0.9170	0.8382	1.0939
Marseille	1.1675	1.2676	0.9210	1.2552	1.4405	0.8713	0.9280	0.8800	1.0546
Monaco	0.4542	0.5639	0.8054	0.5848	0.6634	0.8814	0.7436	0.8500	0.8748
Nantes	0.9071	1.0985	0.8257	1.3216	1.5118	0.8742	0.7259	0.7266	0.9990
Nice	0.6056	1.0120	0.5984	0.8635	1.0179	0.8483	0.7251	0.9942	0.7293
PSG	0.7541	0.8555	0.8814	0.8697	1.0405	0.8358	0.8671	0.8222	1.0546
Rennes	0.7816	1.1816	0.6614	0.8745	1.1808	0.7406	0.8687	1.0007	0.8680
StEtienne	0.7594	1.0000	0.7594	0.7997	1.0000	0.7997	0.9897	1.0000	0.9897
Sochaux	0.8093	1.0000	0.8093	0.7760	1.0000	0.7760	1.0359	1.0000	1.0359
Toulouse	0.5960	0.9454	0.6304	0.6190	0.8038	0.7701	0.9504	1.1761	0.8081

Table d: Malmquist index for each club and each period

Tables and figure to insert:

Table 1: Literature review on efficiency of sportive organizations					
Papers	Method	Units	Inputs	Outputs	Prices
Jardin (2009)	DEA-CCR Model and DEA-BCC model	Soccer clubs in the French First Division	Total wages, home town population	Points, Turnover	
Barros, Del Corral and Garcia-del-Barrio (2009)	Stochastic frontier latent class model	Soccer clubs in the Spanish First Division	Operational cost	Points	Price of labor, price of capital
Barros, Garcia-del-Barrio (2009)	Random stochastic frontier model	Soccer clubs in the English Premier League	Operational cost	Sales, Points, attendance.	Price of labor, price of capital-premises, price of capital-investment
Barros and Barrios (2008)	Random stochastic model	Soccer clubs in the English Premier League	Operational cost	Sales, Points, attendance.	Price of labor, price of capital-players, price of capital-premises
Hoefler and Payne (2006)	Stochastic frontier model	NBA association clubs	Ratios of: field goal %, free throw %, offensive and defensive rebounds, assists, steals, turnover, blocked shots difference	Actual number of wins	
Barros and Leach (2006b)	Technical efficiency effects model	Soccer clubs in the English Premier League	Operational cost	Points, attendance, turnover. *Contextual factors:* population, income, European	Price of labor, price of capital-players, price of capital-premises
Barros and Leach (2006a)	DEA-CCR and BCC model	Soccer clubs in the English Premier League	Players, wages, net assets and stadium facilities	Points, attendance and turnover	
Barros and Santos (2005)	DEA-CCR Model and DEA-BCC model	Soccer clubs in the Portuguese First Division	Supplies & services expenditure, wage expenditure, amortization expenditure, other costs.	Match, membership, TV and sponsorship receipts, gains on players sold, financial receipts, points won, tickets sold	
Haas (2003A)	DEA-CCR and DEA-BCC model	12 US soccer clubs observed in year 2000	Players wages, coaches wages, stadium utilization rate	Points awarded, number of spectators and total revenue	
Haas(2003B)	DEA-CCR and DEA-BCC model	20 Premier League clubs observed in year 2000/2001	Total wages, coach salary, home town population	Points, spectators and revenue	
Barros and Santos (2003)	DEA-Malmquist index	18 training activities of sports federations, 1999-2001	Number of Trainers, trainers reward, number of administrators, administrators reward and physical capital	Number of participants, number of courses, number of approvals	
Barros (2003)	DEA-Allocative model	19 training activities of sports federations, 1998-2001	Number of Trainers, number of administrators, physical capital	Number of participants, number of courses, number of approvals	Price of: trainers, administrators, and capital
Dawson, Dobson and Gerrard (2000)	Stochastic Cobb-Douglas frontier model	Sample of English football managers, 1992-1998	Player age, career league experience, career goals, num. of previous teams, league appearances in previous season, goals scored, player divisional status	Winning percentages	

Hadley,Poitras, Ruggiero and Knowles (2000)	Deterministic frontier model	US NFL teams, 1969/70-1992/93	24 independent variables describing attack and defense.	Team wins	
Audas, Dobson and Goddard (1999)	Hazard functions	English prof soccer, 1972/73-1996/97, match-level data	Match result, league position, manager age, manager experience, player experience	Duration (measured by the number of league matches played)	
Hoefler and Payne (1997)	Stochastic production frontier	27 NBA teams, 1992-1993	Ratios of: field goal %, free throw %, turnover, offensive rebounds, defensive rebounds, assists, steals, difference in blocked shots	Actual number of wins	
Fizel and D'Itri (1997)	DEA-CCR model in first stage and regression analysis in second stage	147 College basketball teams, 1984-1991	Player talent, opponent strength,	Winning percentages	
Fizel and D'Itri (1996)	DEA-CCR model	Baseball managers	Player talent, opponent strength,	Winning percentages	
Scully (1994)	Deterministic and stochastic Cobb-Douglas frontier model	41 Basketball coaches, 1949/50 to 1989/90	Team hitting and team pitching	Win percent	
Porter and Scully (1982)	A linear programming technique (possibly DEA-CCR)	Major League baseball teams, 1961-1980	Team hitting and team pitching	Team percent wins	

DEA is for Data Envelopment Analysis.
DEA-CCR and DEA-BCC model was respectively proposed by Charnes, Cooper and Rhodes (1978) and by Banker, Charnes and Cooper (1984); model acronym are based on authors' name.
This table is for the most part from Barros and Leach (2006a) updated with more recent references.

Table 2 : French football clubs efficiency scores						
CLUBS (alphabetical order)	GE	PTE	SE	Position on/under the frontier	Sportive ranking	Efficiency ranking
Auxerre	1	1	1	c-c-c	8	1
Bordeaux	0.766	0.905	0.846	d-d-d	5	8
Lens	0.733	0.956	0.767	d-d-d	6	9
Lille	0.875	0.954	0.917	d-d-d	2	6
Lyon	0.614	1	0.614	d-d-d	1	13
Marseille	0.697	0.884	0.788	d-d-d	2	10
Monaco	0.483	0.824	0.586	d-d-i	7	14
Nantes	0.662	0.737	0.898	d-d-i	14	11
Nice	0.992	0.994	0.997	i-i-i	12	4
Paris	0.655	0.850	0.770	d-d-d	9	12
Rennes	0.802	0.965	0.831	i-d-i	4	7
St-Etienne	1	1	1	c-c-c	11	1
Sochaux	1	1	1	c-c-c	9	1
Toulouse	0.908	1	0.908	c-i-i	13	5
Mean	**0.79**	**0.93**	**0.85**	with "c" for "constant", "i" for "increasing" and "d" for "decreasing" returns to scale area		

Table 3 : Mann-Whitney tests of efficiency differences		
Subsamples in comparison	Z statistics of Mann-Whitney	Significance level
Lots of points VS few points	0.432	0.6657
Big turnovers VS small turnovers	2.069	0.0385**
Big populations VS small populations	1.993	0.0463**
Big total wages VS small total wages	3.465	0.0005***

(*** means a 1% significant level result; ** 5%)

Table 4 : Malmquist Index and their decompositions		
Period	For all the French first league clubs	Mean
The entire period	Malmquist Index	0.7699
	Efficiency evolution	0.9581
	Environment evolution	0.8050
From 04-05 to 05-06	Malmquist Index	0.8742
	Efficiency evolution	1.0253
	Environment evolution	0.8522
From 05-06 to 06-07	Index de Malmquist	0.9004
	Efficiency evolution	0.9408
	Environment evolution	0.9642

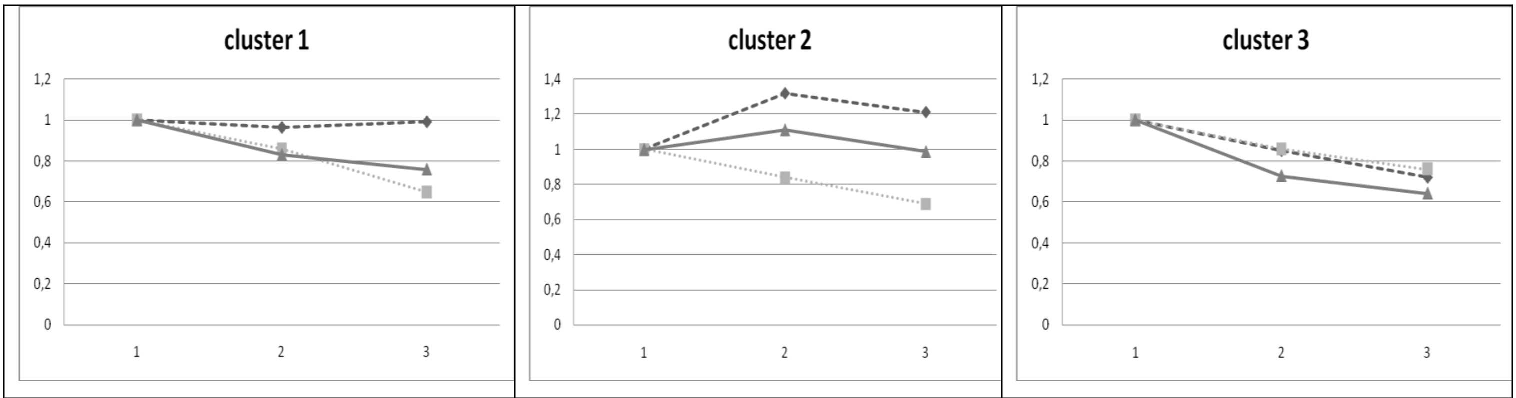

Figure 1 : Three different dynamics for L1 efficiency

NOTES

[1] In 2007, the “Bälle, Tore und Finanzen” from Ernst & Yung study ranked the L1 on top of the “big 5” in terms of competitive balance.

[2] For a discussion about football club production functions see Borland (2006).

[3] In line with Kumbhakar (1997), we selected an output orientation because of the competitive environment in which football clubs operate, controlling (partially) their inputs and trying to maximize their outputs.

[4] We traditionally use output market prices to fix bounds. In our case, points being not valued on any markets, we arbitrarily fixed bounds to 0.1 and 10, preventing one dimension (sportive or financial) to be more than 100 times more important than the other (It is a really soft constraint, our only goal being to guarantee the two objectives presence in the maximization problem).

[5] Talent here is very close to human capital in its broader sense. The total wage also gives information on the size of the club roster.

[6] As testified by administrative switches from Sportive Association to Anonymous Professional Sportive Society or by initial public offerings.

[7] In line with the parsimony rule: $j \geq \max [i*o, (i+o)*3]$ with j the number of observations, i and o respectively our inputs and outputs.

[8] Those impacts span a large range of factors, from an unexpected cost due to exceptional climate conditions to a general increase in football demand (as after the FIFA World Cup in 1998).

[9] We consider this inflation as exogenous because clubs are price takers on the integrated players market.

[10] We may think this domestic over-investment can be explain by European cup participations, but all the revenues coming from those international competitions are included in our financial output measure and so prevent our scores to be biased.