January 2013

Measuring Technical Efficiency of the Japanese Professional Football (Soccer) League (J1 and J2)

Dan Zhao
University of South Florida, dzhao@usf.edu

Measuring Technical Efficiency of the Japanese Professional Football (Soccer) League (J1 and J2)

by

Dan Zhao

A dissertation defense submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Economics
College of Arts and Sciences
University of South Florida

Co-Major Professor: Yi Deng, Ph.D.
Co-Major Professor: Philip Porter, Ph.D.
Gabriel Picone, Ph.D.
Murat Munkin, Ph.D.

Date of Approval:
November 19th, 2013

Keywords: Microeconomics, Productivity and Efficiency, Sports Economics, Data Envelopment Analysis, Malmquist Index

Acknowledgments

I would like to express my sincerest thanks to the members of my dissertation committee: Dr. Yi Deng, Dr. Philip Porter, Dr. Gabriel Picone, and Dr. Murat Munkin for their guidance, understanding, patience, and ideas during my graduate studies at the University of South Florida. I also thank Dr. Jianping Qi for chairing my defense committee and for his kind help.

I would also thank the Department of Economics at the University of South Florida for the nomination for the Presidential Doctoral Fellowship six years ago. This financial support allowed me to be an efficient and successful graduate student. My family and I are proud of my being a Fellow of University of South Florida for the rest of my career.

I am eternally grateful to my parents in China. They spent all they had to support my study from the very beginning. They were always comforting me and encouraging me with their best wishes.

Finally, I would like to thank my wife, Yun Yun. Her support, encouragement, and understanding were undeniably important to my academic and professional career. She is always there cheering me up and she has stood by me through the good and bad.

Table of Contents

List of Tables

List of Figures

Abstract

This is the first paper to measure the efficiency of the Japan Professional Football League clubs both the first and the second divisions. In Chapter 1, a non-parametric method Data Envelopment Development (DEA) is used and the data covers six seasons from 2005 to 2010. The input variables are payroll, cost besides payroll, and total assets. The output variables are attendance, revenue, and points awarded. I use different output combinations in order to check the sensitivity of the efficiency of the clubs after the original composition. This is also the first research to include more than one division of the Professional Football League and hence, the promotion and relegation impact on the efficiency can be analyzed using unique data such as Tokyo Verdy 1969. Tokyo Verdy 1969 operated inefficiently in the second division because it spent so much on inputs hoping for promotion. It was efficient when in the first division. The results indicate that athletic rank in the league is not correlated with the efficiency scores. The efficient clubs in the second division are all ranked at the bottom in the league and this is because they have limited resource inputs, no expectation to promote, and because the expansion policy of the league precludes relegation.

Chapter 2 is an extension of Chapter 1. In this chapter I check the exogenous factors impacting the efficiency scores but not involved in the DEA analysis as the input variables. I aim to estimate the relationship between the input-oriented DEA efficiency scores under the constant returns to scale assumption and use an exogenous variable ordinary least square (OLS) model to

check the relationship between the efficiency scores and exogenous variables. I regress the DEA efficiency scores on all of the exogenous variables collected from various resources during the sample period.

Chapter 3 estimates the productivity and efficiencies of the football clubs in Japan Professional Football League. This chapter is an extension of the first chapter. In this chapter I check the dynamic change of Total Factor Productivity (TFP) based on the calculation of the Malmquist Index, which consists of efficiency change and technical change between two time periods. Additionally, the production frontier used in this chapter was built by the non-parametric input-oriented CRS DEA approach as applied in the first chapter. Based on the results of the Malmquist Index, we find if the change in the TFP growth as increasing, declining or remaining the same.

Chapter 1:

Measuring Technical Efficiency of the Japanese Professional Football (Soccer) League (J1 and J2)

1.1 Introduction

In this paper, I present a data envelopment analysis (DEA) model to measure the technical efficiency (TE) of the Japanese Professional Football League including both the first and second divisions. Research on TE of Japanese professional football clubs is very rare in the current literature. The data set used in this paper covers six seasons from 2005 to 2010 for the first and second divisions and variables used in this research include both the financial side, such as revenue, payroll, costs beside payroll and total assets, and the athletic side, such as points awarded in each season. This research can help us answer questions like the following: Why are some clubs efficient and others not? Is the athletic ranking in the league at the end of the regular season correlated with the efficiency scores? What can the clubs do to enhance the efficiency of the club? These questions and answers provide insights for the fans and researchers of Japanese professional football not only on the athletic competition but also on the operations and administration of the clubs.

As in many countries in Africa, Asia, South America and Europe, football (soccer) is one of the most popular sports in Japan. There is a long history of football in Japan with its first introduction during the Meiji-period along with many other foreign sports including baseball. As early as 1917 the first Japanese football club was founded in Tokyo and interscholastic and regional tournaments have been organized in sequence since then. The Japan Football (Soccer) Association (JFA), the governing and administrative body of football in Japan, was founded in 1921 and became affiliated with FIFA in 1929.

From the early 1990s Japanese football experienced an extremely high-speed development due to the successful reforms directed by JFA. After winning four Asian Football Confederation (AFC) championships (Asian Cup in 1992, 2000, 2004 and 2011), the Japan national team became one of the most competitive teams worldwide. The Japan national team is the only one which won this tournament four times in the history of the Asian Cup (Iran and Saudi Arabia have both won three times). The Japan national team qualified to represent Asia in the FIFA World Cup in 1998, 2002 2006 and 2010. In both the 2002 and 2010 World Cups, Japan advanced through round robin matches and took part in the round of 16. A milestone came in 2010 World Cup: after a 120 minute intense game against Paraguay, Japan lost at Penalty Kick. However, this game changed the image of Japanese football and established Japan as an acknowledged world-class team. After winning the 2011 AFC Asian Cup, the coach of the Japan national team, Alberto Zaccheroni, publicly declared the team's goal was the final of 2014 Brazil World Cup. In order to enhance its competitiveness and broaden its influence, the Japan national team accepted the invitation of Copa América 1999 and 2011, but was not able to play in 2011 because of the aftermath of the Tohoku earthquakes and tsunami.

The Japan national team has kept a high FIFA ranking since the end of 1990s based on its strong performance in tournaments and exhibition matches. Japan is routinely ranked in the top three in Asia and the team's highest ranking was 9th in the world in February 1998. Moreover, the Japan national women's team became the 4th FIFA Women's World Cup champion team (after The United States, Germany and Norway) after winning the final match against the United States in 2011. This is the first time that an Asian women's football team has won this tournament (China was the runner-up in 1999). Also in this tournament, Miss Homare Sawa was awarded the Golden Boot as the leading scorer and the tournament's Most Valuable Player in July 2011. In January 2012, she was awarded the *FIFA Women's World Player of the Year Award* for 2011. She is the only Asian female player who has been awarded this title so far.

What has propelled Japan into these successes during the past two decades? The most important contributing factor is the strong demand and the resulting continued investment in this sport. The number of general registered football players under JFA was 900,800 in 2010, which has been a stable number since 2000. Meanwhile, thousands upon thousands of young players are training in South America, especially in Brazil, and continental Europe in football schools or clubs' echelons. This number is competitive even when compared to some of the traditional football-loving European countries such as the Netherlands and Spain. JFA successfully organized football leagues in high schools, technical schools and universities. Combined with other amateur football leagues under JFA's organization this solid system provides strong support for both the professional football league and the national team's performance on the world stage. In addition, Japan has been very open to using naturalized (foreign) players. Taking advantage of these players has made it possible to enhance the competitiveness of Japan national team directly and rapidly. The most famous examples are Ruy Ramos (1989) and Alessandro Santos (2001) from Brazil and Tadanari Lee (2001) from South Korea all of whom joined the Japan national team and played key roles in the matches. These are the pieces of the puzzle of why there has been such success in Japanese football.

1.2 Professional Football in Japan

Professional football in Japan was started in 1993 with one division (called J1) and 10 clubs, called the Japanese Professional Football League (or J. League). This time point was a milestone for Japanese football and it also had a significant impact on the international football scene. In an attempt to create more attractive and high-quality matches, J. League clubs invited many top world-class players to join in. After years, this has proved to be effective and worthwhile. Stars like Zico (Kashima Antlers), Dunga (Jubilo Iwata) -- both former captains of the Brazil National team -- and Dragan Stojkovic (Nagoya Grampus), the most talented star in the history of Yugoslavia and Serbia, were recruited. Star-strategy is now considered a template by many countries, especially clubs in China and the Middle East. Expansion of the J. League capacity continued until 1998 to a total of 18 clubs in division 1 (J1).

The second division (J2) was initiated in 1999 with 10 clubs to better structure the professional system. J2 kept expanding to a total of 22 clubs in 2012. Japan Football League (JFL), now known as the third division, started originally in 1991 with nine clubs and expanded to 17 clubs in 2012. In addition to JFL, there are nine Regional Leagues and 47 Provincial Leagues playing at the amateur level. Based on their performance, clubs move up or down (promotion and relegation) at the end of each year and this mechanism keeps the system running efficiently and keeps the teams motivated. Professional clubs from J. League have already won five championship titles in the AFC Championship League and three times have been runners-up. Clubs like Urawa Red Diamonds Kashima Antlers and Gamba Osaka are considered to be top Asian clubs based on their performance in this international tournament over the past decade. As a result, in the IFFHS[1] ranking of Asian national leagues of the 21st Century, J. League ranks consistently ahead of the Korean K-League and is therefore Asia's leading league. In 2011, Japan ranked 23rd worldwide among national leagues based on its influence and overall performance.

Because of the high quality of J. League and the players' individual competitiveness, many Japanese top players were recruited by European major leagues, including Italy, Germany, France and the Netherlands during the past two decades. The pioneer among these players is Mr Kazuyoshi Miura, who joined the Italian League, Serie A, Genoa CFC in 1993. Following his footsteps, many Japanese players came to Europe for their professional careers, especially in the most recent four to five years. For example, in season 2011-12 a total of nine players were playing in the first division in Fußball-Bundesliga which means that one in every two German clubs has a Japanese player. Some of the players joined top clubs such as Celtic, Inter, Arsenal, Roma, Dortmund, Bayern München, Schalke 04 and Manchester United. Japan has been considered a new-found treasure by European talent scouts and clubs, some of which have already experienced a stunning gain in profits by searching Japanese young talent in J. League. For example, Shinji Kagawa transferred from Cerezo Osaka to Borussia Dortmund for only €350,000; his estimated value has sprung up more than fifty times by 2012.

Shunsuke Nakamura, the most successful Asian player in Scotland, won three championship titles in the Scottish Premium League and was recognized by his peers for winning the Scottish Professional Footballers' Association's Player of the Year award in 2007 during his career in Celtic. This was followed in May by the Scottish Football Writers Association's Player of the Year award, and both Players' Player of the Year award and the Fans' Player of the Year award at Celtic's own end of season awards ceremony. Shinji Kagawa (Dortmund, transfer fee €17 million),[2] a promising star in Europe with his strong effort in Bundesliga League, helped Dormund to win two championships in the seasons 2010/2011 and 2011/2012 and he was named in the Bundesliga Best XI in his first year in Germany. Many Japanese players had successful professional careers and became well known in Europe -- for instance, Yuto Nagamoto (Inter, €10 million), Keisuke Honda (ZSKA Moscow, €14 million) and Hidetoshi Nakata (Roma, $29 million)[2, 3] -- and all of them can be attributed to the quality and mechanism of J. League. For a long time, players playing in Europe on the major leagues have constituted a big part of the Japan national team, similar to Australia, Brazil and Argentina.

Attendance is another factor contributing to the rising influence and popularity of J. League as shown in Figure 1.1. Attendance in 1999, the first year J. League separated into J1 and J2, was 2.8 million (11,658/match) rising to 5.6 million (18,400/match) in 2010. In the first season of J2 in 1999, attendance was around 800 thousand (4,596/match) and rose to 2.3 million (6,696/match) in 2010. JFL (also called J3) achieved 1,642/match in 2011. All of the numbers above lead other nations in Asia and reflect the popularity professional football in Japan. As a result, the general revenue of J. league (both J1 and J2) continued to rise since 1996. In 2010, the total revenue reached more than $120 million.

Because of all of the factors mentioned above, J. League has the potential to expand its influence. It has already made a mark in the United States, Europe and other parts of Asia. Some mainstream sports channels have started to broadcast the live games from J. League such as the One World Sports Channel covering the North American continent, and European Sports Channel which is available in 59 countries, and Al Jazeera Sports channel covering the Mideast and based on Qatar. These famous channels have effectively and broadly publicized the brand of J. League and make it possible for more people in other parts of the world to enjoy the games from Japan. Moreover, the broadcasting can also significantly increase the revenue of the league through highly profitable contracts.

1.3 Literature Survey

The Data Envelopment Analysis (DEA) model used in this research was first introduced by Farrell (1957) and then developed by Charnes et al. (1978). It is a mathematical programming technique that has found a number of practical applications for measuring the performance of similar units, for instance, hospitals (Ersoy (1997); Osei et al. (2005)), schools (Antreas et al. (2006)), banks (Kenneth et al. (2002)), etc. One of its most interesting advantages is that it allows multiple inputs and multiple outputs to be included in the efficiency measurement.

Ersoy (1997) measured the efficiency of 573 general hospitals in Turkey in 1994 with three output variables (discharges, outpatient visits and surgical operations) and three input variables (size, specialists and primary care physicians) by the method developed by Charnes, Cooper and Rhodes (1978). The result showed us that about 90.6% of the general hospitals in Turkey were inefficient. Only 54 hospitals were efficient. Efficient hospitals produced more discharges and had a higher occupancy rate. Moreover, efficient hospitals had a lower rate of physicians per bed, per outpatient visit and per surgical operation. In addition the efficient hospitals achieved a higher rate of bed turnover and the average length of stay in an efficient hospital is less compared to the inefficient ones.

With different outputs and inputs in the DEA model, Osei et al. (2005) analyzed 17 public hospitals in Ghana by using both Technical Efficiency (TE) and Scale Efficiency (SE) scores. They found 47% of the hospitals as rated by TE and 59% of the hospitals as rated by SE were inefficient in Ghana, so they suggested that "there is still a need for the Planning and Budgeting Unit of the Ghana Health Services to continually monitor the productivity growth, allocative efficiency and technical efficiency of all its health facilities in the course of the implementation of health sector reforms" (Osei et al. (2005), p.1).

Antreas et al. (2006) measured the comparative efficiency of the higher education institutions in the United Kingdom by using both constants return to scale and variable returns to scale models. They concluded that a group of six institutions were running on the efficiency frontier in the U.K. during the period 1992-1993. The data set covered a total of 45 institutions.

In addition, a large number of researchers, such as Kenneth et al. (2002), who measured the efficiency of relationship managers at Canada Imperial Bank of Commerce, used DEA models in the banking system. After measuring the regular DEA scores, they applied the second stage of the analysis by using the ordinary least square (OLS) model. They regressed the efficiency scores on several environmental variables such as average loan size, number of loans and their square values in order to estimate the impact of the environmental variables on bank efficiency. The result showed that the managers were less efficient when dealing with larger numbers of loans or smaller loans according to the information from 1990 to 1995.

Charnes et al. (1978) described the model: "A nonlinear programming model provides a new definition of efficiency for use in evaluating activities of not-for-profit entities participating in public programs. A scalar measure of the efficiency of each participating unit is thereby provided, along with methods for objectively determining weights by reference to the observational data for both multiple outputs and multiple inputs that characterize such programs." Since then a large number of books and academic articles have been written on DEA or applying DEA to various fields. Because of the influence and popularity of the DEA model, many researchers are using DEA to analyze sports organizations such as baseball (Howard et al.

(1993)), football (Einolf (2004)), basketball (Cooper et al. (2009)), golf (Fried et al. (2004)) and football (soccer) in recent years.

By using DEA, Howard et al. (1993) could identify those players who were underpaid, equitably paid, or overpaid based on data covering 433 professional baseball players from 26 U.S. major league clubs. Einolf (2004) measured the payroll efficiency in the National Football League (NFL) from 1981 to 2000 and Major League Baseball (MLB) from 1985 to 2001. As a result, he found that the differences between the efficiencies of these professional leagues were significant. He concluded that "the financial system in MLB rewards large-market teams with more revenue and the opportunity to spend inefficiently for on-the field performance. In MLB, winning is everything. The NFL's financial system does not favor any subset of franchises. All teams certainly want to win; yet no team has the opportunity to seriously overspend for a win. In the NFL, winning is almost everything and efficiency is important as well" (Einolf (2004), p.149).

Cooper et al. (2009) assessed the performance of basketball players playing in the Spanish Basketball League. They pointed out that their DEA model could distinguish a good player in all aspects from those players with the same efficiency scores achieved by a high value for one attribute accompanied by low values on the other attributes. Based on those outcomes, the teams can analyze the information and then make the decisions about which aspect should be strengthened.

In the field of golf, Fried et al. (2004) used DEA to measure the performance of individual golfers in the Professional Golf Association, the Ladies Professional Golf Association and the Senior Professional Golf Association (SPGA) in 1998. After adjusting the pooled data set, the result from the model indicated that the women performed under pressure better than the men, and the men better than the seniors.

In this paper, I measure the efficiencies of Japanese professional football clubs by DEA with constant returns to scale (CRS) and with variable returns to scale (VRS). Each observation is an individual Japanese professional football club. In the past decade, several papers employed DEA models in analyzing professional football leagues: For example, England Premier League (Haas (2003b); Barros et al. (2006)), Primera división de Liga (González-Gómez et al. (2010); García-Sánchez (2007); Espitia-Escuer et al. (2004)), Fußball-Bundesliga (Haas et al. (2004)) and Major League Soccer (Haas (2003)).

As one of the most successful professional leagues, England Premier has been attractive to fans all over the world. A large number of academic publications study this organization. Haas (2003b) estimated both technical and scale efficiencies in the 2000/2001 season in his study. In this study, Ipswich Town and Charlton Athletic, two small clubs, were the only clubs that were efficient in all models and specifications. He also concluded that almost all clubs are operating on the optimal or very close to optimal scale. Inefficient operations were the main reason for the inefficiency of those clubs.

Spanish Professional League (Primera división de Liga) has become a hotspot in the field of sports economics, and plenty of research covers this league. Espitia-Escuer et al. (2004) concluded that teams' efficiency was not highly correlated to the end-of-the-season rankings in the league based on three seasons' data from 1998/1999 to 2000/2001. There were no financial related or spectator variables included. Both input and output variables were about the game itself. García-Sánchez (2007) used a special DEA model with three stages to estimate the economic behavior of the clubs. These stages are operating efficiency including the offence and the defence, athletic effectiveness, and social effectiveness. The study revealed that Barcelona FC was the only team running effectively on the athletic level and it had an efficient performance on both offence and defence. Barcelona FC was also the only team which could keep improving the athletic effectiveness in all aspects during the last few seasons. It also demonstrated the main goal of large clubs in Division 1 of the Spanish Professional League was to do well in international competitions while the goal of the small clubs was to survive in Division 1. As a result the social effectiveness score was very high, with an average of about 90% in all teams. González-Gómez et al. (2010) estimated the performances of Spanish football at different competition levels, i.e. the Spanish Professional League, King Cup and European competitions, during the 2001/2002 to 2006/2007 seasons. The results showed that teams with less tradition in the first division in Spain, such as Getafe and Villarreal, had obtained outcomes very close to their potential. Hence, their supporters were satisfied at a relatively high level. On the other hand, large clubs with a greater tradition and higher income, such as Real Madrid and Barcelona, showed a very high level of performance. Finally Atle´tico de Madrid, Real Sociedad, and Athletic de Bilbao were the teams who offered relatively unsatisfying performance to the fans. Those teams should enhance the management skills and improve the efficiency of their operations in order to please the fans.

Haas et al. (2004) assessed the German professional league, Fußball-Bundesliga, by using both coaches' and players' wage bills as input variables in the 1999/2000 season. They concluded that "about a quarter to one third of teams are on the efficiency frontier, depending upon whether we allow for variable returns to scale or whether we restrict production technology to constant returns to scale" (Haas et al. (2004), p.266). Only two teams, Bayem Munchen and Werder

Bremen, were efficient under different specifications used in this research. Based on the different combinations of variables, they found that the key variable that determines the efficiency of the football clubs on the input side was the players' payroll. In Haas et al. (2004), the efficiency scores are not correlated with ranking of the athletic performance in the league at the end of season, so the performance of the team and the efficiency are two completely different matters. On the output side, the determining factor is team revenues which do not depend on the performance of the team. In the case of the teams with efficient VRS but inefficient CRS scores, Haas et al. (2004) explained that inefficient operations were the main source of overall inefficiencies.

Haas (2003) analyzed Major League Soccer in the U.S. with payroll of players and payroll of coaches as input variables and points awarded, number of spectators and revenues as output variables in the season 2000. He concluded that "the efficiency scores are highly correlated with performance in the league, and when decomposing inefficiency into technical inefficiency and scale inefficiency it can be shown that the largest part of inefficiency can be explained by suboptimal scale of production (Haas (2003), p.203)".

In this paper, I focus on the Japanese Professional Football (Soccer) League J. League. Compared to studies about major European leagues very little research has been done on Asian football even though in many Asian countries football is the most popular sport and has a tremendous impact on Asian culture, especially in Japan. The paper is organized as follows: Section 1.4 introduces the theoretical framework of DEA. Section 1.5 discusses the data and Section 1.6 the results. Section 1.7 concludes the paper and outlines possible extensions of this study in the future.

1.4 Methodology

In this paper, I use Data Envelopment Analysis (DEA) which was originally developed as a non-parametric linear programming method to estimate the production efficiency of a decision making unit (DMU). In this research each DMU represents one football club in J. League. These DMUs can have multiple inputs and multiple outputs. Different from the ordinary least squares (OLS) technique, DEA develops a function whose form is determined by the most efficient producers. Unlike both linear and nonlinear regression models, DEA does not require explicitly formulated assumptions such as the distribution of the data and is a methodology directed to frontier determined by the most efficient producers rather than central tendencies (fitting a regression plane through the center of the data as in statistical regression). At the same time, DEA is applied in cases which have been resistant to other approaches because of the complex nature of the relations between the multiple outputs and multiple inputs involved in DMUs. DEA avoids the need for recourse to prices and other assumptions of weights which are supposed to reflect the relative importance of the different inputs and outputs. Another merit in the case of DEA is described in Cooper et al. (2004): “the concept of a frontier is more general than the concept of a ‘production function’ which has been a fundamental in economics in that the frontier concept admits the possibility of multiple production functions, one for each DMU, with the frontier boundaries consisting of ‘supports’ which are ‘tangential’ to the more efficient members of the set of such frontiers” (p.8). The mechanism can be simply explained: DEA identifies a production frontier on which the relative performance of all DMUs in the sample can be compared and benchmarks firms only against the best producers. Efficiencies estimated using DEA are relative to the best performing DMU (or DMUs if there are more than one best performing DMU). The best-performing DMU is assigned an efficiency score of one or 100 percent, and the performances of other DMUs vary between 0 and 100 percent relative to this best performance.

I denote n DMUs by index DMU_j (j = 1, 2,… n). Each DMU consumes a varying amount of m different inputs, x_{ij} (i = 1, 2..., m) to produce s different outputs, y_{rj} (r =l, 2... s). Specifically, DMU_j consumes x_{ij} amount of input i and produces y_{rj} amount of output r. I assume that $x_{ij} \geq 0$ and $y_{rj} \geq 0$ and further assume that each DMU has at least one positive input and one positive output value. A set of normalizing constraints (one for each DMU) reflects the condition that the virtual output to virtual input ratio of every DMU, including $DMU_j = DMU_o$, must be less than or equal to one. The mathematical programming problem may thus be stated as

$$\max_{\underline{u},\underline{v}} E_o(\underline{u},\underline{v}) = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}} \quad (1)$$

Subject to
$$0 \leq \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \; (j = 1,2,\cdots,n) \quad (1.1)$$

$$v_i \geq 0 \; (i = 1,2,\cdots,m) \quad (1.2)$$

$$u_r \geq 0 \; (r = 1,2,\cdots,s) \quad (1.3)$$

E_o is the efficiency of DMU_o; x_{io} and y_{ro} are the observed outputs and inputs values, respectively, of DMU_o; u_r and v_i are the weights assigned to output r and input i during the aggregation.

It is tricky that there is not one unique set of weights and the weights assigned should be flexible and reflect the requirement of the individual DMUs. For example, some clubs consider the athletic outcome, points awarded in the league at the end of year, to be the most important and some clubs are pursuing economic profit as their main goal in the competition. Therefore, they will assign different weights to those outcomes in their own aggregate outputs.

The transformation developed by Charnes and Cooper (1962) for linear fractional programming selects a representative solution [i.e., the solution (*u*, *v*) for which $\sum_{i=1}^{m} v_i x_{ij} = 1$] and yields the equivalent linear programming problem in which they change the weight of variables from (*u*, *v*) to (μ, υ) during the transformation as shown in the Appendix. A general output maximization CCR (named after Chames, Cooper and Rhodes 1978) DEA model can be represented as follows

$$\max z(\underline{\mu}) = \sum_{r=1}^{s} \mu_r y_{ro} \qquad (2)$$

Subject to

$$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} \upsilon_i x_{ij} \leq 0; \;\; j = 1,2,\cdots,n \qquad (2.1)$$

$$\sum_{i=1}^{m} \upsilon_i x_{ij} = 1 \qquad (2.2)$$

$$-\upsilon_i \leq -\varepsilon \; (i = 1,2,\cdots,m) \qquad (2.3)$$

$$-\mu_r \leq -\varepsilon \; (r = 1,2,\cdots s) \qquad (2.4)$$

where ε is an infinitesimal constant.

In the basic theory of linear programming, each linear programming problem (called the primal problem) has another closely related linear program (called the dual problem). Information about the transformation from primal to dual program is shown in the Appendix. For the Linear Programming (LP) dual problem, let θ be the dual variable corresponding to the inequality constraint with the weighted sum of inputs normalized. Let λ be the dual variable corresponding to the other inequality constraints of the dual problem. This model is sometimes referred to as the "Farrell model" because it is the one used in Farrell (1957).

$$\theta^* = \min \theta \qquad (3)$$

Subject to $\sum_{j=1}^{n} x_{ij}\lambda_j \leq \theta x_{io} \;\; (i = 1, 2, \cdots, m) \qquad (3.1)$

$$\sum_{j=1}^{n} y_{rj}\lambda_j \geq y_{r0} \;\; (r = 1, 2, \cdots, s) \qquad (3.2)$$

$$\lambda_j \geq 0 \;\; (j = 1, 2, \cdots, n) \qquad (3.3)$$

The intuitive way to understand (3.1) is that the weighted combination of the inputs of all the firms cannot be more than the input for the reference firms multiplied by its efficiency. So in (3.1) the DMU will be efficient if $\theta^*$is one and the constraint becomes strictly equal with zero slack. For the Formula (3.2), the constraint shows that the dual variables λ should be chosen such that the weighted combination of all the outputs of all the firms should be at least equal to the output of the reference firm. Similar to (3.1), the DMU will be efficient if the strict equality holds with no slack in the constraint. Hence, the problem takes the DMU_o and then seeks to radically contract the input vector x_i as much as possible while still remaining within the feasible input set. The radical contraction of the input vector x_i produces the projected point, $(\sum_{j=1}^{n} x_{ij}\lambda_j, \sum_{j=1}^{n} y_{rj}\lambda_j)$ on the surface of this technology. The projected point is a linear combination of these observed data points. And the constraint in (3) ensures that this projected point cannot lie outside the feasible set. A more clear formation is described below. The use of infinitesimals (ε) can distinguish weakly efficient DMU_s from strongly efficient ones. The dual formulation (with ε constraints) to obtain the efficiency of DMU_o is the following

$$\min \; g_0(\theta, \underline{s}^-, \underline{s}^+) = \theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{j=1}^{s} s_r^+\right) \qquad (4)$$

Subject to $\theta x_{i0} - \sum_{j=1}^{n} x_{ij}\lambda_j - s_i^- = 0 \;\; (i = 1,2, \cdots, m) \qquad (4.1)$

$$\sum_{j=1}^{n} y_{rj}\lambda_j - s_i^{+} = y_{r0} \quad (r = 1,2,\cdots,s) \quad (4.2)$$

$$\lambda_j \geq 0 \; (j = 1,2,\cdots,n) \qquad (4.3)$$

$$s_i^{-} \geq 0 \; (i = 1,2,\cdots,m) \qquad (4.4)$$

$$s_r^{+} \geq 0 \; (r = 1,2,\cdots,s) \qquad (4.5)$$

Where λ_j is still the weight on DMU_j, s_i^{-} are the input slacks and s_i^{+} are the output slacks. Formula (4) seeks values of λ_j to construct a composite unit with outputs $\sum_{j=1}^{n} y_{rj}\lambda_j$ outputs and inputs $\sum_{j=1}^{n} x_{ij}\lambda_j$. The dual constraint (4.1) implies that even after the reduction of all inputs, the inputs of the evaluated DMU_o cannot be lower than the inputs of the composite unit. According to Formula (4.2) the outputs of DMU_o cannot be higher than the outputs of the composite unit. In other words, DMU_o is efficient when it is impossible to construct a composite unit that outperforms DMU_o. Conversely, if DMU_o is inefficient, the optimal values of λ_j form a composite unit outperforming DMU_o and providing targets for DMU_o. Moreover DMU_o is DEA efficient if, and only if, $\theta^* = 1$. If $\theta^* < 1$, the DMU_o is DEA inefficient. θ^* is a measurement of the radial DEA efficiency of DMU_o. The model assesses efficiency in a production context and its counterpart, primal program, assesses efficiency in a value context. By virtue of duality, the primal and dual models yield the same efficiency ratings in respect to DMU_o (Charnes et al., 1978). The dual model is denoted as an input-oriented model.

The DEA model so far assumes that the operations follow constant returns to scale (CRS). DEA was not widely accepted for the analysis of production processes because of this limitation. However, Banker et al. (1984) modified the CCR DEA model in order to deal with the situation of variable returns to scale (VRS). This is also called BCC (Banker-Charnes-Coopers) and they add the convexity condition $\sum_{j=1}^{N} \lambda_j = 1$ to the constraints in (4) - (4.5). This convexity constraint can essentially ensure that an inefficient firm is only “benchmarked” against firms of a similar size. And the projected point for that firm on the DEA frontier is a convex combination of observed firms. However, this convexity restriction is not imposed in the CRS case where a firm may be benchmarked against firms that are substantially larger or smaller than it. The CCR model measures the gross efficiency of a DMU which is called global technical efficiency (TE) and this efficiency comprises both technical efficiency and scale efficiency. Technical efficiency describes the efficiency in converting inputs to outputs; scale efficiency explains that economy of scale cannot be attained at all scales of production and there is one most productive scale size. The BCC model describes the variation of efficiency controlling for the scale of operation and hence local pure technical efficiency (PTE). As a result, the CRS efficiency score is always less than or equal to the pure technical (VRS) efficiency. Moreover, comparing the TE scores with the PTE scores provides a deeper insight into the sources of inefficiency that a DMU might have.

$$S\text{cale efficiency} = \frac{\text{Technical and Scale Efficiency (CCR efficiency)}}{\text{Technical Efficiency (BCC efficiency)}} = \frac{\text{TE}}{\text{PTE}}$$

$$\text{and} \qquad \text{TE} = \text{SE} \times \text{PTE}$$

This decomposition yields the sources of inefficiency: inefficient operation (PTF), inefficient scale (SE) or both.

1.5 Data

The data have been collected from the official homepage of the Japan Professional Football League (http://www.j-league.or.jp/). Unlike almost all of the professional football clubs in major leagues in Europe, South America, other Asian countries and even in America, where an individual club's financial report and balance sheet are confidential, J. League publishes some financial information of the J. League and individual clubs' general financial reports to the public every year. The homepage started to reveal financial information for individual clubs, including both J1 and J2, from 2005 with detailed revenue, costs, and even financial standing. Also the league offers the general financial performance of the whole organization of J. League from the very beginning of its establishment in 1993. The data set in this paper covers the seasons from 2005 to 2010, for a total of six seasons for both J1 and J2. There are a total of 108 observations in J1 and 90 observations in J2 during the period. As shown in Table 1.1, there are 37 clubs in this time period and 11 clubs which never experienced relegation from J1; four clubs in J2 were playing without relegation or promotion during this time period; the rest of them (15 clubs) move back and forth between J1 and J2. Moreover, according to the needs of expansion in J2, new clubs keep joining from Japan Football League (JFL) every year. Table 1.1 presents the time table of the clubs' participation in J1 and J2 throughout the study period. Since this paper measures the efficiencies of the performance of professional football clubs in Japan, we consider all clubs as commercial firms. Technical and tactical practice information from individual matches is not utilized.

As Haas et al. (2004) and Haas (2003) do, I use payroll as one of three input variables. However, unlike those publications, I include both players' wages and coaches' wages as payroll variable. Payroll also includes players' transfer fees from selling current players and hiring new players from other clubs and the payroll of club staff. Obviously, more money spent hiring players, staff and coaches can potentially increase performance and improve the outcome of the club finances and attendance. Choosing payroll as an input variable is accepted widely in related fields and research.

Similar to those of professional leagues in Europe, the range of individual salaries in J1 is very wide, since the top star players, like Yasuhito Endo (Gamba Osaka), and Marcus Túlio Tanaka (Nagoya Grampus Eight) can earn more than one million dollars a year and some first year players only about forty thousand dollars. Also a famous coach with successful experiences, such as Dragan Stojković (Nagoya Grampus Eight), can receive a contract for more than one million dollars and an average domestic coach will earn around four hundred thousand dollars a year.

The second input variable is the rest of the cost ("other cost") in the same fiscal year besides payroll expenditures, including both operation costs and administrative costs. Those expenses, such as stadium usage, administration, and advertisement have a strong impact on the final outcome.

Like Barros et al. (2010), I used total assets as the third input variable. Total assets consist of both aggregate debt (total liability) and net asset (equity). Total assets represent the resources that the club can use to serve the team and the match as well. So it is an important factor for running the company and affecting the profit and social outcome to the company.

Most researchers, like Barros et al. (2010) and Haas (2003), use the same output variables for football clubs when using the DEA method. The first output variable, points awarded, reflects the clubs' athletic performance in match competitions. Points awarded in J1 decide the championship and the relegation to the lower league in the next year (three clubs in J1 are relegated each year). In J2, both relegation and promotion are the results of the final points awarded. Points awarded also decide the qualification to the international tournament Asian Football Confederation Champions League (two clubs with the highest ranking before 2008 and three clubs after 2008). This output variable can directly capture the performance of the coaches and players after one season's play.

The second output variable is the total revenue of one fiscal year, which measures the economic success of the club. This output variable includes all of the revenues of a club such as tickets sales, sponsoring, advertisement revenue and the fund redistributed from the league. The variable also includes the income from domestic cup tournaments, the J. League Yamazaki Nabisco Cup and international matches. Therefore, total revenue can measure the clubs' economic success effectively.

The third output variable is the total number of spectators who attend home games. This variable can measure how much the club performance can entertain the spectators at a home match each season. Since more supporters usually mean more attention to the club from the city, even the region, this variable can obviously reveal the popularity and influence on the local residents and beyond and can also be considered the social achievement of the club.

By taking into account all three financial input variables I consider the club as a commercial firm and every weekly match as a production procedure. I do not include any variables from the match itself, as many researchers did in football related publications, such as times of passes, times of shoots and time of possession. At the same time, the three output variables measure the success of the club, profitably, athletically and socially. Average values of these variables are presented in Table 1.2 and Table 1.3 for teams in J1 and J2, respectively.

1.6 Results

The efficiency scores are calculated by Statistical Analysis System (SAS) and the results are shown in both Table 1.4 and Table 1.5. Technical efficiency (TE) with constant returns to scale (CRS) and pure technical efficiency (PTE) with variable returns to scale (VRS) and scale efficiency (SE) are reported as results of CCR and BCC models. Each division has 26 clubs from 2005 to 2010. An obvious result from the tables is that the points awarded ranking is not correlated with efficiency since the Pearson correlations are very low in J1 and J2. Most researchers obtained this result in their analyses.[4] This means that the performance at the athletic level was not a decisive factor for the final efficiencies in either CRS or VRS. According to the result of constant return to scale (CRS), seven clubs in J1 were considered to have achieved the level of global technical efficiency: Albirex Niigata, Urawa Red Diamonds, Nagoya Grampus Eight, Cerezo Osaka, Ventforet Kofu, Vegalta Sendai and Montedio Yamagata. All of the clubs had their CRS efficiency scores equal to one.

Urawa Red Diamonds was the club with the largest revenue and was ranked at a very high position in the points awarded and attracted the largest number of fans to the stadium. Urawa Red Diamonds successfully performed in all three aspects of outputs although they spent much on inputs than the other clubs. Despite its low revenue and middle position in the rank, Albirex Niigata had a higher attendance record than most clubs and in the meantime Albirex Niigata had very limited inputs compared to others, which made it an efficient club. Nagoya Grampus Eight had good revenue with a relatively small total asset investment, so it achieved a position on the frontier. Cerezo Osaka, Ventforet Kofu and Montedio Yamagata all had very successful control over inputs although none of them led the results in any of the three output aspects. The efficiency of Vegalta Sendai with moderate revenue and attendance was mainly because of its successful cost control. Nine clubs had a score above 0.95. Those clubs were quite close to the efficient frontier but could not successfully achieve it. Vissel Kobe was the only one which fell far away from the efficient frontier with an efficiency score of only 0.68. Vissel Kobe had moderate revenue and attendance during the period in J1 and lacked success in ranking (it was 19^{th}) at the same time, the amounts of all three inputs were abundant compared to the inputs of the other clubs.

In J2, the situation is much better than J1, since there are 10 clubs who achieved the efficient frontier with CRS efficiency score equal to one. Among those 10 efficient clubs, only Ventforet Kofu had a relatively high rank (7^{th}) during the period. The rest of them were all lower than 16^{th} which showed a very interesting trend. Oita Trinita and Ventforet Kofu had successful revenues and attendance with comparably limited inputs. Mito HollyHock, Thespa Kusatsu, Roasso Kumamoto, FC Gifu, Tochigi SC, Kataller Toyama, Fagiano Okayama and Giravanz Kitakyushu all succeeded in controlling inputs and keeping clubs running in effective ways. The average CRS efficiency score in J2 was lower than J1 ($0.92 < 0.94$), although there were more efficient clubs on the frontier in J2 than in J1. Obviously, J2 had a larger standard deviation than did J1. Tokyo Verdy 1969 and Vissel Kobe were two clubs with the lowest CRS efficiency scores among the 26 clubs in J2, with scores of 0.65 and 0.63, respectively. In the situation of Tokyo Verdy 1969, it had relatively high revenue in J2. However, Tokyo Verdy 1969 had ineffective control of inputs, especially in payroll and other cost. Vissel Kobe had a decent points awarded and revenue, but all three inputs were excessive and lacked control. Vissel Kobe experienced five seasons in J1 and one season in J2 after its relegation in 2005. No matter whether in J1 or in J2, Vissel Kobe was the club which could not effectively control capital expenditures.

When applying the variable returns to scale model more clubs placed on the efficient frontier since VRS controls for the scale of the club and loosens the condition for efficiency. As explained in the section above, the efficient clubs under CRS would still remain efficient under VRS. In J1, beside the seven efficient clubs with a full CRS efficiency score, there were six more, for a total of 13 clubs, which were considered efficient under the condition of VRS. Moreover, scores of 10 clubs were equal to or higher than 0.9 and three clubs were between 0.72 and 0.89. Vissel Kobe was still an outlier with the lowest score among those clubs in J1. This showed us that most clubs in J1 were highly efficient in the transformation of inputs to outputs. The status in J2 was even stronger. There were 19 clubs on the efficient frontier and five more clubs with a score equal to or higher than 0.9. Tokyo Verdy 1969 and Vissel Kobe remained in the bottom positions. The fact that eight clubs in J1 did not reach the efficient frontier under the CRS assumption but had efficient VRS scores can be explained as inefficient production scale; those clubs exhibited pure technical efficiency but scale inefficiency. In the situation of J2, nine clubs were efficient operations but did not have appropriate production scales. Column 5 in both Table 1.4 and Table 1.5 is the Scale Efficiency described in Section 1.4 as the ratio of CCR over BCC. Vissel Kobe had scale efficiency of 0.95 during five seasons in J1 and 0.98 during one season in J2, which means that Vissel Kobe's scale was more suitable for J2 than J1. All clubs in J1 had relatively high scale efficiencies (above 0.88) which means that all J1 clubs were close to the optimal scale. However, six clubs in J2 had scale efficiencies under 0.90, which means that those clubs are inefficient because of the inappropriate scales.

In order to check the sensitivity of the efficiency measure, I use different combinations of outputs as shown in the Table 1.6 and Table 1.7. First, I use only revenue and points awarded as output variables and drop attendance. Attendance can contribute to revenue and thus its impact as an output is partly captured by the revenue variable. The results with two output variables, points awarded and revenue, are shown in the third and fourth columns in Table 1.6 and Table 1.7. Both tables also include the original results when three output variables and three input variables are used in the first and second columns. The Pearson correlation of CRS efficiency scores between Column 1 (three output variable case) and Column 3 (two output variable case) is 0.95 in J1 which means the efficiency scores were not significantly affected after dropping the attendance output variable. The rank of club efficiencies remains the same except for Albirex Niigata, which had a dramatic drop in efficiency from 1.00 to 0.89. Moreover, Oita Trinita experienced a slight change from 0.89 to 0.83. This is mainly because both of the clubs, especially Albirex Niigata, had a relative large attendance. Compared to the commercial and athletic outcome, they were more successful in entertaining the fans who came into the stadium on the home game day. In J2, the result is even more stable since the correlation between the efficiency scores before and after attendance is dropped as an output variable is as high as 0.987 and only two clubs had very moderate changes in their scores. In the meantime, the VRS efficiency scores in J1 have a high correlation of 0.96, before and after the change of output combination and in J2 the correlation is 0.937 with three clubs having small changes.

Next, I drop the output variable points awarded, keeping only revenue as an output measure. The results are shown in both Table 1.6 and Table 1.7 in columns 7 and 8. In J1, there are only slight changes in several clubs after dropping the points awarded variable in CRS model and the tiny changes all happened on the third decimal points, so the numerical changes are not shown in the table. This means that compared to the output variable points awarded revenue is a strongly dominant output in CRS in J1. In the case of VRS, changes are more intense since four clubs which were efficient with two output variables are now less than efficient after dropping points awarded. Based only on the output variable, revenue, fewer clubs are running efficiently when scale efficiency is controlled for.

In the case of J2, the CRS shows that only four clubs are still globally efficient when revenue is the only output variable; Ventforet Kofu, Mito HollyHock, Thespa Kusatsu, Roasso Kumamoto, FC Gifu and Tochigi SC are no larger efficient. This is mainly because those six clubs had relatively good athletic performance which brought these clubs close to efficiency under the conditions with three or two output variables. Under VRS, only nine clubs are still efficient compared to the 15 clubs with efficient VRS scores under the original output combination. The efficiency measures of most other clubs decrease in comparison to the original case. The Pearson correlation between the efficiency scores before and after points awarded is dropped is 0.914 which shows they were still significantly correlated to the original combination and that dropping this variable did not significantly affect the efficiency scores.

In J2, only eight clubs had efficient VRS scores compared to 19 in the original case. As with J1, most other clubs had slight downward changes of the VRS score. From all four iterations, I found that revenue is the most important output variable which affects the efficiency measurement of the clubs in the Japan Professional Football League. Efficiency measures in both J1 and J2 were very stable and only slightly depended on the combination of outputs and different technologies (CRS or VRS). Dropping attendance or the points awarded did not significantly affect the efficiency scores under both CRS and VRS.

1.7 Discussion and Conclusion

The goal of this paper is to estimate the efficiency of the clubs in the Japan Professional Football League, both in J1 and J2. The data used in this research covers six seasons from 2005 to 2010. The nonparametric approach, Data Envelopment Analysis (DEA) is used to measure the efficiency under both constant returns to scale and variable returns to scale. The output variables are the revenue of the club, total attendance for the year and points awarded; the input variables are the payroll, other cost beside payroll and the total assets.

In J1, a total of six clubs Urawa Red Diamonds, Nagoya Grampus Eight, Cerezo Osaka, Ventforet Kofu, Vegalta Sendai and Montedio Yamagata were efficient in all of the models applied in this research even after changing the combination of outputs. Urawa Red Diamonds had the highest revenue and ranked second during the period although its cost was larger than that of most other clubs. Even with the high expenditure, Urawa Red Diamonds was running efficiently and productively. With decent revenue, moderate attendance and a moderate position at the end of the season, Nagoya Grampus Eight was successful, because it had better control of its inputs. Total assets was very limited compared to most of the clubs. The remaining four clubs, especially Vegalta Sendai, Montedio Yamagata, did not have leading positions in any of the three outputs aspects, but the amount of inputs invested was very limited and this made them relatively efficient. Their operations placed them on the production frontier although they were not the clubs who were attracting most of the attention in J. League. In summary, many of the clubs in J1 were operating close to efficiently with an efficiency score of over 0.90. Only Vissel Kobe and Kyoto Sanga FC had an efficiency score far below the average.

In J2, Oita Trinita, Kataller Toyama, Fagiano Okayama and Giravanz Kitakyushu were the only efficient clubs in all models with different combinations of input and output variables. The main reason for this efficiency was the successful control of inputs. Giravanz Kitakyushu had the lowest total assets invested during the period and both Giravanz Kitakyushu and Kataller Toyama had a very modest payroll. On the other hand, although Vissel Kobe and Tokyo Verdy 1969 had relatively high rankings, they were the only two clubs with inefficient scores across all models. This is mainly because they lack efficient cost controls; their invested inputs were leading the division in all three input aspects. Sagan Tosu had a clear downwards change when attendance and points awarded were dropped as shown in Table 1.7, because Sagan Tosu was not successful in the revenue aspect, but relatively successful in attendance and points awarded. This shows that revenue is the most important factor in this analysis.

I have shown that the final rankings in J. league are not highly correlated to the efficiency scores. For instance, Urawa Red Diamonds had a higher efficiency score than Kashima Antlers, but Urawa Red Diamonds ranked lower than Kashima Antlers during the period. Secondly, on the output side I found that efficiency is primarily determined by the revenue of the club. This is consistent with our consideration that football clubs are commercial organizations and the main goal of the clubs is pursuing economic profit. Thirdly, some clubs have efficient scores under variable returns to scale (VRS) but are not efficient when using constant returns to scale (CRS). This reveals that those clubs are technically efficient but are run at a suboptimal scale. Such clubs can alter the size of the club and adjust their investment to move closer to the optimal scale.

Fourthly, all nine efficient clubs in the original model under both CRS and VRS (three inputs / three outputs) in J2 had very low rankings except Ventforet Kofu which ranked relatively highly, seventh in the league. Although they were on the efficient frontier, they ranked 16th, 17th, 18th, 19th, 20th, 22th, 24th, 25th, and 26th because none of them had a decent number of points awarded during the period. This phenomenon is certainly different from the situation of J1. In J2, efficient clubs are the ones who had poor athletic performance during the season. Those clubs did not have the expectation or strong desire to promote to J1, so that the resources they invested were limited and clubs were relatively efficient because of better control over their inputs.

More attention and concern are given to the top division, for example, more live TV on the mainstream channels and larger section of newspapers. So teams in J1 have better opportunities for exposure. That's the main reason why some clubs yearn for promotion and invest a large amount of resources in order to achieve this target. For those clubs, efficiency is not the primary goal; their real long-term goal is to promote to J1. Hence it is understandable that they are willing to bear high costs compared to those clubs who do not have the goal of promotion.

Other issues remain as subjects of future studies. For example, do the environmental variables, such as the size of the host city, or the stability of settling in the same division, have an impact on efficiency? Although they are not the resources invested by the club, they do influence the operation of the club. In a future study, those environmental variables should be tested to see how they affect the final efficiency of the club. In this paper, I checked the efficiencies by using the average value of each variable during the six-season period. A remaining question is to study the dynamics of how efficiency scores change over the years. I study these dynamics in the third chapter of my dissertation.

1.8 Endnotes

[1] The International Federation of Football History & Statistics (IFFHS) is an organization that chronicles the history and records of association football. The IFFHS was founded on 27 March 1984 at Leipzig (East Germany) by Dr. Alfredo Pöge with the blessings of general secretary of the FIFA at the time, Dr. Helmut Käser.

[2] Transfer fees are estimated by *TransferMarkt* in Germany in 2012, one of the most authoritative websites in Europe to estimate the transfer fees in worldwide leagues.

[3] In 2000, after one and a half seasons at Perugia, Nakata moved to Roma for 42 Billion ITL, (29 million dollars) to help the club win the scudetto.

[4] The Pearson correlations between the rank and efficiency scores are shown in the table below:

Correlation	CRS	VRS
J1	-0.31	-0.42
J2	0.57	0.23

Figure 1.1 Trend of Attendance and Revenue of J. League

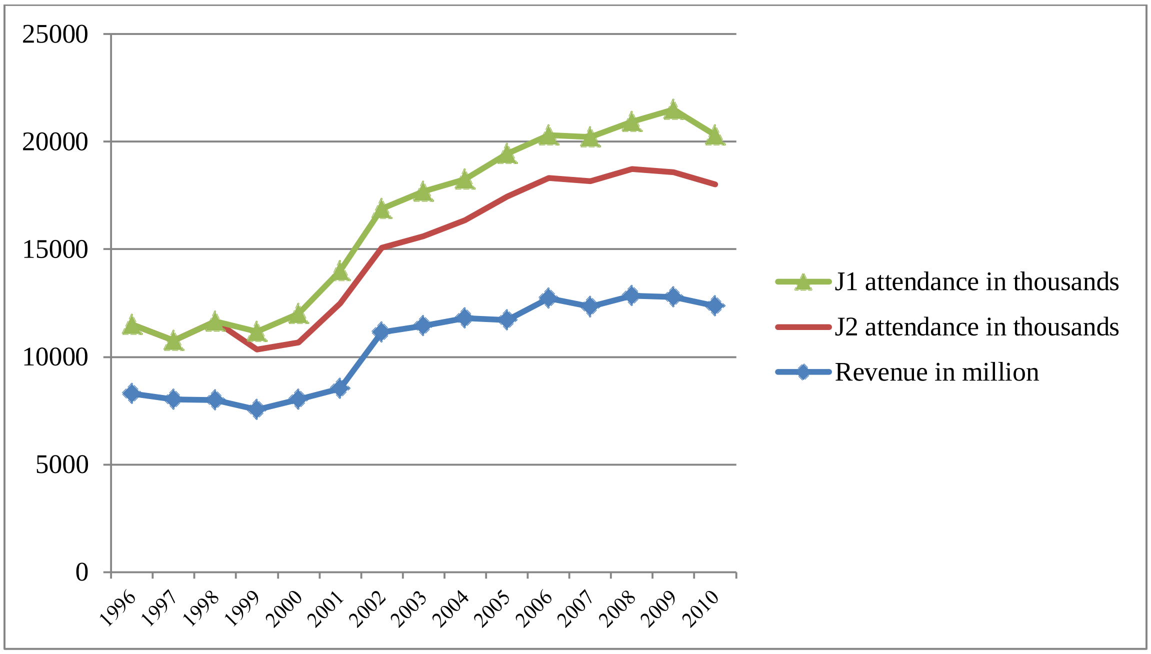

Table 1.1 The Time Table of the Clubs in J1 and J2

Club Name	2005	2006	2007	2008	2009	2010	# of seasons in J1	# of seasons in J2	# of seasons in JFL
Kashima Antlers	J1	J1	J1	J1	J1	J1	6	0	0
Urawa Red Diamonds	J1	J1	J1	J1	J1	J1	6	0	0
Omiya Ardija	J1	J1	J1	J1	J1	J1	6	0	0
Yokohama F・Marinos	J1	J1	J1	J1	J1	J1	6	0	0
Albirex Niigata	J1	J1	J1	J1	J1	J1	6	0	0
Shimizu S-Pulse	J1	J1	J1	J1	J1	J1	6	0	0
Jubilo Iwata	J1	J1	J1	J1	J1	J1	6	0	0
Nagoya Grampus Eight	J1	J1	J1	J1	J1	J1	6	0	0
Kawasaki Frontale	J1	J1	J1	J1	J1	J1	6	0	0
Gamba Osaka	J1	J1	J1	J1	J1	J1	6	0	0
F.C. Tokyo	J1	J1	J1	J1	J1	J1	6	0	0
JEF United Ichihara Chiba	J1	J1	J1	J1	J1	J2	5	1	0
Sanfrecce Hiroshima	J1	J1	J1	J2	J1	J1	5	1	0
Oita Trinita	J1	J1	J1	J1	J1	J2	5	1	0
Vissel Kobe	J1	J2	J1	J1	J1	J1	5	1	0
Kashiwa Reysol	J1	J2	J1	J1	J1	J2	4	2	0
Kyoto Sanga FC	J2	J1	J2	J1	J1	J1	4	2	0
Cerezo Osaka	J1	J1	J2	J2	J2	J1	3	3	0
Ventforet Kofu	J2	J1	J1	J2	J2	J2	2	4	0
Tokyo Verdy 1969	J1	J2	J2	J1	J2	J2	2	4	0
Montedio Yamagata	J2	J2	J2	J2	J1	J1	2	4	0
Avispa Fukuoka	J2	J1	J2	J2	J2	J2	1	5	0
Yokohama F.C.	J2	J2	J1	J2	J2	J2	1	5	0
Vegalta Sendai	J2	J2	J2	J2	J2	J1	1	5	0
Consadole Sapporo	J2	J2	J2	J1	J2	J2	1	5	0
Shonan Bellmare	J2	J2	J2	J2	J2	J1	1	5	0
Mito HollyHock	J2	J2	J2	J2	J2	J2	0	6	0
Thespa Kusatsu	J2	J2	J2	J2	J2	J2	0	6	0
Tokushima Vortis	J2	J2	J2	J2	J2	J2	0	6	0
Sagan Tosu	J2	J2	J2	J2	J2	J2	0	6	0
Ehime F.C.	JFL	J2	J2	J2	J2	J2	0	5	1
Roasso Kumamoto	RL	JFL	JFL	J2	J2	J2	0	3	2
FC Gifu	RL	RL	RL	J2	J2	J2	0	3	3
Tochigi SC	JFL	JFL	JFL	JFL	J2	J2	0	2	4
Kataller Toyama	NA[a]	NA[a]	NA[a]	JFL	J2	J2	0	2	1
Fagiano Okayama	RL	RL	RL	JFL	J2	J2	0	2	1
Giravanz Kitakyushu	RL	RL	RL	JFL	JFL	J2	0	1	2

[a] Kataller Toyama began playing in 2008

Table 1.2 Data Description J1 League

OBS	Team Name	Points	Attend[c]	Revenue[a,]	Payroll[a,b,]	Other Cost[a,]	Total Assets[a,]
1	Kashima Antlers	63	319.1	3914.8	88361.9	3871.3	2284.2
2	Urawa Red Diamonds	58.8	746.2	6639.5	2463.4	6534.2	2003.8
3	Omiya Ardija	40.7	186.4	2886.2	1593.5	2901.5	750.7
4	Yokohama F・Marinos	48	410.4	4236.7	1678.9	4234.6	1660.7
5	Albirex Niigata	46	610.8	2543.3	1170	2660.5	1110.9
6	Shimizu S-Pulse	53.3	270.7	3271.4	1346.5	3273.2	1070.5
7	Jubilo Iwata	46.7	262.9	3514.4	1622.3	3566.9	1102.9
8	Nagoya Grampus Eight	52.2	272.7	3958.4	2105.5	3975.1	878.8
9	Kawasaki Frontale	58.2	284.2	3032.3	1714.8	2982.6	1012.3
10	Gamba Osaka	60.8	283.8	3620.6	1958.8	3553	1224.8
11	F.C. Tokyo	46.5	434.1	3434.8	1592.9	3413.3	947.6
12	JEF United Ichihara Chiba	42	224	2976.6	1467.6	2824.8	984.6
13	Sanfrecce Hiroshima	46.8	222.4	2503.8	1287.2	2670.9	877.8
14	Oita Trinita	43.4	343.2	1921.6	1127.9	2021.8	953
15	Vissel Kobe	38.4	225.2	2042.1	1374.3	2596.4	1512
16	Kashiwa Reysol	41.3	210.4	3201.3	1643	3218.1	775
17	Kyoto Sanga FC	30.8	191.7	2353.4	1298.2	2735.9	1224.7
18	Cerezo Osaka	49	259	2325.8	1226.5	2377.6	497.4
19	Ventforet Kofu	34.5	220.6	1494.5	646.6	1300.1	557.8
20	Montedio Yamagata	40.5	202	1197	678.9	1220.2	238.5
21	Tokyo Verdy 1969	33.5	251.2	3575.8	2578.1	3568.4	1166.1
22	Avispa Fukuoka	27	234.3	1570.3	775.7	1677	556.3
23	Yokohama F.C.	16	238.7	1700.9	859.4	1855.4	472.6
24	Vegalta Sendai	39	294.6	2049.6	861.6	1870.9	1156.9
25	Consadole Sapporo	18	247.3	1590.9	773.8	1740.3	1176
26	Shonan Bellmare	16	188.6	1293.5	648.7	1347.7	355.5
	Max	63	746.2	6639.5	88361.9	6534.2	2284.2
	Min	16	186.4	1197	646.6	1220.2	238.5
	Mean	41.9	293.6	2801.9	4725.2	2845.8	1021.2
	STD	12.9	130.2	1187.7	17066.7	1147.2	474.2

[a] in million in Japanese Yen.
[b] payroll information is not provided by some clubs in 2005 and the numbers shown are the average value from 2006 to 2010.
[c] in thousands.

Table 1.3 Data Description J2 League

OBS	Team Name	Points	Attend[c,d]	Revenue[a,]	Payroll[a,b,]	Other Cost[a,]	Total Assets[a,]
1	JEF United Ichihara Chiba	61.0	222.1	2315.8	1354.7	2633.1	1489.3
2	Sanfrecce Hiroshima	85.7	206.0	2248.7	1188.7	2491.5	796.4
3	Oita Trinita	41.0	198.8	1112.7	475.0	1022.3	216.9
4	Vissel Kobe	64.5	131.3	1357.9	1020.9	2023.9	2800.6
5	Kashiwa Reysol	72.0	156.4	2994.5	1836.4	3080.5	1290.2
6	Kyoto Sanga FC	71.6	137.1	2088.3	1047.9	1954.4	909.8
7	Cerezo Osaka	64.6	170.6	2067.3	926.2	2105.6	546.2
8	Ventforet Kofu	61.4	192.1	1018.6	452.7	983.2	438.9
9	Tokyo Verdy 1969	57.4	115.0	1601.8	1054.3	2270.3	549.5
10	Montedio Yamagata	52.4	101.6	599.5	339.4	630.6	202.0
11	Avispa Fukuoka	55.9	178.0	1143.9	509.5	1171.5	444.0
12	Yokohama F.C.	46.6	101.4	978.6	423.8	1020.8	343.3
13	Vegalta Sendai	62.4	273.2	1534.3	783.1	1662.6	826.1
14	Consadole Sapporo	55.7	207.6	1271.8	567.5	1480.0	989.8
15	Shonan Bellmare	53.0	110.8	876.9	485.5	953.9	326.1
16	Mito HollyHock	39.5	56.6	345.4	147.4	351.4	98.7
17	Thespa Kusatsu	36.5	77.3	539.5	181.4	539.6	127.6
18	Tokushima Vortis	36.4	74.4	684.0	309.1	675.1	499.3
19	Sagan Tosu	54.3	130.2	647.5	319.1	760.3	224.5
20	Ehime F.C.	36.8	72.6	471.5	190.8	475.0	239.1
21	Roasso Kumamoto	43.3	114.4	604.4	226.0	600.7	138.5
22	FC Gifu	41.6	71.9	444.8	172.5	479.6	94.5
23	Tochigi SC	36.0	85.0	621.1	262.7	642.0	119.6
24	Kataller Toyama	36.8	76.8	591.9	183.7	589.9	170.6
25	Fagiano Okayama	28.1	125.0	667.6	236.8	642.1	246.6
26	Giravanz Kitakyushu	15.0	79.6	497.1	169.7	495.1	89.4
	Max	85.7	273.2	2994.5	1836.4	3080.5	2800.6
	Min	15.0	56.6	345.4	147.4	351.4	89.4
	Mean	50.4	133.3	1127.9	571.7	1220.6	546.8
	STD	15.7	57.1	707.3	444.7	794.2	596.7

[a] in millions of Japanese Yen.
[b] payroll information is not provided by some clubs in 2005 and the numbers shown are the average value from 2006 to 2010.
[c] in thousands.
[d] calculated as average attendance per game times the average number of games per year.

Table 1.4 Results From J1

OBS	DMU	Rank	CRS	VRS	SE
1	Albirex Niigata	12	1.00	1.00	1.00
2	Avispa Fukuoka	23	0.90	0.92	0.97
3	Cerezo Osaka	7	1.00	1.00	1.00
4	Consadole Sapporo	24	0.86	0.89	0.97
5	F.C. Tokyo	11	0.99	1.00	0.99
6	Gamba Osaka	2	0.94	1.00	0.94
7	JEF United Ichihara Chiba	14	0.97	0.99	0.97
8	Jubilo Iwata	10	0.95	0.95	0.99
9	Kashima Antlers	1	0.88	1.00	0.88
10	Kashiwa Reysol	15	0.99	0.99	1.00
11	Kawasaki Frontale	4	0.94	1.00	0.94
12	Kyoto Sanga FC	22	0.77	0.79	0.96
13	Montedio Yamagata	17	1.00	1.00	1.00
14	Nagoya Grampus Eight	6	1.00	1.00	1.00
15	Oita Trinita	13	0.89	0.95	0.94
16	Omiya Ardija	16	0.97	0.97	1.00
17	Sanfrecce Hiroshima	9	0.88	0.91	0.97
18	Shimizu S-Pulse	5	0.99	1.00	0.99
19	Shonan Bellmare	25	0.95	1.00	0.95
20	Tokyo Verdy 1969	21	0.93	0.96	0.97
21	Urawa Red Diamonds	3	1.00	1.00	1.00
22	Vegalta Sendai	18	1.00	1.00	1.00
23	Ventforet Kofu	20	1.00	1.00	1.00
24	Vissel Kobe	19	0.68	0.72	0.95
25	Yokohama F.C.	25	0.92	0.94	0.97
26	Yokohama F・Marinos	8	0.96	0.97	1.00

Table 1.5 Results From J2

OBS	DMU	Rank	CRS	VRS	SE
1	Avispa Fukuoka	10	0.92	0.98	0.94
2	Cerezo Osaka	4	0.91	1.00	0.91
3	Consadole Sapporo	11	0.82	1.00	0.82
4	Ehime F.C.	21	0.98	0.98	1.00
5	Fagiano Okayama	25	1.00	1.00	1.00
6	FC Gifu	17	1.00	1.00	1.00
7	Giravanz Kitakyushu	26	1.00	1.00	1.00
8	JEF United Ichihara Chiba	8	0.81	1.00	0.81
9	Kashiwa Reysol	2	0.89	1.00	0.89
10	Kataller Toyama	20	1.00	1.00	1.00
11	Kyoto Sanga FC	3	0.98	1.00	0.98
12	Mito HollyHock	19	1.00	1.00	1.00
13	Montedio Yamagata	14	0.93	1.00	0.93
14	Oita Trinita	18	1.00	1.00	1.00
15	Roasso Kumamoto	16	1.00	1.00	1.00
16	Sagan Tosu	12	0.92	1.00	0.92
17	Sanfrecce Hiroshima	1	0.83	1.00	0.83
18	Shonan Bellmare	13	0.87	0.90	0.97
19	Thespa Kusatsu	22	1.00	1.00	1.00
20	Tochigi SC	24	1.00	1.00	1.00
21	Tokushima Vortis	23	0.95	0.96	0.99
22	Tokyo Verdy 1969	9	0.65	0.75	0.86
23	Vegalta Sendai	6	0.85	1.00	0.85
24	Ventforet Kofu	7	1.00	1.00	1.00
25	Vissel Kobe	5	0.63	0.64	0.98
26	Yokohama F.C.	15	0.91	0.94	0.97

Table 1.6 DEA Result for Different Output Combination J1

		Revenue Point Attendance		Point Revenue		Revenue		Point		Attendance	
OBS	DMU	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1	Albirex Niigata	1.00	1.00	0.89	0.93	0.88	0.89	0.66	0.82	1.00	1.00
2	Avispa Fukuoka	0.90	0.92	0.88	0.91	0.88	0.91	0.58	0.84	0.69	0.88
3	Cerezo Osaka	1.00	1.00	1.00	1.00	1.00	1.00	0.67	1.00	0.66	0.72
4	Consadole Sapporo	0.86	0.89	0.84	0.88	0.84	0.88	0.39	0.84	0.62	0.88
5	F.C. Tokyo	0.99	1.00	0.99	0.99	0.99	0.99	0.49	0.63	0.70	0.77
6	Gamba Osaka	0.94	1.00	0.94	1.00	0.94	0.97	0.52	1.00	0.38	0.42
7	JEF United Ichihara Chiba	0.97	0.99	0.97	0.99	0.97	0.99	0.48	0.52	0.38	0.46
8	Jubilo Iwata	0.95	0.95	0.95	0.95	0.95	0.95	0.48	0.62	0.39	0.45
9	Kashima Antlers	0.88	1.00	0.88	1.00	0.88	0.97	0.49	1.00	0.36	0.42
10	Kashiwa Reysol	0.99	0.99	0.99	0.99	0.99	0.99	0.42	0.44	0.37	0.41
11	Kawasaki Frontale	0.94	1.00	0.94	1.00	0.94	0.96	0.59	1.00	0.46	0.51
12	Kyoto Sanga FC	0.77	0.79	0.77	0.79	0.77	0.79	0.40	0.50	0.31	0.50
13	Montedio Yamagata	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	Nagoya Grampus Eight	1.00	1.00	1.00	1.00	1.00	1.00	0.42	0.77	0.40	0.44
15	Oita Trinita	0.89	0.95	0.83	0.90	0.83	0.86	0.65	0.75	0.74	0.85
16	Omiya Ardija	0.97	0.97	0.97	0.97	0.97	0.97	0.43	0.43	0.35	0.42
17	Sanfrecce Hiroshima	0.88	0.91	0.88	0.91	0.88	0.88	0.61	0.79	0.41	0.52
18	Shimizu S-Pulse	0.99	1.00	0.99	1.00	0.96	0.96	0.66	1.00	0.43	0.54
19	Shonan Bellmare	0.95	1.00	0.95	1.00	0.95	1.00	0.41	1.00	0.78	1.00
20	Tokyo Verdy 1969	0.93	0.96	0.93	0.96	0.93	0.96	0.28	0.34	0.35	0.39
21	Urawa Red Diamonds	1.00	1.00	1.00	1.00	1.00	1.00	0.40	0.72	0.64	1.00
22	Vegalta Sendai	1.00	1.00	0.99	1.00	0.99	1.00	0.76	0.78	0.69	0.87
23	Ventforet Kofu	1.00	1.00	1.00	1.00	1.00	1.00	0.89	1.00	0.74	1.00
24	Vissel Kobe	0.68	0.72	0.68	0.72	0.68	0.72	0.47	0.49	0.38	0.50
25	Yokohama F.C.	0.92	0.94	0.92	0.94	0.92	0.94	0.31	0.75	0.75	0.82
26	Yokohama F・Marinos	0.96	0.97	0.96	0.97	0.96	0.97	0.48	0.64	0.47	0.54
	Correlation to 3 outputs	1.00	1.00	0.95	0.97	0.94	0.92	0.32	0.42	0.36	0.18

Table 1.7 DEA Result for Different Output Combination J2

		Revenue Point Attendance		Point Revenue		Revenue		Point		Attendance	
OBS	DMU	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1	Avispa Fukuoka	0.92	0.98	0.92	0.96	0.91	0.94	0.42	0.69	0.78	0.80
2	Cerezo Osaka	0.91	1.00	0.91	1.00	0.91	1.00	0.29	0.75	0.42	0.42
3	Consadole Sapporo	0.82	1.00	0.82	0.96	0.82	0.93	0.37	0.61	0.72	0.90
4	Ehime F.C.	0.98	0.98	0.98	0.98	0.94	0.98	0.72	0.77	0.78	0.88
5	Fagiano Okayama	1.00	1.00	1.00	1.00	1.00	1.00	0.44	0.62	1.00	1.00
6	FC Gifu	1.00	1.00	1.00	1.00	0.91	0.97	1.00	1.00	0.87	0.97
7	Giravanz Kitakyushu	1.00	1.00	1.00	1.00	1.00	1.00	0.38	1.00	1.00	1.00
8	JEF United Ichihara Chiba	0.81	1.00	0.81	0.88	0.81	0.88	0.21	0.37	0.43	0.46
9	Kashiwa Reysol	0.89	1.00	0.89	1.00	0.89	1.00	0.21	0.53	0.26	0.26
10	Kataller Toyama	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.80	0.80	0.91
11	Kyoto Sanga FC	0.98	1.00	0.98	1.00	0.98	1.00	0.33	0.83	0.36	0.36
12	Mito HollyHock	1.00	1.00	1.00	1.00	0.92	1.00	1.00	1.00	0.83	1.00
13	Montedio Yamagata	0.93	1.00	0.93	1.00	0.87	0.91	0.74	1.00	0.83	0.86
14	Oita Trinita	1.00	1.00	1.00	1.00	1.00	1.00	0.44	0.44	1.00	1.00
15	Roasso Kumamoto	1.00	1.00	1.00	1.00	0.97	0.98	0.75	0.85	1.00	1.00
16	Sagan Tosu	0.92	1.00	0.84	1.00	0.80	0.81	0.64	1.00	0.88	0.89
17	Sanfrecce Hiroshima	0.83	1.00	0.83	1.00	0.83	0.93	0.31	1.00	0.42	0.44
18	Shonan Bellmare	0.87	0.90	0.87	0.90	0.84	0.86	0.49	0.70	0.60	0.61
19	Thespa Kusatsu	1.00	1.00	1.00	1.00	0.99	0.99	0.75	0.81	0.83	0.92
20	Tochigi SC	1.00	1.00	1.00	1.00	0.95	0.96	0.68	0.78	0.78	0.80
21	Tokushima Vortis	0.95	0.96	0.95	0.96	0.93	0.96	0.48	0.52	0.56	0.63
22	Tokyo Verdy 1969	0.65	0.75	0.65	0.75	0.65	0.70	0.25	0.51	0.26	0.27
23	Vegalta Sendai	0.85	1.00	0.85	0.90	0.85	0.88	0.33	0.63	0.84	1.00
24	Ventforet Kofu	1.00	1.00	0.98	1.00	0.95	0.96	0.56	1.00	1.00	1.00
25	Vissel Kobe	0.63	0.64	0.63	0.64	0.62	0.62	0.28	0.58	0.33	0.33
26	Yokohama F.C.	0.91	0.94	0.91	0.94	0.90	0.92	0.41	0.54	0.51	0.53
	Correlation to 3 outputs	1.00	1.00	0.99	0.94	0.95	0.87	0.61	0.34	0.68	0.51

Chapter: 2

Factors Affecting the Production Efficiency in Japan Professional Football League

2.1 Introduction

In Chapter 1, I estimated the production efficiency in Japan Professional Football League in a framework of Data Envelopment Analysis (DEA). This chapter is an extension of Chapter 1 where I check the exogenous factors impacting the efficiency scores. For example, the city location should have a strong influence on the revenue of the club because a larger pool of potential audience can increase the incomes from advertisement and clubs' merchandise sale. In addition, time spent on the way to the stadium can effect one's decision on whether or not to go to the stadium on the game day and so on. This chapter aims at estimating the relationship between the input-oriented DEA efficiency scores under the Constant-Returns-to-Scale assumption and the exogenous variables. An ordinary least square (OLS) model is used. I regress the DEA efficiency scores on all of the environmental variables collected from various resources during the sample period.

This approach is similar to Kenneth et al. (2002) measured the efficiency of relationship managers at Canada Imperial Bank of Commerce. In a second stage of the analysis, he regressed the efficiency scores on several environmental variables such as average loan size and the number of loans in order to estimate effect of changes in environmental variables. He found that the managers were less efficient when dealing with large numbers of loans or small loans.

The remainder of this chapter is organized as follows: Section 2.2 is the description of the data set used in this chapter and Section 2.3 presents the OLS model and the estimation result. The last section is the conclusion based on the result.

2.2 Data

As in Kenneth et al. (2002), I perform a similar OLS estimation using the DEA efficiency scores calculated in the first chapter as the dependent variable. I use a total of six independent exogenous variables for J1 and five for J2. All variables cover the six seasons between 2005 and 2010. There are 26 observations in each division. Value of the variables used (except dummy variables) is averaged across all seasons in which a club participated in a division.

Explanatory variables include cards per game, gross domestic product (GDP), win rate, average travel time, major population center and players on the Japan national team. The variables are discussed below. Card/game is a variable representing the average number of both yellow cards and red cards in one game during the sample period. I add up the card number in each game and then divide it by the total number of games to obtain this independent variable. Since the number of clubs in J2 every year is different, this is a reasonable way to represent the average number of cards per game despite various numbers of games J2 clubs have to play. As is common knowledge, cards are used by the referees to punish these who foul opponents or use improper actions in the game. This punishment is divided into two levels: The first level is normal foul, such as tripping, diving or delay of game and will be given a yellow card. The player will be banished after the second yellow card is given. The second level is a serious foul, such as serious striking, offensive communication or action against the referees in the game. These behaviors will be given a red card and the player will be banished. Hence, the number of cards is an effective factor to measure the intensity of the game. The main reason to add this exogenous variable is to check the direction of its influence. For example, more fouls could break the continuity of the game which makes the game lose aesthetic appeal and shortens its net play time; on the other hand, more fouls means the game is even more competitive, which can be attractive to passionate fans. We will be able to see how these two opposing forces balance with the OLS estimation.

The second independent environmental variable is the gross domestic product (GDP) in the province where the club's home base is. The intuition of adding this variable is that some clubs are located in highly developed provinces which have large commercial cities, for instance Tokyo Verdy 1969 and Nagoya Grampus Eight. Conversely, some of them are located in small towns with a smaller economy, such as Sagan Tosu and Montedio Yamagata. This variable can estimate the influence of the economic background in the local province on the football club.

The third variable is the win rate in all of the games the club played during the period. I sum up the number of wins in all the games and then divide by the total number of games number to obtain this exogenous factor. Obviously, the more games the club wins during a season the more will be points, ticket sales, advertisement revenue and redistribution of money from J. League. To consistently win games, the quality of players, coaches and the administration team are the decisive factors. To keep all of those factors on a high quality level in order to maintain a great win rate, the club has to invest a large amount of money to hire top domestic and international stars, famous coaches and experienced administrators. As described in the first chapter, the average wages of a top star and a first-class coach in J. League are both more than one million U.S. dollars and the transfer fee is sometimes more than two million dollars. These investments have a negative influence on the efficiency score whereas the potential increase in win rate following these investments has a positive effect. The OLS estimation will tell us which of these two opposing effects dominate.

The fourth variable is the average time spent to travel to the stadium. J. League started to investigate the characteristics of the supporters for both J1 and J2 in 2004. This resulted in "J. League Fan Survey Summary Report," published on the official website of J. League (http://www.j-league.or.jp/) the following year. This report includes many topics such as fans' motivation, fans' behavior and summary characteristics, such as the fan's age and gender. I select travel time to stadium as one of the independent variables in the OLS model because this factor has a direct effect on the fans' choice of whether or not to go to the stadium to support the home team on game day. The implicit intuition here is very interesting and mixed. On one hand, there tend to be less traffic jams in relatively underdeveloped regions compared with big cities; On the other hand, people reside more densely in big cities which may reduce their physical distance from the stadium.

In Japan, there are three main metropolis circles, Capital Circle, Chukyo Circle and Kinki Circle which are centered in Tokyo, Nagoya and Osaka, respectively. The fifth independent variable is a dummy equal to one if the location of the club is in one of the three metropolis circles. About 66 million people, out of a total of 130 million in Japan, live in these three metropolis circles. This concentration of population implies easy access to many alternative forms of sports and entertainment, which compete with football to attract audiences and revenues.

The last variable is another dummy equal to one if the club had a player(s) who joined the Japan national team during the period covered by the data set. From 2005 to 2010, Japan participated in four international tournaments, the 2007 and 2011 AFC Asian Cup and 2006 and 2010 FIFA World Cup. Although the 2011 AFC Asian Cup is out of coverage of the data set, the qualifications for representation in the Japan national team in this tournament were based on the performance of the players in 2010. So it is reasonable to include this event in the construction of this variable. There were about a hundred people on the various national teams and 70 of them were from 11 J. League clubs. The rest of them were from Japan Europe group, since many top Japanese football stars were playing in European major leagues during the regular seasons. They only come back to play for Japan national team in important events and international friendship games. Only one club that provided these elite players, Vissel Kobe, experienced relegation to J2. This happened in 2005 and the team was promoted back to J1 in 2006 and continued playing J1 after that. No player from a J2 club represented Japan in international events during the period. Hence, this dummy variable is only included in J1. There are a total of six exogenous variables in J1 and five variables in J2. The detailed information on each variable is shown in Table 2.1 and Table 2.2.

2.3 The OLS Estimation and Result

The OLS model that I use to evaluate the impact of the environment variables on efficiency scores for J1 and J2 is as follows:

$$\theta_{J1i} = \beta_0 + \beta_1 \mathrm{CARDS} + \beta_2 \mathrm{GDP} + \beta_3 \mathrm{WINRATE} + \beta_4 \mathrm{ACCESS\ T} + \beta_5 \mathrm{BC} + \beta_6 \mathrm{NT} + \varepsilon_i$$

$$\theta_{J2i} = \beta_0 + \beta_1 \mathrm{CARDS} + \beta_2 \mathrm{GDP} + \beta_3 \mathrm{WINRATE} + \beta_4 \mathrm{ACCESS\ T} + \beta_5 \mathrm{BC} + \varepsilon_i$$

where

θ_i = Input-oriented CRS DEA efficiency score from Chapter 1

CARDS = average number of cards per game

GDP = Province gross domestic product

WINRATE = win rate

ACCESS T = Travel time to the stadium on the game day

BC = dummy variable for whether or not the club is located in the big three Japanese metropolis circles

NT = dummy variable for whether or not club players made the Japan national team

The result of the regression for both J1 and J2 are shown in Table 2.3 and Table 2.4. As we can see from those tables, several independent variables are significant in both divisions. In J1, the coefficient on WINRATE is positive and significant, which means a higher winning percentage will increase the efficiency score. At least in the case of J1, the positive effect of winning outweighs the negative effect of higher expenses in order to achieve a higher win rate. Hence the general impact of the win rate in the league is to improve efficiency and bring the club closer to the production frontier.

In J1, the independent variable GDP also had a positive impact on the efficiency score and is significant at 5% level. This situation is reversed for J2. Higher GDP leads to a lower efficiency score for clubs in J2. It is out of the scope of this study to explain why the result is different for J1 and J2. But I can try and provide some intuition. J1 clubs enjoy a high visibility in the region and the fan base steadily expands with the local economy. As a result, a larger economy leads to higher revenue from ticket sales, advertisement or team related merchandise. On the other hand, J2 clubs do not have the advantage of being the most renowned teams among locals and face much more severe competition from other forms of sports and entertainment. In wealthier and better developed regions, these alternative choices are abundant, and they steal consumer demand from the J2 football clubs significantly.

In J2, we have four significant independent variables. It is interesting that two of them work in directions opposite to those of J1. The WINRATE coefficient in J1 was positive but negative in J2 (significant at 1% level). As described in Chapter 1, most clubs promoted from Japan Football League (JFL), which is called J3, are small clubs from relatively underdeveloped areas. In J2, those teams built up the production frontier and most of them are on or very close to the production frontier. They ranked near the bottom for points awarded at the end of a season and they did not have an extremely large attendance. They are able to reach the production frontier only because each of them had very successful cost control.

Starting in 1998, J. League changed to a pyramid structure, much like those adopted by major European leagues, consisting of more clubs in J2 than in J1 and more J3 clubs than in J2. During the years when the number of clubs in J2 was being expanded, the threat of being relegated to J3 was very small. As a result, J2 clubs did not have the incentive to invest if it was unlikely that they would be promoted to J1. The exceptions were five to eight clubs who had a real potential to be promoted to J1. These clubs did have the incentive to invest a large amount of resources towards seeking promotion. All in all, however, it proved to be very expensive to win a game, and those J2 clubs who adopted better cost control (even if that means a lower winning rate) had higher efficiency.

As expected, increased time spent traveling to the stadium has a negative impact on the DEA efficiency score in J2. Intuitively, longer travel time leads to lower attendance, and lower attendance leads to lower efficiency for the club.

As described in the data section, the number of cards in one game measures the impetuosity of the game. Although a competitive game will attract more supporters to the stadium, more violence and the break of continuity may lower the clubs' performance. In the soccer world, weak teams tends to make more fouls than the ones with better control of the game Our OLS result shows that a larger number of fouls leads to a lower efficiency score for J2 clubs.

Finally, I present supplementary data to further illustrate the reason why the GDP coefficient is positive for J1 clubs but negative for J2 clubs. In areas with a higher GDP, there are other professional leagues like Japan Basketball League (JBL), Japan Baseball League, Japan Ice Hockey League, KFC, Sumo and so on. Table 2.6 shows the number of teams in alternative sport leagues.

Since J1 is the most popular sport and has a dominant position in Japanese professional sports, it is always one of the consumers' first choices on game day. The existence of alternative sports has a limited impact on the market share of J1 teams. However, in the case of J2 it is a different story since all of the other professional sports, even college sports, are close alternatives to J2. A higher level of GDP represents a better developed area and higher sports expenditure but it also means J2 is unlikely to be the first choice of the public even if there is no J1 club in town. On the other hand, in the rural areas or small towns, clubs in J2 do not face as many alternatives. This is the main reason why the GDP coefficient carries opposite signs for J1 and J2 clubs.

2.4 Conclusion

In this research I used Ordinary Least Squares (OLS) to analyze the influence of exogenous variables on efficiency scores derived from the input-oriented DEA model from Chapter 1. I use six exogenous variables in J1 and five in J2. The result showed that in J1 a higher level of GDP and win rate would increase the efficiency of the club. If there is any chance to change the location of the club to a relatively more developed area, it is not a bad idea to do so since higher GDP is overall good for increasing the club's efficiency.

In J2, we have four significant independent variables and two of them work in directions opposite to those of J1. In particular, a higher GDP and higher win rate lead to lower efficiency. This illustrates the importance of understanding the different market environment J2 clubs face as well as the key role that cost control plays in increasing J2 clubs' efficiency. On the other hand, more fouls decrease the efficiency of J2 clubs.

In J2, if there is opportunity to change the location of the club to a better developed area, it has to consider the increased competition from other professional sports in the new location which lowers the efficiency of the club in spite of the larger population in more developed areas. It also has to consider the stadium's location relative to residential areas since travel time can significantly affect the supporters' willingness to come to the game and thus efficiency of the club. Finally, reducing the number of fouls enhances the game quality and increases the efficiency of J2 clubs.

Table 2.1 Data on J1

OBS	TEAM NAME	CRS	WINRATE	NT	BC	GDP	ACCESS T	CARDS
1	Kashima Antlers	0.88	0.54	1.00	1.00	11.18	101.92	1.90
2	Urawa Red Diamonds	1.00	0.51	1.00	1.00	20.96	57.45	1.91
3	Omiya Ardija	0.97	0.32	0.00	1.00	20.96	45.42	2.15
4	Yokohama F・Marinos	0.96	0.38	1.00	1.00	31.20	60.35	1.66
5	Albirex Niigata	1.00	0.36	1.00	0.00	8.95	46.43	1.81
6	Shimizu S-Pulse	0.99	0.44	1.00	0.00	16.51	66.10	1.42
7	Jubilo Iwata	0.95	0.38	1.00	0.00	16.51	65.57	1.79
8	Nagoya Grampus Eight	1.00	0.44	1.00	1.00	35.21	58.43	2.13
9	Kawasaki Frontale	0.94	0.50	1.00	1.00	31.20	39.53	1.99
10	Gamba Osaka	0.94	0.53	1.00	1.00	37.92	61.35	1.39
11	F.C. Tokyo	0.99	0.38	1.00	1.00	90.71	51.68	1.69
12	JEF United Ichihara Chiba	0.97	0.33	1.00	1.00	31.02	53.40	1.85
13	Sanfrecce Hiroshima	0.88	0.37	1.00	0.00	11.57	61.40	1.69
14	Oita Trinita	0.89	0.36	0.00	0.00	4.35	44.92	2.16
15	Vissel Kobe	0.68	0.28	1.00	1.00	18.79	55.62	2.22
16	Kashiwa Reysol	0.99	0.31	0.00	1.00	19.30	48.05	2.24
17	Kyoto Sanga FC	0.77	0.22	0.00	1.00	9.85	48.00	1.85
18	Cerezo Osaka	1.00	0.38	0.00	1.00	38.56	50.07	2.06
19	Ventforet Kofu	1.00	0.28	0.00	0.00	3.18	36.50	2.57
20	Tokyo Verdy 1969	0.93	0.24	0.00	1.00	89.91	58.20	2.56
21	Montedio Yamagata	1.00	0.31	0.00	0.00	3.95	49.60	1.25
22	Avispa Fukuoka	0.90	0.15	0.00	0.00	18.24	50.10	2.50
23	Yokohama F.C.	0.92	0.12	0.00	1.00	31.74	52.20	1.94
24	Vegalta Sendai	1.00	0.29	0.00	0.00	8.32	50.50	1.26
25	Consadole Sapporo	0.86	0.12	0.00	0.00	18.06	59.60	2.38
26	Shonan Bellmare	0.95	0.09	0.00	1.00	32.10	33.00	1.71
	Mean	0.94	0.33	0.50	0.62	25.39	54.05	1.93
	Std	0.08	0.12	0.51	0.50	21.92	12.84	0.37

CRS = Efficiency Scores under the assumption of Constant Return to Scale.

NT= Japan National Team dummy.

BC = metropolis circle dummy.

GDP = gross domestic production (in trillion Japanese Yen) adjusted by the inflation index.

ACCESS T = Travel time (in minutes).

CARDS = cards per game.

Table 2.2 Data on J2

OBS	TEAM NAME	CRS	WINRATE	CARDS	BC	GDP	ACCESS T
1	Avispa Fukuoka	0.92	0.43	1.89	0.00	51.1	2.15
2	Cerezo Osaka	0.91	0.54	1.48	1.00	44.97	2.16
3	Consadole Sapporo	0.82	0.42	2.03	0.00	62.1	1.97
4	Ehime F.C.	0.98	0.26	2.56	0.00	54.08	1.78
5	FAGIANO OKAYAMA	1	0.18	1.89	0.00	40	1.86
6	FC GIFU	1	0.3	1.7	1.00	40.2	1.9
7	Giravanz Kitakyushu	1	0.03	2.16	0.00	43.3	2.22
8	JEF United Ichihara Chiba	0.81	0.5	1.83	1.00	52.8	1.89
9	Kashiwa Reysol	0.89	0.6	2.2	1.00	47.15	1.89
10	Kataller Toyama	1	0.26	1.81	0.00	49.25	1.77
11	Kyoto Sanga FC	0.98	0.59	2.15	1.00	47.9	1.7
12	Mito HollyHock	1	0.29	2.01	1.00	47.53	2.15
13	Montedio Yamagata	0.93	0.39	1.59	0.00	50.3	1.81
14	Oita Trinita	1	0.28	1.97	0.00	39.6	2.03
15	Roasso Kumamoto	1	0.31	1.99	0.00	39.43	2.03
16	Sagan Tosu	0.92	0.42	2.15	0.00	45.78	1.88
17	Sanfrecce Hiroshima	0.83	0.74	2.12	0.00	53.2	1.48
18	Shonan Bellmare	0.87	0.42	1.91	1.00	36.04	1.99
19	Thespa Kusatsu	1	0.25	1.88	1.00	41.95	2.12
20	Tochigi SC	1	0.25	1.78	1.00	40.7	2.15
21	Tokushima Vortis	0.95	0.25	2.03	0.00	50.43	1.91
22	Tokyo Verdy 1969	0.65	0.46	1.9	1.00	56.05	2.2
23	Vegalta Sendai	0.85	0.49	2.15	0.00	43.74	1.59
24	Ventforet Kofu	1	0.47	1.77	0.00	36.05	1.83
25	Vissel Kobe	0.63	0.52	1.86	1.00	62.3	2.56
26	Yokohama F.C.	0.91	0.34	2.22	1.00	53.66	2.01
	Mean	0.92	0.38	1.96	0.46	47.29	1.96
	Std	0.10	0.15	0.21	0.50	7.06	0.22

CRS = Efficiency Scores under the assumption of Constant Return to Scale.

NT= Japan National Team dummy.

BC = metropolis circle dummy.

GDP = gross domestic product (in trillion Japanese Yen) and adjusted by the inflation index.

ACCESS T = Travel time (in minute);

CARDS = card per game.

Table 2.3 Result for J1

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1.012979	0.109706	9.233543	1.87E-08	0.783361	1.242597
WINRATE	0.422132	0.165021	2.558055	0.019228	0.07674	0.767525
NT	-0.06164	0.040649	-1.51648	0.14586	-0.14672	0.023436
GDP	0.001382	0.000759	1.821516	0.084312	-0.00021	0.002969
ACCESS T	-0.00186	0.001243	-1.49479	0.151394	-0.00446	0.000744
CARDS	-0.04642	0.040828	-1.13693	0.269705	-0.13187	0.039036
BC	-0.05046	0.033629	-1.50046	0.14993	-0.12085	0.019927

Table 2.4 Result for J2

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1.557061	0.13729	11.34139	3.66E-10	1.270679	1.843443
WINRATE	-0.31118	0.090258	-3.44771	0.002545	-0.49946	-0.12291
BC	0.025857	0.026652	0.970162	0.343553	-0.02974	0.081452
GDP	-0.00218	0.000726	-2.99669	0.007129	-0.00369	-0.00066
ACCESS T	-0.00527	0.001703	-3.09372	0.005726	-0.00882	-0.00172
CARDS	-0.12693	0.064067	-1.98121	0.061485	-0.26057	0.006711

Table 2.5 Regression Statistics

Regression Statistics	J1	J2
Multiple R	0.888316	0.656781
R Square	0.789104	0.431361
Adjusted R Square	0.736381	0.251791
Standard Error	0.05345	0.062439
Observations	26	26

Table 2.6 Japan Professional Leagues

Professional League	Number of Teams
Japanese Baseball League	12
Japan Basketball League	8
Japan Basketball League division 2	8
Japan Hockey League	6
V.Premier League (Volleyball)	8
Japan Sumo Association	105 (Membership)

Chapter: 3

Measuring the Change of Total Factor Productivity in the Japan Professional Football League Using the Malmquist Index

3.1 Introduction

In the first chapter, I estimated the productivity and efficiencies of the football clubs in Japan Professional Football League (J. League) for both the first (J1) and the second (J2) divisions. The methodology applied in the first chapter is a non-parametric approach, Data Envelopment Analysis (DEA), including three kinds of efficiency scores, constants returns to scale (CRS), variable returns to scale (VRS) and scale efficiency. This chapter is an extension of the first chapter, and checks the dynamic change of Total Factor Productivity (TFP) based on the calculation of the Malmquist Index, which consists of efficiency change and technical change between two time periods. In addition, the production frontier used in this chapter is built by the non-parametric input-oriented CRS DEA approach as applied in the first chapter. Based on the results of the Malmquist Index, I can clearly demonstrate the trends of the change in the TFP growth as increasing, declining or remaining at the same rate. This research can help us to understand what caused the change of TFP in each season and how they affect the final outcome of efficiencies in J1 and J2. In addition, the club level results can illustrate the special productivity change for each club and the factors influencing the change in each season. I explained the relationship between the productivity change and the macroeconomic environmental background.

The remainder of this paper is organized as follows: the second section is a brief review of the literature about Malmquist Index. The third section is about the models and the methodologies used in this paper including the DEA model and Malmquist Index. Section 3.4 is a description of the database collected from the homepage of the Japan Professional Football League. Section 3.5 is about the results of models. The last section concludes with findings and discussions.

3.2 Literature Review

The Malmquist TFP Index was first introduced in two very influential papers by Caves, Christensen and Diewert (CCD) (1982a, 1982b). In these papers, CCD defined the TFP Index using Malmquist input and output distance functions, and thus the resulting index has come to be known as the Malmquist TFP index. Because of the influence and the advantages of the Malmquist TFP index, a large number of researchers employed this model in many fields after the CCD's introduction, for example, in agriculture (Coelli et al. (2005), Umetsu et al. (2003) and Guy Blaise Nkamleu (2004)), in banking (Casu et al. (2004) and Milind Sathye (2002)), and in retail (Barros et al. (2004)).

Coelli et al. (2005) analyzed the TFP growth in agriculture in 93 countries from six continents over 20 years, from 1980 to 2000 by Malmqusit Index based on the CRS DEA efficiency scores. The database was collected from the Food and Agriculture Organization of the United Nation.

Input variables involved in the DEA efficiency approach were land, tractor, labor, fertilizer, livestock and irrigation. The paper concluded that the annual TFP growth in those countries was 2.1%. China had an average of 6.0% growth in TFP which was the highest and India had a growth rate of 1.4% which was the lowest. Among different regions, Asia had the highest annual TFP growth rate of 2.9%.

Umetsu et al. (2003) examined the productivity change in the rice sector for the Post-Green Revolution era from 1971 to 1990 in the Philippines by the Malmquist TFP Index. The average annual Malmquist TFP growth was positive. It was negative in the early 1970s and then turned positive. However, the Malmquist TFP growth was negative again in the early 1980s. The positive change was caused by the introduction of new rice varieties and the negative impact was mainly because of the intensification of rice production in lowland farming systems. They also demonstrated the different growth between the regions in the Philippines.

Guy Blaise Nkamleu (2004) estimates the performance of agricultural sectors in 16 African countries and the panel data covers 32 years from 1970 to 2001. The TFP had a positive evolution in those countries during the period. The decomposition of the TFP showed that the progress could mainly be attributed to the efficiency change rather than the technical change. He found a disparity of the technical efficiency and productivity among the countries in the sample and it was necessary to investigate the reasons for the poor performance in those less competitive countries and to narrow the differences.

In the banking field, Casu et al. (2004) used both parametric (cost productivity) and non-parametric (Malmquist TFP Index) approaches to estimate the productivity change in European banking during the period 1994 to 2000. The data used in this research covered more than 2000

European banks. By comparing the results from both methodologies, they found that the banks in both Italy and Spain experienced an obvious productivity growth within the period; however, the cases of French and German banking were mixed.

Milind Sathye (2002) estimated the productivity change of Australian banks using the Malmquist Index based on the results of DEA technique during the period 1995 to 1999. The panel data included 17 incorporated banks in Australia. He found that technical efficiency declined but on average TFP still remained greater than zero during the period. Eight out of 17 banks did not show any positive productivity growth. He attributed the growth to deregulation in early 1980s, since Australia reached a stage which is called “limit of deregulation”.

Barros et al. (2004) estimated the productivity change in a Portuguese retail store chain with 47 retail outlets from 1999 to 2000 which was based on the DEA model on the first stage by the Malmquist Index. They found that the majority of the outlets were efficient but some of them were not. Moreover, they concluded that scale economies were the decisive factor of the efficiency difference.

The Malmquist Index is also used in many other fields such as education, farm industries and others. Flegg et al. (2004) used the DEA model and Malmquist Index to analyze British universities during the period of 1980/81 to 1992/93. Thirtle et al. (1996) used a farm-level panel data set to analysis the Malmqusit TFP Index in the Yugoslav Republic of Slovenia. Estache et al. (2004) measures the change of inefficiency in Mexico’s Port System after the reforms in 1993. Carlos Pestana Barros (2005) analyzed a Portuguese public owned hotel chain (42 hotels).

In the past decade, football became one of the most popular topics for research because of its influence in the world. Guzmán et al. (2007) estimated the efficiency of the football clubs in the

English Premier League by Malmquist TFP Index based on the DEA efficiency scores as well as canonical correlation theory. Six years were covered by the data, from 1997/98 to 2002/03. Based on the result of the Malmquist TFP Index, most clubs experienced a negative productivity growth since they had a value of TFP score less than one.

Isidoro Guzmán (2006) measured the efficiency and sustainable growth in Spain football teams (first division) by the data collected from 2000/01 to 2002/03. After the first step, application of DEA model, the dynamic change of the TFP was caught by the Malmquist Index. He then estimated the sustainable growth of the clubs in this sample. In conclusion, he claimed that the mean value of the Malmquist Index was about one and found that "technological change reveals a negative displacement of the efficiency frontiers during the periods evaluated, whereas the change in technical efficiency is trending positively, suggesting the clubs provide better performance in terms of movements with respect to the efficiency frontiers over the assessed seasons." (p.283) There were two teams, Sevilla and Real Club Deportivo de la Coruna which made their way closer to the frontier, since both of them showed an obvious positive growth of productivity, which could not be attributed to the technical efficiency change. They only experienced a very limited technological change because of the scarce adoption of the new teaching technologies by best-practice teams.

Espitia-Escuer et al. (2008) also analyzed the first division of the Spain Football League from 1998 to 2004 by the Mamlquist TFP Index based on the DEA efficiency scores. In the season 1998/99 and 2001/02, the league experienced a decrease in TFP which could be attributed to technical decline. And in the season 2000/01 the decline in the TFP was caused by the fall of efficiency. Both season 2002/03 and 2003/04 had a positive TFP growth; growth in 2002/03 was due to technical increase; and growth in 2003/04 is attributed to both technical progress and efficiency.

3.3 DEA and Malmquist TFP Index

Data Envelopment Analysis

The production frontier used in this research has given rise to the methodology of a non-parametric estimator, Data Envelopment Analysis (DEA). The variables used here are the same as those used in the first chapter: points awarded, revenue and attendance on the output side and payroll, other cost besides the payroll and total assets on the input side. The structure of the DEA model is described below:

$$\max_{\underline{u},\underline{v}} E_o(\underline{u},\underline{v}) = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}}$$

Subject to $$0 \leq \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \ (j = 1,2,\cdots,n)$$

$$v_i \geq 0 \ (i = 1,2,\cdots,m)$$

$$u_r \geq 0 \ (r = 1,2,\cdots,s)$$

E_o is the efficiency of DMU_o ; x_{io} and y_{ro} are the observed outputs and inputs values, respectively, of DMU_o, and u_r and v_i are the weights assigned to output r and input i during the aggregation. Each DMU represents one of the 26 football clubs in J1 or J2. Detailed information about the DEA model is showed in Section 1.4 which is the same model as the one used in this chapter.

Malmquist Total Factor Productivity (TFP) Index

In order to estimate the productivity change between two time periods, I use the Malmquist Index of the change in Total Factor Productivity. The TFP is a measure of the change of productivity for the DMU producing multiple outputs using multiple inputs. The Malmquist TFP Index is based on the measurement of the radial distance of the observed inputs and outputs between two time periods according to a reference technology. The distance function is calculated by using input-oriented CRS (constant returns to scale) DEA model in this research. In addition, I applied the input-oriented Malmquist TFP Index. The definition of input-oriented productivity is to measure the minimum level of usage of the inputs given a certain amount of output and a production technology relative to the collected observation set.

The following model is reproduced from Coelli, Timothy J., D.S. Prasada Rao, Christopher J. O'Donnell and George E. Battese (2005).

> The Malmquist TFP index measures the TFP change between two data points by calculating the ratio of the distances of each data point relative to a common technology. If the period t technology is used as the reference technology, the Malmquist TFP change index between period s (the base period) and period t is can be write as
>
> $$m_o^t(y_s, y_t, x_s, x_t) = \frac{d_o^t(y_t, x_t)}{d_o^t(y_s, x_s)}$$
>
> Alternative, if the s reference technology is used it is defined as

$$m_o^s(y_s, y_t, x_s, x_t) = \frac{d_o^s(y_t, x_t)}{d_o^s(y_s, x_s)}$$

Note that in the above equations the notations $d_o^s(y_t, x_t)$ represents the distance from period t observation to the period s technology. A value of m_o greater than one indicates positive TFP growth from period s to period t while a value less than one indicates a TFP decline.

The Malmquist TFP index is ofren defined as the geometric mean of these tweo indices, in the spirit of Fisher (1922) and Caves, Christensen and Diewert (1982b). That is

$$m_o(y_s, y_t, x_s, x_t) = [\frac{d_o^t(y_t, x_t)}{d_o^t(y_s, x_s)} \times \frac{d_o^s(y_t, x_t)}{d_o^s(y_s, x_s)}]^{\frac{1}{2}}$$

The distance functions in this productivity index can be rearranged to show that it is equivalent to the product of a technical efficiency change index and an index of technical change

$$m_o(y_s, y_t, x_s, x_t) = \frac{d_o^t(y_t, x_t)}{d_o^s(y_s, x_s)} [\frac{d_o^s(y_t, x_t)}{d_o^t(y_t, x_t)} \times \frac{d_o^s(y_s, x_s)}{d_o^t(y_s, x_s)}]^{\frac{1}{2}}$$

Those two terms are:

$$\text{Efficiency change} = \frac{d_o^t(y_t, x_t)}{d_o^s(y_s, x_s)}$$

and

$$\text{Technical Change} = [\frac{d_o^s(y_t, x_t)}{d_o^t(y_t, x_t)} \times \frac{d_o^s(y_s, x_s)}{d_o^t(y_s, x_s)}]^{\frac{1}{2}}$$

As mentioned above, these distance functions can be calculated by the input-oriented CRS DEA efficiency scores. From the formula of the technical change, we can see that it consists of two efficiency ratios with respect to the isoquants in t and s. In the meantime, the value of the ratios in some units can be demonstrated to increase or decrease in comparison to other units (football clubs) in a given period and a given sample.

When considering the productivity change from period t to period t+1and then also the change from t+1 to t+2, the productivity indices can be chained to a comparison between period t and t+2. However, it cannot be denoted in the way below:

$$\mathrm{MTFP}(t, t+2) \neq \mathrm{MTFP}(t, t+1) \times \mathrm{MTFP}(t+1, t+2)$$

This is mainly because of the nature of the production technology. From the Malmquist TFP Index, I can see that the first component, change of Technical Efficiency, can be transitive, but the second term cannot be transitive unless the technology change is neutral.

3.4 Data

The data used in this research is collected from the official site of the Japan Professional Football League (J. League) including the first and the second division (J1 and J2). It covers five seasons from 2006 to 2010. The general financial reports for each club every year are published on the official website in the middle of the next year. Different from the data set used in Chapter 1, it only covers five years since several football clubs' payroll information in both J1 and J2 is not available in 2005. The Malmquist Index is calculated by using the input-oriented DEA approach. In order to obtain meaningful and accurate DEA scores for both divisions in each year, this data set includes all of the clubs that played in one or more seasons during the period. In order to meet the requirement of the Malmquist TFP Index, the football club has to play in two consecutive seasons during the period; otherwise the Malmquist TFP Index cannot be computed. As a result, there are a total of 19 football clubs in each division for which a Malmquist TFP Index could be computed in at least one year.

In general, there are a total of 36 clubs, both in J1 and J2, presented during the period. Eleven clubs in J1 and five clubs in J2 played in all five seasons. The detailed information about individual club's participation in J1 or J2 is shown in Table 3.1 and Table 3.2. There are three input variables and three output variables involved in the DEA model which are the same as in the first chapter: payroll, cost besides the payroll, total assets on the input side; annual revenue, points awarded and attendance on the output side. Data on these variables are presented in Table 3.3 and Table 3.4. The detailed reasons why I choose those variables as the ones involved in the production are explained in the data section in Chapter 1.

3.5 Result

In the first step, I calculated the input-oriented DEA efficiency scores of each club in each year during the period using both constant returns to scale (CRS) and variable returns to scale (VRS). Results are presented in Table 3.5 and Table 3.6. In J1, Albirex Niigata was the only club with an efficiency score of one in both CRS and VRS through the whole period. Ventforet Kofu and Montedio Yamagata, which attended two seasons each in J1, were also efficient in CRS and

VRS. This is mainly because Albirex Niigata had the largest attendance in every year with relatively moderate inputs compared to other clubs. Ventforet Kofu and Montedio Yamagata had the smallest amount of inputs in the seasons they played although they did not have any extraordinary outcomes. Kyoto Sanga FC in 2006 had the lowest efficiency score, 0.7482, among all of the clubs from 2006 to 2010, which is far below the average value because of its weak performance, especially the points awarded. Kawasaki Frontale, Vissel Kobe, Sanfrecce Hiroshima and Kyoto Sanga FC all played J1 in at least four seasons during the period. However, none of them reached the production frontier (CRS) based on their inefficient operations.

Four clubs, Montedio Yamagata, Mito HollyHock, FC Gifu and Roasso Kumamoto, played three seasons or more in J2 and all of them had efficient DEA scores in the season they played. Mito HollyHock, FC Gifu and Roasso Kumamoto did not lead any output position. Their efficiencies were all based on successful cost control. Montedio Yamagata had efficient cost control, ranked the second in points awarded at the end of season 2008 and was promoted to J1 in season 2009. So I can conclude that Montedio Yamagata was the most efficiently organized club according to the effects from both input and output side in J2. Yokohama F.C., Shonan Bellmare, Avispa Fukuoka, Tokyo Verdy 1969 and Cerezo Osaka played J2 three seasons or more, but none of those clubs had ever reached the production frontier (CRS) during the period. This is mainly because they had the motivation and possibility to promote to J1. They all successfully experienced playing J1 during the period.

After promotion to J1, revenue can be increased in several ways. More attention and concerns will be given to the top division games. For example, more live TV on the mainstream channels and a larger share of newspaper coverage. If they promote to J1, they get better opportunities for exposure and then subsequent gains. Based on the value of promotion, J2 clubs could increase input use temporarily, earn promotion and then receive a relatively large payoff after joining J1. This is experienced by Tokyo Verdy 1969.

In general, the average value of DEA efficiency scores experienced an increase from 2006 to 2007 as shown in Figure 3.1 and Figure 3.2. In the case of J1, the range of fluctuation was relatively narrow, between 0.94 and 0.98, during the period. Especially after 2007 the range was from 0.957 to 0.963 which means that the efficiencies were very stable and the change is gradual. On the other hand, the VRS efficiency score is even more stable. In J2 the range was much wider than in J1, between 0.887 and 0.975 in CRS and 0.946 and 0.992 in VRS. It shows that the CRS efficiencies in J2 were unstable and the change was more intense compared to J1. This is because the number of clubs was changing all the time as new clubs kept joining J2. The decline of efficiencies in 2009 can be attributed to the performance of Tokyo Verdy 1969 which had the lowest efficiency in J2. The average value without Tokyo Verdy 1969 was nearly 0.95 which was very close to the ones in 2008 and 2010. So we can say that the wider range of CRS efficieny scores in J2 was caused by the outlier clubs Tokyo Verdy 1969 in 2009 and Vissel Kobe in 2006 which were very inefficient.

The Malmquist Indexes of TFP for each club in each season are presented in Table 3.7 and Table 3.8 from 2007 to 2010, where each year is compared to the previous year. There were four groups of comparison in J1 and J2. As most researchers did in their papers, technical efficiency is based on the input-oriented CRS DEA approach. From Table 3.7, we can see that the average Malmquist Index values in J1 are less than one through the period. This means that the first division of J. League experienced a decline of total factor productivity year by year although the speed of decline is different every year. The lowest value, 0.8511, happened at United Ichihara Chiba in 2009. After the decomposition of the Malmquist Index to the efficiency change and the technical change in J1, we see that there was an increase in efficiency in 2007 and then J1 experienced a consistent efficiency decline from 2008 to 2010. Conversely, 2007 showed a decline in technology but the technical change was positive after 2007. There is no year with both positive technical and positive efficiency changes in the first division of J. League during the period of analysis. As described in Espitia-Escuer et al. (2008), when the average Malmquist Index values are close to one and the technical and efficiency changes move in opposite directions, no component dominated in the total factor productivity variations.

However, at the club level it can be a different story from the general results of J1. First of all, most clubs did not realize TFP changes in the same directions. There were two exceptions: Sanfrecce Hiroshima and Vissel Kobe. Sanfrecce Hiroshima showed a negative TFP change in the Malmqusit Index in 2007 and 2010; the decline in 2007 was due to both the decline in efficiency and a technology decline. In 2010, it was only due to the decline in efficiency. In the case of Vissel Kobe, it had a positive TFP change in the Malmquist Index for three consecutive seasons. The result showed that Vissel Kobe achieved technical progress from 2007 to 2010 and experienced an improvement in efficiency only in year 2008. Second, similar to the results in Coelli et al. (2005) and Barros et al. (2003), several clubs in each season had a value of the Malmquist Index equal to one. There were six such clubs in 2007 and three clubs in 2008. This is because those clubs were efficient in consecutive seasons even after switching the values of components in the Technical Efficiency function as $d_i^s(y_t, x_t)$ and $d_i^t(y_s, x_s)$. In this situation, the club will be efficient in both periods anyway. As a result, $d_i^s(y_t, x_t)$, $d_i^t(y_s, x_s)$, $d_i^t(y_t, x_t)$ and $d_i^s(y_s, x_s)$ are all equal to one as well as the Malmquist Index. These clubs reached the production frontier in both seasons and were the most efficient. Albirex Niigata had a value of the Malmquist Index equal to one in all seasons because of highest attendance in each season and relatively successful cost control. That the value of the Malmquist Index remains equal to one does not mean that the clubs do not improve efficiency and promote new technologies. It shows that the clubs are already on the production frontier and remain there.

In addition, I checked the values of the Malmquist Index for the clubs relegated from J1 to J2. Five clubs met the condition that they played at least two consecutive seasons before the relegation from J1, JEF United Ichihara Chiba (relegated in 2009), Oita Trinita (2009), Sanfrecce Hiroshima (2007), Ventforet Kofu (2007) and Kashiwa Reysol (2009). United Ichihara Chiba, Oita Trinita and Sanfrecce Hiroshima all experienced a TFP decline in the relegation season which can be attributed to the low points awarded in the season. United Ichihara Chiba had a Malmquist Index value of 0.8511. In the case of Ventforet Kofu and Kashiwa Reysol, they were still efficient in the relegation year although they received limited points because of successful cost control.

In 2007, four clubs achieved a Malmquist Index with value more than one: Kashima Antlers, Yokohama F. Marinos, Nagoya Grampus Eight and F.C. Tokyo. All of their TFP growth can be attributed to an improvement in efficiency although they all experienced a technical decline. In 2008, six clubs with the Malmquist Index more than one had different component combinations. The TFP growth of Omiya Ardija and Yokohama F. Marinos were due to the improvement in efficiency and Kashiwa Reysol, Gamba Osaka and Vissel Kobe were due to the technical progress. Only the TFP growth of Kawasaki Frontale is because of both positive changes in efficiency and technology. In 2009, six clubs achieved positive growth in TFP. Three clubs (Omiya Ardija, Jubilo Iwata, Gamba Osaka) can be explained by the improvement of efficiency and F.C. Tokyo by technical progress. Moreover, the TFP growth of Vissel Kobe and Shimizu S-Pulse were caused by positive efficiency and technology changes. In 2010, there were five clubs with a growth in TFP. Three clubs (Nagoya Grampus Eight, Vissel Kobe, Kyoto Sanga FC) were due to the technical progress. F.C. Tokyo was due to efficiency increase. Jubilo Iwata was because of both positive changes in efficiency and technology.

The Malmquist Index of J2 clubs is shown in Table 3.8. I found TFP growth in 2007, 2009 and 2010 when average values were more than one. The positive change of average Malmquist Index values in 2009 and 2010 can be attributed to technical progress and in 2007 was caused by the improvement of efficiency. On the other hand, the decline of the Malmquist Index in 2008 can be explained by both a negative change in efficiency and technology. At the club level, the lowest value in J2 was 0.8755, Shonan Bellmare in 2007. This was moderately higher than the lowest value in J1. Only 2 clubs had the Malmquist Index moving in the same direction; Tokyo Verdy 1969 had positive productivity growth in 2007 and 2010 and the Malmquist Index was 1.8071 in 2010, which is the highest value in J2 and J1. This is mainly because Tokyo Verdy 1969 had an extremely dramatic cost reduction in 2010 compared to 2009. Conversely, Cerezo Osaka had a decline trend in TFP in 2008 and 2009. Several clubs in J2 each year had a Malmquist Index equal to one. There were three clubs each in 2007 and 2010 and one club each in 2008 and 2009 that had Malmquist TFP equal to one. Among those clubs, Montedio Yamagata played three seasons in J2 and all of its TFP values were equal to one, because of its efficient and successful cost control during the seasons.

There were six clubs promoted to J1 from J2 during the period and I checked the Malmquist Index of the last year in J2 before the promotion. Consadole Sapporo (promotion decided in 2008), Shonan Bellmare (2009) and Tokyo Verdy 1969 (2007) had positive TFP growth, which can be attributed to their leading positions in the athletic rank at the end of season. Montedio Yamagata was an efficient club in any time and any formation.

In 2007, four clubs had positive TFP growth. Tokyo Verdy 1969 and Shonan Bellmare were caused by positive changes in both technology and efficiency. TFP growths for Consadole Sapporo and Vegalta Sendai were the result of improvement in efficiency only. In 2008, three clubs had positive TFP growth. Sagan Tosu had positive change from both efficiency and technology progress. Tokushima Vortis achieved efficiency improvement and Mito HollyHock was the result of technical progress. In 2009, five clubs realized positive growth in TFP (Yokohama F.C., Shonan Bellmare, Ventforet Kofu, FC Gifu, Roasso Kumamoto). This was due to a change in both efficiency and technical progress. The TFP growths of Tokushima Vortis and Ehime F.C. were the result of technical progress. In 2010, all five clubs with increased TFP (Tokushima Vortis, Avispa Fukuoka, Sagan Tosu, Tokyo Verdy 1969, Tochigi SC) were due to the efficiency improvement.

In sum, the Malmquist Index in J1 had a downward trend as shown in Figure 3.3. This means that the TFP was consistently decreasing through the period. In J2, the situation was more complicated. In the case of J1, the decreasing trend can be attributed to movement of the production frontier which decreased in 2007 compared to 2006 and then kept increasing after 2007. Some clubs who were inefficient in 2006 (Omiya Ardija, Kawasaki Frontale, Gamba Osaka, F.C. Tokyo, Sanfrecce Hiroshima) became efficient after switching their components to 2007, $d_i^{2007}(y_{2006}, x_{2006})$, and all of the other inefficient clubs in 2006 received higher efficiency after this switch. Conversely, some clubs (Kashima Antlers, Shimizu S-Pulse, Gamba Osaka, Oita Trinita) who were efficient in 2007 were inefficient after switching the components from 2007 to 2006, $d_i^{2006}(y_{2007}, x_{2007})$. Moreover, clubs such as Urawa Red Diamonds, Albirex Niigata, JEF United Ichihara Chiba and Ventforet Kofu were efficient before and after the switch. This means that clubs in 2006 had a higher (or at least equal in certain dimensions), production frontier than clubs in 2007 and the efficient clubs in 2006 were more efficient than (or at least equal to) the efficient clubs in 2007. After this decline in 2007, the production frontier kept increasing as the technical changes are greater than one after that. Clubs' efficiencies in 2006 were very low although they had a relatively higher production frontier. This is because the inefficient clubs had positions relatively far from the frontier. On the other hand, clubs in 2007 had extremely high efficiencies due to their relatively short distances to the frontier. So, from 2006 to 2007 J1 experienced an improvement of efficiency. Although the production frontier increased after 2007, the efficiency of inefficient clubs remained the same, declined or at least did not improve as much as the ones already on the production frontier achieved. As a result, the efficiency changes in J1 were consistently less than one after 2007. In general, the negative impact of technology decline overcame the positive impact of efficiency improvement in 2007; the negative impact of efficiency overcame the positive impact of technical progress after 2007. Hence, the trend of the Malmquist Index in J1 was decreasing during in the entire period.

In J2, there was no clear trend. First, the size of J2 kept expanding through the period, so the number of clubs was different year after year. According to the expansion plan, there was no relegation to the JFL (the Japan Football League, also called J3). Most of the new clubs promoted from JFL were smaller clubs and from relatively and economically underdeveloped areas. Hence, those clubs did not have the incentive and capability to promote to J1 right away and there was no threat to be relegated back to JFL. The new J2 clubs, Giravanz Kitakyushu (2010), Kataller Toyama (2009), Fagiano Okayama (2009), FC Gifu (2008) and Roasso Kumamoto (2008) were running at extremely low cost. All of these clubs were efficient with CRS efficiency score equal to one in the first year of play in J2 due to the successful cost control. Some dimensions of the production frontier were determined by the new clubs from JFL.

Secondly, three clubs (two in 2008) were relegated from J1 into J2 and the top three clubs (two in 2008) in the points rank promoted to J1 every year. This mechanism made the composition of J2 unstable and unpredictable. New clubs from J1 or JFL can change the production frontier in J2 as Oita Trinita (2009) noted. Therefore, the technical change fluctuation through the period is understandable since the production frontier kept changing as the new clubs were relegated from J1 and promoted from JFL. The production frontier's position was different and the composition and structure of J2 was also changing every year. For this reason the result shown in Table 3.8, where no clear trend of the Malmquist Index in J2 occurs, is understandable.

3.6 Conclusion and Discussion

This research has analyzed the dynamic change in Total Factor Productivity of the first and second divisions in the Japan Professional Football League between 2006 and 2010. The method used in this analysis employs the Malmquist Index based on the efficiency values calculated by the non-parametric Data Envelopment Analysis (DEA). Then the Malmquist Index is decomposed to the technical change and the efficiency change and the results are explained.

Input-oriented DEA efficiency scores of J1 and J2 are calculated in both constant and variable returns to scale. The results showed that the most efficient clubs were Albirex Niigata, Ventforet Kofu and Montedio Yamagata, which were on the production frontier under both CRS and VRS, in all of the seasons they played in J1. Albirex Niigata's efficiency was due to the large amount of attendees and the other two clubs were due to successful cost control. Some clubs, for instance Sanfrecce Hiroshima and Kyoto Sanga FC, never reached the production frontier under CRS. In the case of J2, Montedio Yamagata, Mito HollyHock, FC Gifu and Roasso Kumamoto consistently stayed on the production frontier in the years they played in J2. Montedio Yamagata had very good athletic performance and cost control even in the season they were promoted to J1, the others were on the top because of efficient cost control. Some clubs in J2 wanted to promote to J1 because of the greater return. Except for Montedio Yamagata, other clubs which did promote to J1 were not on the production frontier due to the large amount of resources inputted to secure the promotion. As a whole, the average value of CRS DEA efficiency scores had a sharp increase from the lowest value in 2006 and then a decrease after 2007 in J1. After 2007, the scores fluctuated in a relatively narrow range and the changes were very small. In J2, the CRS DEA efficiency scores were unstable. The range was much wider than J1 and there was more than one direction during the period. One cause of the low value of average CRS DEA scores in 2006 and 2009 was the outlier clubs, Tokyo Verdy 1969 (2009) and Vissel Kobe (2006), which had extremely inefficient performance.

There are four calculation of the Malmquist Index during the period in each division based on the input-oriented CRS DEA efficiency approach. The TFP of J1 was consistently decreasing. The decomposition of the Malmquist Index into the technical change and the efficiency change revealed the decline of technology in 2007 and then the technical progress after 2007. After the decline of efficiency in 2007, it kept increasing from 2008 to the end of the period. At the club level, only Sanfrecce Hiroshima and Vissel Kobe had the change of productivity in the same direction, one downward and one upward. Moreover, some clubs, such as Montedio Yamagata, had a Malmquist Index equal to one since the clubs were efficient in two consecutive seasons and would be efficient even after switching the components of each other season ($d_i^s(y_t, x_t)$ and $d_i^t(y_s, x_s)$). Those clubs stayed on the production frontier between two consecutive seasons anyway. Among the clubs who experienced relegation to J2 from J1, some of them experienced a productivity decline in the relegation season which can be attributed to the low points awarded in the season. However, Ventforet Kofu and Kashiwa Reysol were still efficient in the relegation year due to the successful cost control even though each received limited points. In J2, the TFP grew in 2007, 2009 and 2010. The growths were caused by the technical progress in 2009 and 2010 and by the improvement of efficiency in 2007. The negative change of Malmquist Index in 2008 was due to decline of both efficiency and technology. At the club level, Tokyo Verdy 1969 increased productivity in 2007 and 2010, (the seasons played) and Cerezo Osaka had a decline in TFP in 2007 and 2008, (the seasons played). Several J2 clubs were constantly on the production frontier even after the switch of the components to those of another season. The TFP was decreasing through the period, but the reasons that caused this phenomenon were different. The decrease from 2006 to 2007 was because the production frontier decreased which means that the efficient clubs in 2006 were more efficient than the efficient ones in 2007. The average value of $d_i^{2007}(y_{2006}, x_{2006})$ was higher than the value of $d_i^{2007}(y_{2007}, x_{2007})$ and this revealed that the decline of TFP was caused by the decline of efficiency of the efficient clubs in 2007 compared to 2006 as shown in Table 3.9. This can be attributed to the clubs on the production frontier in 2007 (Kashima Antlers, Shimizu S-Pulse, Gamba Osaka and Oita Trinita) spending more to achieve a certain level of outcome than the efficient ones in 2006. The decline of TFP after 2007 was due to decreasing efficiency although the production frontier kept improving after 2007. The production frontier improvement from 2007 to 2008 was due to the increase in revenue of the clubs although the cost also increased in the same year. This is shown in the Figure 3.4. The revenue of the clubs kept increasing before the global financial crisis in 2008. The clubs on the frontier gained more from increase in revenue than the loss from an increase in cost. This made clubs on the frontier more efficient than the ones on the frontier the year before. Conversely, the improvement of production frontier from 2008 to 2010 was purely due to cost control.

The revenue of the clubs was obviously declining, since the Japanese economy experienced a serious financial crisis in 2008. From 2008 to 2010, although losing part of its revenue, clubs on the frontier successfully cut their cost and made them more efficient year after year. On the other hand, most of the inefficient clubs did not improve as much as the ones on the frontier did, and in some case even did worse. As a result, the efficiency change was decreasing through the period despite the improvement of the production frontier.

There is no obvious trend we can see in the case of J2. And this is mainly because the number of clubs kept changing all the time. The new clubs promoted from JFL were all smaller ones and from less developed areas. So they usually input extremely limited resource in the first year since there was no relegation from J2 and they could not hope to promote to J1 based on their capability and experience. Those new clubs made the frontier every year so the change of the production frontier depends on the new clubs performance in cost control. Moreover, besides those new clubs from JFL, there are three clubs relegated from J2 to J1 and three new clubs joined J2 from J1 each year. Sometimes, the new clubs would position the frontier by its performance. So there were so many uncertain factors which influence the composition and structure of the production frontier in J2. Hence, the fluctuated change of TFP is understandable.

Figure 3.1 Average Efficiency Levels in J1

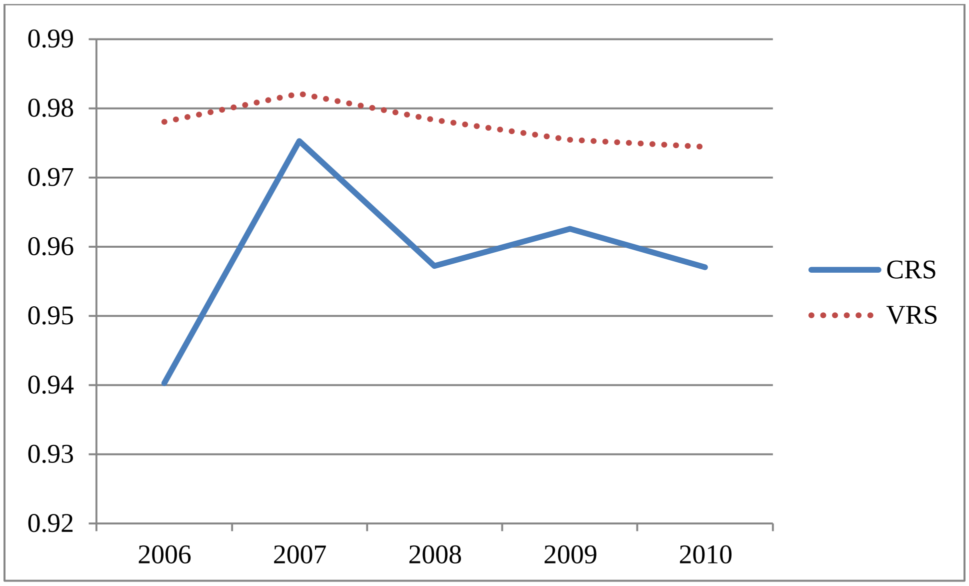

Figure 3.2 Average Efficiency Levels in J2

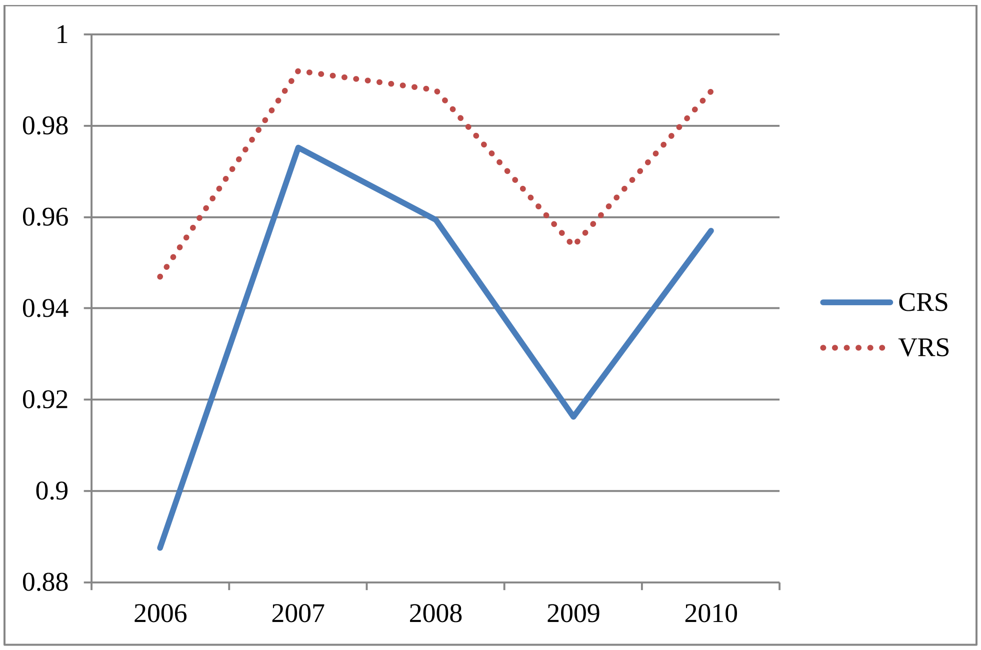

Figure 3.3 Malmquist Index Trends in J1 and J2

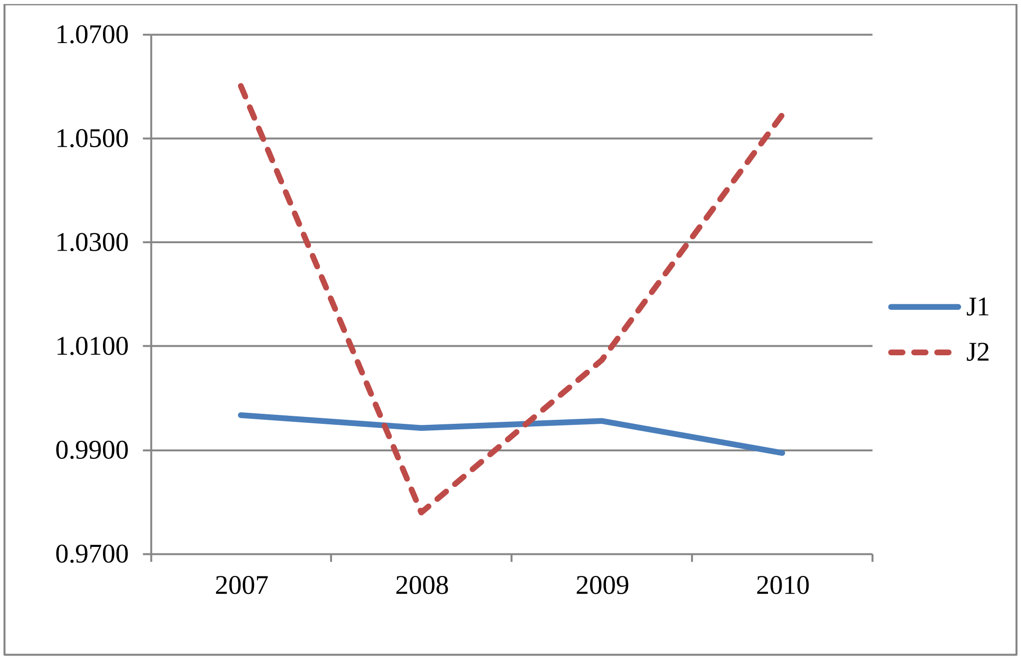

Figure 3.4 Average Revenue and Cost in J. League

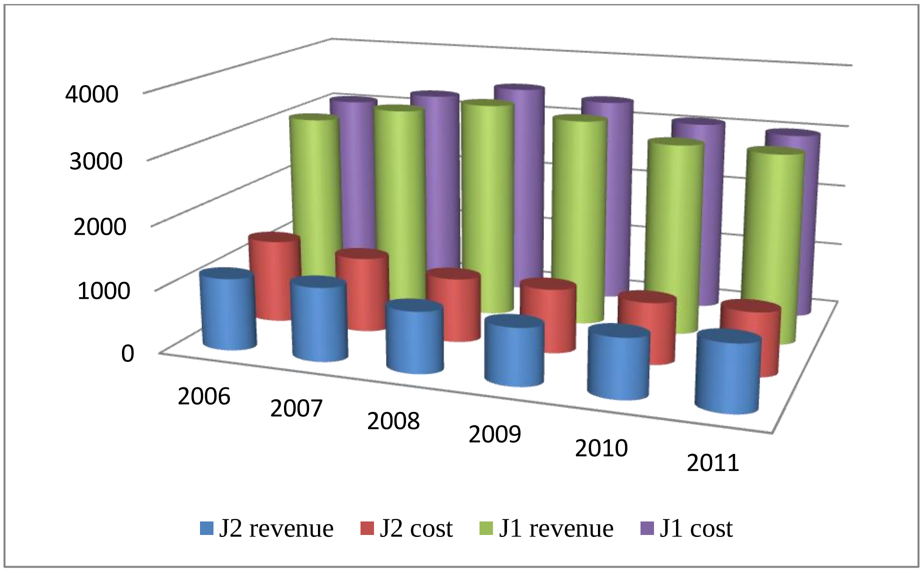

Table 3.1 J1 Malmquist TFP Index Database

OBS	Club Name	2006	2007	2008	2009	2010	Years of Play
1	Kashima Antlers	J1	J1	J1	J1	J1	5
2	Urawa Red Diamonds	J1	J1	J1	J1	J1	5
3	Omiya Ardija	J1	J1	J1	J1	J1	5
4	Yokohama F・Marinos	J1	J1	J1	J1	J1	5
5	Albirex Niigata	J1	J1	J1	J1	J1	5
6	Shimizu S-Pulse	J1	J1	J1	J1	J1	5
7	Jubilo Iwata	J1	J1	J1	J1	J1	5
8	Nagoya Grampus Eight	J1	J1	J1	J1	J1	5
9	Kawasaki Frontale	J1	J1	J1	J1	J1	5
10	Gamba Osaka	J1	J1	J1	J1	J1	5
11	F.C. Tokyo	J1	J1	J1	J1	J1	5
12	JEF United Ichihara Chiba	J1	J1	J1	J1		4
13	Sanfrecce Hiroshima	J1	J1		J1	J1	4
14	Oita Trinita	J1	J1	J1	J1		4
15	Vissel Kobe		J1	J1	J1	J1	4
16	Kashiwa Reysol		J1	J1	J1		3
17	Kyoto Sanga FC			J1	J1	J1	3
18	Ventforet Kofu	J1	J1				2
19	Montedio Yamagata				J1	J1	2

Table 3.2 J2 Malmquist TFP Index Database

OBS	Club Name	2006	2007	2008	2009	2010	Years of Play
1	Cerezo Osaka		J2	J2	J2		3
2	Ventforet Kofu			J2	J2	J2	3
3	Tokyo Verdy 1969	J2	J2		J2	J2	4
4	Montedio Yamagata	J2	J2	J2			3
5	Avispa Fukuoka		J2	J2	J2	J2	4
6	Yokohama F.C.			J2	J2	J2	3
7	Vegalta Sendai	J2	J2	J2	J2		4
8	Consadole Sapporo	J2	J2		J2	J2	4
9	Shonan Bellmare	J2	J2	J2	J2		4
10	Mito HollyHock	J2	J2	J2	J2	J2	5
11	Thespa Kusatsu	J2	J2	J2	J2	J2	5
12	Tokushima Vortis	J2	J2	J2	J2	J2	5
13	Sagan Tosu	J2	J2	J2	J2	J2	5
14	Ehime F.C.	J2	J2	J2	J2	J2	5
15	Roasso Kumamoto			J2	J2	J2	3
16	FC Gifu			J2	J2	J2	3
17	Tochigi SC				J2	J2	2
18	Kataller Toyama				J2	J2	2
19	Fagiano Okayama				J2	J2	2

Table 3.3 Yearly Input and Output Data in J1

		2006(18)						2007(18)						2008(18)					
OBS	Team Name	Poi	Attend	Reve	Payro	O C	T A	Poi	Attend	Reve	Payro	O C	T A	Poi	Attend	Reve	Payro	O C	T A
1	Kashima Antlers	58	262365	3381	1564	3536	1885	72	276058	3983	1736	3805	2337	63	335140	4180	1850	4063	2387
2	Urawa Red Diamonds	72	774749	7078	2499	6855	2240	70	793347	7964	2841	7744	2262	52	809353	7091	2406	7057	2116
3	Omiya Ardija	44	173986	2376	1246	2518	612	35	194912	2842	1384	2840	1044	43	158944	3059	1565	3046	1015
4	Yokohama F・Marinos	45	402270	4559	2210	4508	2462	50	408656	4909	1961	4674	2425	48	402593	4092	1290	4089	1426
5	Albirex Niigata	42	658050	2793	1248	2857	1304	51	650698	2661	1374	2953	1145	42	586325	2590	1208	2720	1043
6	Shimizu S-Pulse	60	243137	2986	1139	2978	912	61	271180	3180	1263	3166	1105	55	282190	3457	1484	3451	1241
7	Jubilo Iwata	58	306033	3717	1869	3939	956	49	278109	3594	1575	3515	1158	37	262911	3387	1657	3659	1343
8	Nagoya Grampus Eight	48	253702	3801	2313	4093	834	45	264939	3635	1770	3592	764	59	281442	4071	2005	3971	873
9	Kawasaki Frontale	67	243780	2780	1535	2765	996	54	294751	3105	1639	3096	1104	60	298597	3320	1743	3250	1075
10	Gamba Osaka	66	276395	3361	1623	3118	1281	67	296465	3212	1927	3304	1216	50	274169	4399	2304	4137	1255
11	F.C. Tokyo	43	409634	3299	1612	3355	883	45	429934	3347	1680	3581	703	55	437176	3433	1570	3562	833
12	JEF United Ichihara Chiba	44	227680	2887	1436	2752	751	42	240535	3112	1310	2692	1041	38	239436	3564	1612	3174	992
13	Sanfrecce Hiroshima	45	190066	2267	1414	2765	610	32	194199	2626	1236	2567	1088						
14	Oita Trinita	47	345955	1800	754	1892	1185	41	335896	2261	1283	2172	1047	56	345481	2184	1299	2177	754
15	Vissel Kobe							47	211822	1865	1317	2422	1012	47	220672	2026	1369	2505	829
16	Kashiwa Reysol							50	220442	3143	1693	3105	758	46	209229	2997	1694	3048	553
17	Kyoto Sanga FC	22	166280	2230	1072	3476	926							41	232671	2502	1334	2505	1577
18	Cerezo Osaka	27	221438	2108	1150	2318	314												
19	Ventforet Kofu	42	207629	1343	556	1102	553	27	233476	1655	741	1506	566						
20	Montedio Yamagata																		
21	Tokyo Verdy 1969													37	252231	4144	2622	4134	1844
22	Avispa Fukuoka	27	234259	1575	778	1682	558												
23	Yokohama F.C.							16	238662	1706	862	1861	474						
24	Vegalta Sendai																		
25	Consadole Sapporo													18	247305	1618	787	1770	1196
26	Shonan Bellmare																		

Poi = Points Awarded; Attend = Attendance; Reve = Revenue; Payro = Payroll; OC = Other Cost; TA = Total Assets

Table 3.3 (Continued)

		2009(18)						2010(18)					
OBS	Team Name	Poi	Attend	Reve	Payro	O C	T A	Poi	Attend	Reve	Payro	O C	T A
1	Kashima Antlers	66	367486	4408	1913	4303	2471	60	356430	4466	2004	4449	2561
2	Urawa Red Diamonds	52	751565	6432	2464	6358	1890	48	678994	5625	2282	5898	1450
3	Omiya Ardija	39	233013	3553	1954	3546	661	42	188088	3308	1850	3290	441
4	Yokohama F・Marinos	46	374975	3505	1165	3505	739	51	436624	3565	1374	3905	719
5	Albirex Niigata	50	568582	2418	1038	2470	1007	49	519221	2216	910	2341	897
6	Shimizu S-Pulse	51	304900	3514	1378	3378	1062	54	306022	3486	1498	3567	962
7	Jubilo Iwata	41	229891	3422	1582	3395	1011	44	206324	3151	1254	2901	948
8	Nagoya Grampus Eight	50	270773	4506	2350	4485	1072	72	339638	4103	2133	4198	797
9	Kawasaki Frontale	64	320394	3604	1951	3543	1097	54	315550	3540	1743	3493	1039
10	Gamba Osaka	60	301105	4078	2215	3939	1188	62	283111	3346	1773	3380	1037
11	F.C. Tokyo	53	440032	3763	1768	3731	951	36	426899	3671	1370	3274	1349
12	JEF United Ichihara Chiba	27	250413	2683	1552	3036	1519						
13	Sanfrecce Hiroshima	56	267299	2728	1313	2708	786	51	247550	2605	1372	2853	977
14	Oita Trinita	30	313281	1915	1345	2242	543						
15	Vissel Kobe	39	222153	2446	1545	2722	1441	38	218004	2035	1167	2275	913
16	Kashiwa Reysol	34	199552	2859	1580	2930	466						
17	Kyoto Sanga FC	41	189149	2416	1503	2596	1154	19	178673	2311	1308	2416	1269
18	Cerezo Osaka							61	255439	2554	1301	2528	724
19	Ventforet Kofu												
20	Montedio Yamagata	39	204953	1163	569	1136	286	42	199069	1229	787	1302	191
21	Tokyo Verdy 1969												
22	Avispa Fukuoka												
23	Yokohama F.C.												
24	Vegalta Sendai							39	294644	2041	858	1863	1152
25	Consadole Sapporo												
26	Shonan Bellmare							16	188614	1288	646	1342	354

Table 3.4 Yearly Input and Output Data in J2

		2006(13)						2007(13)						2008(15)					
OBS	Team Name	Poi	Attend	Reve	Payro	O C	T A	Poi	Attend	Reve	Payro	O C	T A	Poi	Attend	Reve	Payro	O C	T A
1	Consadole Sapporo	72	251476	1177	607	1527	983	91	290676	1255	537	1442	983						
2	Vegalta Sendai	77	346868	1609	792	1685	902	83	352432	1543	732	1601	777	70	295679	1421	606	1467	873
3	Montedio Yamagata	65	122042	665	393	657	179	58	101836	539	251	510	163	78	131725	626	392	716	173
4	Mito HollyHock	51	72405	341	141	338	124	34	57957	301	140	337	112	47	63933	349	159	361	116
5	Thespa Kusatsu	42	89670	586	162	535	116	42	91401	553	184	525	83	53	88510	544	196	528	98
6	Yokohama F.C.	93	122852	1195	523	1197	442							50	142655	1164	461	1292	306
7	Shonan Bellmare	49	128766	709	425	855	233	77	112254	970	504	970	288	65	125865	930	542	1062	392
8	Ventforet Kofu													59	217428	1263	587	1236	506
9	Tokushima Vortis	35	83452	636	220	620	496	33	78936	634	334	674	446	29	81093	638	280	651	456
10	Avispa Fukuoka							73	228702	1421	610	1385	439	58	211651	1157	559	1209	437
11	Sagan Tosu	79	179151	705	376	821	312	72	146731	572	377	775	201	64	152486	702	317	695	215
12	Kashiwa Reysol	88	199872	3244	2188	3462	756												
13	Tokyo Verdy 1969	71	136926	2143	1546	3015	591	89	175850	2672	1290	2662	669						
14	Ehime F.C.	53	99334	435	163	431	257	45	79619	466	185	466	241	37	77775	492	191	491	240
15	Cerezo Osaka							80	159044	2066	889	2045	486	69	221629	1940	824	1999	543
16	FC Gifu													42	78650	401	178	477	82
17	Roasso Kumamoto													43	110860	537	204	532	165
18	Tochigi SC																		
19	Kataller Toyama																		
20	Fagiano Okayama																		
21	Kyoto Sanga FC							86	159105	2125	1051	2085	822						
22	Vissel Kobe	86	165834	1362	1024	2030	2809												
23	Sanfrecce Hiroshima													100	227631	2287	1209	2534	810
24	Giravanz Kitakyushu																		
25	JEF United Ichihara Chiba																		
26	Oita Trinita																		

Poi = Points Awarded; Attend = Attendance; Reve = Revenue; Payro = Payroll; OC = Other Cost; TA = Total Assets

Table 3.4 (Continued)

		2009(18)						2010(19)					
OBS	Team Name	Poi	Attend	Reve	Payro	O C	T A	Poi	Attend	Reve	Payro	O C	T A
1	Consadole Sapporo	79	265376	1548	699	1683	1022	46	193280	1132	500	1366	840
2	Vegalta Sendai	106	336719	1529	711	1651	623						
3	Montedio Yamagata												
4	Mito HollyHock	73	66818	413	163	399	89	38	64949	366	152	380	82
5	Thespa Kusatsu	65	112584	536	182	550	150	48	79638	512	187	571	104
6	Yokohama F.C.	44	91898	966	330	966	381	54	104230	948	545	947	489
7	Shonan Bellmare	98	189088	1066	618	1178	521						
8	Ventforet Kofu	97	276463	1094	498	1080	463	70	223309	1067	473	1056	516
9	Tokushima Vortis	72	105897	759	342	771	517	51	83057	854	375	799	574
10	Avispa Fukuoka	65	194071	1006	479	1119	463	69	158777	938	401	925	440
11	Sagan Tosu	88	154408	676	313	755	233	51	119392	816	290	829	240
12	Kashiwa Reysol							80	145766	2743	1485	2698	1819
13	Tokyo Verdy 1969	74	143539	888	1044	2342	453	58	100297	718	347	1081	488
14	Ehime F.C.	47	96054	503	203	502	245	48	78945	472	216	495	218
15	Cerezo Osaka	104	247796	2241	1085	2319	622						
16	FC Gifu	62	107557	420	156	464	122	45	55950	519	186	505	81
17	Roasso Kumamoto	58	150150	616	226	613	108	54	124317	668	251	665	145
18	Tochigi SC	37	117643	580	247	627	126	50	74821	661	278	656	113
19	Kataller Toyama	61	93507	610	168	586	185	28	80327	573	199	593	156
20	Fagiano Okayama	36	154039	639	191	614	261	32	128900	695	282	669	232
21	Kyoto Sanga FC												
22	Vissel Kobe												
23	Sanfrecce Hiroshima												
24	Giravanz Kitakyushu							15	75393	495	169	493	89
25	JEF United Ichihara Chiba							61	210394	2306	1349	2622	1483
26	Oita Trinita							41	188340	1108	473	1018	216

Table 3.5 DEA Scores in J1

		2006(18)[a]		2007(18)[a]		2008(18)[a]		2009(18)[a]		2010(18)[a]	
OBS	Club Name	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1	Kashima Antlers	0.8417	0.8905	1.0000	1.0000	0.9885	1.0000	0.9851	1.0000	0.9035	1.0000
2	Urawa Red Diamonds	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9940	1.0000	0.9778	1.0000
3	Omiya Ardija	0.9433	0.9919	0.8776	0.8827	0.9260	0.9316	1.0000	1.0000	1.0000	1.0000
4	Yokohama F・Marinos	0.8430	0.9588	0.9684	0.9763	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	Albirex Niigata	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	Shimizu S-Pulse	1.0000	1.0000	1.0000	1.0000	0.9842	1.0000	1.0000	1.0000	0.9569	0.9970
7	Jubilo Iwata	0.9473	1.0000	0.9517	0.9520	0.8525	0.8617	0.9730	0.9736	1.0000	1.0000
8	Nagoya Grampus Eight	0.9488	1.0000	1.0000	1.0000	1.0000	1.0000	0.9854	1.0000	0.9801	1.0000
9	Kawasaki Frontale	0.9103	1.0000	0.9504	0.9698	0.9731	1.0000	0.9805	1.0000	0.9521	0.9724
10	Gamba Osaka	0.9363	1.0000	1.0000	1.0000	0.9584	1.0000	0.9985	1.0000	0.9391	0.9815
11	F.C. Tokyo	0.9755	1.0000	1.0000	1.0000	1.0000	1.0000	0.9856	1.0000	1.0000	1.0000
12	JEF United Ichihara Chiba	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8505	0.8516		
13	Sanfrecce Hiroshima	0.9144	1.0000	0.8891	0.9015			0.9744	1.0000	0.8673	0.8710
14	Oita Trinita	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8378	0.9682		
15	Vissel Kobe			0.9685	0.9955	0.8167	0.9327	0.8649	0.8668	0.8384	0.8441
16	Kashiwa Reysol			1.0000	1.0000	1.0000	1.0000	1.0000	1.0000		
17	Kyoto Sanga FC	0.7482	0.8114			0.9355	0.9610	0.8965	0.8979	0.8531	0.8731
18	Cerezo Osaka	1.0000	1.0000							0.9958	1.0000
19	Ventforet Kofu	1.0000	1.0000	1.0000	1.0000						
20	Montedio Yamagata							1.0000	1.0000	1.0000	1.0000
21	Tokyo Verdy 1969					0.8927	0.9222				
22	Avispa Fukuoka	0.9155	0.9525								
23	Yokohama F.C.			0.9493	1.0000						
24	Vegalta Sendai									1.0000	1.0000
25	Consadole Sapporo					0.9021	1.0000				
26	Shonan Bellmare									0.9623	1.0000

[a] the number in brackets following each year is the number of teams playing in J1 in that year.

Table 3.6 DEA Scores in J2

		2006(13)[a]		2007(13)[a]		2008(15)[a]		2009(18)[a]		2010(19)[a]	
OBS	Club Name	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS	CRS	VRS
1	Consadole Sapporo	0.7520	0.9293	1.0000	1.0000			0.8836	1.0000	0.8223	0.9840
2	Vegalta Sendai	0.9336	1.0000	1.0000	1.0000	0.9581	1.0000	0.8909	1.0000		
3	Montedio Yamagata	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000				
4	Mito HollyHock	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	Thespa Kusatsu	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9923	1.0000	1.0000	1.0000
6	Yokohama F.C.	0.9176	1.0000			0.9097	1.0000	0.9607	1.0000	0.9367	0.9471
7	Shonan Bellmare	0.8122	0.8821	0.9466	1.0000	0.8500	0.8791	0.8696	0.9707		
8	Ventforet Kofu					0.9952	1.0000	1.0000	1.0000	1.0000	1.0000
9	Tokushima Vortis	0.9365	0.9506	0.8900	0.8965	0.9512	0.9532	0.9457	0.9573	1.0000	1.0000
10	Avispa Fukuoka			0.9720	1.0000	0.9357	1.0000	0.8637	0.8873	0.9907	1.0000
11	Sagan Tosu	1.0000	1.0000	0.9958	1.0000	1.0000	1.0000	0.9099	1.0000	0.9972	1.0000
12	Kashiwa Reysol	0.8555	1.0000							0.9341	1.0000
13	Tokyo Verdy 1969	0.7178	0.8649	0.9511	1.0000			0.3732	0.4738	0.7429	0.8333
14	Ehime F.C.	1.0000	1.0000	1.0000	1.0000	0.9726	0.9847	0.9635	0.9653	0.9823	1.0000
15	Cerezo Osaka			0.9575	1.0000	0.9419	1.0000	0.9310	1.0000		
16	FC Gifu					1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
17	Roasso Kumamoto					1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	Tochigi SC							0.9069	0.9127	0.9683	1.0000
19	Kataller Toyama							1.0000	1.0000	0.9998	1.0000
20	Fagiano Okayama							1.0000	1.0000	1.0000	1.0000
21	Kyoto Sanga FC			0.9643	1.0000						
22	Vissel Kobe	0.6125	0.6832								
23	Sanfrecce Hiroshima					0.8760	1.0000				
24	Giravanz Kitakyushu									1.0000	1.0000
25	JEF United Ichihara Chiba									0.8080	1.0000
26	Oita Trinita									1.0000	1.0000

[a] the number in brackets following each year is the number of teams playing in J2 in that year

Table 3.7 Malmquist Index including both Efficiency change and Technical change in J1

		Changes in 2007 compared to 2006			Changes in 2008 compared to 2007		
OBS	Teams	Efficiency change	Technical change	Malmquist Index	Efficiency change	Technical change	Malmquist Index
1	Kashima Antlers	1.1880	0.9200	1.0929	0.9885	0.9710	0.9599
2	Urawa Red Diamonds	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	Omiya Ardija	0.9304	0.9847	0.9162	1.0551	0.9692	1.0226
4	Yokohama F・Marinos	1.1488	0.9679	1.1119	1.0326	0.9841	1.0162
5	Albirex Niigata	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	Shimizu S-Pulse	1.0000	0.9946	0.9946	0.9842	1.0080	0.9921
7	Jubilo Iwata	1.0046	0.9881	0.9926	0.8958	0.9741	0.8726
8	Nagoya Grampus Eight	1.0540	0.9835	1.0366	1.0000	1.0000	1.0000
9	Kawasaki Frontale	1.0441	0.9298	0.9708	1.0239	1.0135	1.0376
10	Gamba Osaka	1.0680	0.9017	0.9630	0.9584	1.0442	1.0008
11	F.C. Tokyo	1.0251	0.9877	1.0125	1.0000	1.0000	1.0000
12	JEF United Ichihara Chiba	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	Sanfrecce Hiroshima	0.9724	0.9563	0.9300			
14	Oita Trinita	1.0000	0.9298	0.9298	1.0000	1.0000	1.0000
15	Vissel Kobe				0.8433	1.1926	1.0057
16	Kashiwa Reysol				1.0000	1.0074	1.0074
17	Kyoto Sanga FC						
18	Ventforet Kofu	1.0000	1.0000	1.0000			
19	Montedio Yamagata						
	Mean	1.0290	0.9696	0.9967	0.9855	1.0109	0.9943
	Maximum	1.1880	1.0000	1.1119	1.0551	1.1926	1.0376
	Minimum	0.9304	0.9017	0.9162	0.8433	0.9692	0.8726

Table 3.7 (Continued)

OBS	Teams	Changes in 2009 compared to 2008			Changes in 2010 compared to 2009		
		Efficiency change	Technical change	Malmquist Index	Efficiency change	Technical change	Malmquist Index
1	Kashima Antlers	0.9966	1.0014	0.9980	0.9171	1.0662	0.9778
2	Urawa Red Diamonds	0.9940	1.0030	0.9970	0.9837	0.9816	0.9656
3	Omiya Ardija	1.0799	0.9794	1.0576	1.0000	1.0000	1.0000
4	Yokohama F・Marinos	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	Albirex Niigata	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	Shimizu S-Pulse	1.0160	1.0001	1.0161	0.9569	1.0034	0.9601
7	Jubilo Iwata	1.1414	0.9630	1.0992	1.0277	1.0124	1.0405
8	Nagoya Grampus Eight	0.9854	0.9910	0.9766	0.9946	1.0170	1.0116
9	Kawasaki Frontale	1.0077	0.9877	0.9952	0.9710	1.0243	0.9946
10	Gamba Osaka	1.0418	0.9616	1.0018	0.9406	1.0249	0.9640
11	F.C. Tokyo	0.9856	1.0332	1.0183	1.0146	0.9928	1.0073
12	JEF United Ichihara Chiba	0.8505	1.0006	0.8511			
13	Sanfrecce Hiroshima				0.8902	1.0077	0.8971
14	Oita Trinita	0.8378	1.1054	0.9261			
15	Vissel Kobe	1.0589	1.0028	1.0619	0.9694	1.0447	1.0127
16	Kashiwa Reysol	1.0000	1.0000	1.0000			
17	Kyoto Sanga FC	0.9583	0.9719	0.9313	0.9516	1.0609	1.0095
18	Ventforet Kofu						
19	Montedio Yamagata				1.0000	1.0000	1.0000
	Mean	0.9971	1.0001	0.9956	0.9745	1.0157	0.9894
	Maximum	1.1414	1.1054	1.0992	1.0277	1.0662	1.0405
	Minimum	0.8378	0.9616	0.8511	0.8902	0.9816	0.8971

Table 3.8 Malmquist Index including both Efficiency change and Technical change in J2

		Changes in 2007 compared to 2006			Changes in 2008 compared to 2007		
OBS	Teams	Efficiency change	Technical change	Malmquist Index	Efficiency change	Technical change	Malmquist Index
1	Consadole Sapporo	1.3298	0.8879	1.1807			
2	Vegalta Sendai	1.0711	0.9595	1.0277	0.9581	1.0216	0.9788
3	Montedio Yamagata	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	Mito HollyHock	1.0000	1.0000	1.0000	1.0000	1.0052	1.0052
5	Thespa Kusatsu	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	Yokohama F.C.						
7	Shonan Bellmare	1.1655	1.0029	1.1689	0.8979	0.9751	0.8755
8	Ventforet Kofu						
9	Tokushima Vortis	0.9504	0.9633	0.9155	1.0687	0.9756	1.0426
10	Avispa Fukuoka				0.9627	0.9722	0.9360
11	Sagan Tosu	0.9958	1.0021	0.9979	1.0043	1.0028	1.0071
12	Tokyo Verdy 1969	1.3250	1.0128	1.3420			
13	Ehime F.C.	1.0000	0.9685	0.9685	0.9726	1.0019	0.9744
14	Cerezo Osaka				0.9837	0.9766	0.9607
15	FC Gifu						
16	Roasso Kumamoto						
17	Tochigi SC						
18	Kataller Toyama						
19	Fagiano Okayama						
	Mean	1.0838	0.9797	1.0601	0.9848	0.9931	0.9780
	Maximum	1.3298	1.0128	1.3420	1.0687	1.0216	1.0426
	Minimum	0.9504	0.8879	0.9155	0.8979	0.9722	0.8755

Table 3.8 (Continued)

		Changes in 2009 compared to 2008			Changes in 2010 compared to 2009		
OBS	Teams	Efficiency change	Technical change	Malmquist Index	Efficiency change	Technical change	Malmquist Index
1	Consadole Sapporo				0.9305	0.9866	0.9181
2	Vegalta Sendai	0.9299	1.0457	0.9723			
3	Montedio Yamagata						
4	Mito HollyHock	1.0000	1.0000	1.0000	1.0000	0.9836	0.9836
5	Thespa Kusatsu	0.9923	1.0039	0.9962	1.0077	0.9782	0.9858
6	Yokohama F.C.	1.0560	1.0390	1.0971	0.9750	0.9931	0.9683
7	Shonan Bellmare	1.0231	1.0129	1.0363			
8	Ventforet Kofu	1.0048	1.0069	1.0117	1.0000	0.9853	0.9853
9	Tokushima Vortis	0.9942	1.0103	1.0045	1.0574	0.9781	1.0343
10	Avispa Fukuoka	0.9230	1.0196	0.9411	1.1470	0.9837	1.1283
11	Sagan Tosu	0.9099	1.0593	0.9638	1.0960	0.9296	1.0188
12	Tokyo Verdy 1969				1.9906	0.9078	1.8071
13	Ehime F.C.	0.9907	1.0172	1.0077	1.0195	0.9482	0.9667
14	Cerezo Osaka	0.9884	1.0075	0.9959			
15	FC Gifu	1.0000	1.0645	1.0645	1.0000	1.0000	1.0000
16	Roasso Kumamoto	1.0000	1.0046	1.0046	1.0000	1.0000	1.0000
17	Tochigi SC				1.0676	0.9678	1.0333
18	Kataller Toyama				0.9998	0.9899	0.9897
19	Fagiano Okayama				1.0000	1.0000	1.0000
	Mean	0.9856	1.0224	1.0074	1.0861	0.9755	1.0546
	Maximum	1.0560	1.0645	1.0971	1.9906	1.0000	1.8071
	Minimum	0.9099	1.0000	0.9411	0.9305	0.9078	0.9181

Table 3.9 (2007) Technical Change in J1

OBS	TEAM NAME	$E_{2006}(y_{2006}, x_{2006})$	$E_{2007}(y_{2007}, x_{2007})$	$E_{2007}(y_{2006}, x_{2006})$	$E_{2006}(y_{2007}, x_{2007})$
1	Kashima Antlers	0.84	1.00	0.90	0.91
2	Urawa Red Diamonds	1.00	1.00	1.00	1.00
3	Omiya Ardija	0.94	0.88	1.00	0.90
4	Yokohama F・Marinos	0.84	0.97	0.88	0.95
5	Albirex Niigata	1.00	1.00	1.00	1.00
6	Shimizu S-Pulse	1.00	1.00	1.00	0.99
7	Jubilo Iwata	0.95	0.95	0.98	0.96
8	Nagoya Grampus Eight	0.95	1.00	0.98	1.00
9	Kawasaki Frontale	0.91	0.95	1.00	0.90
10	Gamba Osaka	0.94	1.00	1.00	0.87
11	F.C. Tokyo	0.98	1.00	1.00	1.00
12	JEF United Ichihara Chiba	1.00	1.00	1.00	1.00
13	Sanfrecce Hiroshima	0.91	0.89	1.00	0.89
14	Oita Trinita	1.00	1.00	1.00	0.86
15	Ventforet Kofu	1.00	1.00	1.00	1.00

References

Athanassopoulos, A. D., & Shale, E. (2006). Assessing the Comparative Efficiency of Higher Education Institutions in the UK by Means of Data Envelopment Analysis. Education Economics, 5 (2), 117-134

Barros, C. P., & Santos, A. (2003). Productivity in Sports Organizational Training Activities: A DEA Study. European Sport Management Quarterly, 3, 46-65

Barros, C. P. (2005). Evaluating the Efficiency of a Small Hotel Chain with A Malmquist Productivity Index. International Journal of Tourism Research, 7, 173–184

Barros, C. P., & Leach, S. (2006). Performance Evaluation of the English Premier Football League with Data Envelopment Analysis. Applied Economics, 38, 1449–1458

Barros, C. P., Assaf, A., & Sá-Earp, F. (2010). Brazilian Football League Technical Efficiency: A Simar and Wilson Approach. Journal of Sports Economics, 11(6), 641-651

Barros, C. P., & Alves, C. (2004). An Empirical Analysis of Productivity Growth in A Portuguese Retail Chain Using Malmquist Productivity Index. Journal of Retailing and Consumer Services, 11, 269–278

Barros, C. P., & Leach, S. (2006). Analyzing the Performance of the English F.A. Premier League With An Econometric Frontier Model. Journal of Sports Economics, 7(4), 391–407

Bjurek, H. (1996). The Malmquist Total Factor Productivity Index. The Scandinavian Journal of Economics, 98 (2), 303-313

Casu, B., Girardone, C., & Molyneux, P. (2004). Productivity Change in European Banking: A Comparison of Parametric and Non-parametric Approaches. Journal of Banking & Finance, 28, 2521–2540

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. European Journal of Operational Research, 2, 429-444.

Cooper, W.W., Ruiz, J. L., & Sirvent, I. (2009). Selecting Non-zero Weights to Evaluate Effectiveness of Basketball Players with DEA. European Journal of Operational Research, 195(2), 563-574

Cooper, W. W., Seiford, L. M., & Zhu, J. (2004). Handbook On Data Envelopment Analysis. Boston : Kluwer Academic

Coelli, T. J., & Prasada Rao, D. S. (2005). Total Factor Productivity Growth in Agriculture: A Malmquist Index Analysis of 93 Countries, 1980–2000. Agricultural Economics, 32, 115–134

Coelli, T. J., Prasada Rao, D.S., O'Donnell C. J., & Battese, G. E. (2005). An Introduction to Efficiency and Productivity Analysis. Springer Science and Business Media Inc.

Einolf, K. W. (2004). Is Winning Everything? : A Data Envelopment Analysis of Major League Baseball and the National Football. Journal of Sports Economics, 5 (2), 127–151

Ersoy, K., Kavuncubasi, S., Ozcan, Y. A., & Harris II, J. M. (1997). Technical Efficiencies of Turkish Hospitals: DEA Approach. Journal of Medical Systems, 21(2), 67-74

Espitia-Escuer, M., & Garcia-Cebian, L. I. (2004). Measuring the Efficiency of Spanish First-Division Soccer Teams. Journal of Sports Economics, 5 (4), 329–346

Espitia-Escuer, M., & García-Cebrián, L. I. (2008). Measuring the Productivity of Spanish First Division Soccer Teams. European Sport Management Quarterly, 8(3), 229-246

Estache, A., Tovar de la Fe´, B., & Trujillo, L. (2004). Sources of Efficiency Gains in Port Reform: A DEA Decomposition of A Malmquist TFP Index for Mexico. Utilities Policy, 12, 221–230

Flegg, A.T., Allen, D.O., Field, K., & Thurlow. T.W. (2004). Measuring the Efficiency of British Universities: A Multi-period Data Envelopment Analysis. Education Economics, 12(3), 231-249

Fried, H. O., Lambrinos, J., & Tyner, J. (2004). Evaluating the Performance of Professional Golfers on the PGA, LPGA and SPGA Tours. European Journal of Operational Research, 154,548–561

García-Sánchez, I. M. (2007). Efficiency and Effectiveness of Spanish Football Teams: A Three-Stage-DEA Approach. Central European Journal of Operations Research, 15, 21-45

González-Gómez, F., & Picazo-Tadeo, A. J. (2010). Can We Be Satisfied With Our Football Team? Evidence from Spanish Professional Football. Journal of Sports Economics, 11(4), 418-442

Guzmán, I., & Morrow, S. (2007). Measuring Efficiency and Productivity in Professional Football Teams: Evidence From the English Premier League. Central European Journal of Operations Research, 15(4), 309-328

Guzmán, I. (2006). Measuring Efficiency and Sustainable Growth in Spanish Football Teams. European Sport Management Quarterly, 6(3), 267-287

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

Haas, D., Kocher, M. G., & Slitter, M. (2004). Measuring Efficiency of German Football Teams by Data Envelopment Analysis. Central European Journal of Operations Research, 12, 251-268

Haas, D. J. (2003). Productive Efficiency of English Football Teams: A Data Envelopment Analysis Approach. Managerial and Decision Economics, 24(5), 403-410

Howard, L. W., & Miller, J. L. (1993). Fair Pay for Fair Play: Estimating Pay Equity in Professional Baseball with Data Envelopment, 36 (4), 882-894

Nkamleu, G. B. (2004). Productivity Growth, Technical Progress and Efficiency Change in African Agriculture. African Development Review, 16 (1), 203–222

Ohkusa, Y. (2001). An Empirical Examination of the Quit Behavior of Professional Baseball Players in Japan. Journal of Sports Economics, 2, 80-88

Osei, D., d'Almeida, S., George, M. O., Kirigia, J. M., Mensah, A. O., & Kainyu, L. H. (2005). Technical Efficiency of Public District Hospitals and Health Centers in Ghana: A Pilot Study. Cost Effectiveness and Resource Allocation, 3(1), 1-13

Ramanathan, R. (2003). An Introduction to Data Envelopment Analysis: A Tool for Performance Management. SAGE Publications Inc New Delhi

Sathye, M. (2002). Measuring Productivity Change in Australian Banking: An Application of Malmquist Indices. Managerial Finance, 28(9), 48-59

Stanton, K. R. (2002). Trends in Relationship Lending and Factors Affecting Relationship Lending Efficiency. Journal of Banking and Finance, 26, 127-152

Simar, L., & Wilson, P. W. (2007). Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes. Journal of Econometrics, 136, 31–64

Simar, L., & Wilson, P. W. (2011). Two-stage DEA: Caveat Emptor. Journal of Productivity Analysis, 36, 205-218

Simar, L., & Wilson, P. W. (1999). Estimating and Bootstrapping Malmquist Indices. European Journal of Operational Research, 115, 459-471

Thirtle, C., Piesse, J., & Turk, J. (1996). The Productivity of Private and Social Farms: Multilateral Malmquist Indices for Slovene Dairying Enterprises. The Journal of Productivity Analysis, 7, 447-460

Umetsu, C., Lekprichakul, T., & Chakravorty, U. (2003). Efficiency and Technical Change in the Philippine Rice Sector: A Malmquist Total Factor Productivity Analysis. American Journal of Agricultural Economics, 85 (4), 943-963.

Appendix:

Primal and Dual Problems in DEA

Observe that if we have two valid inequalities

$$a \leq b \text{ and } c \leq d$$

Then we can deduce that the inequality

$$a + c \leq b + d$$

In fact, we also scale the inequalities by a positive multiplicative factor before adding them up, so for every nonnegative value$y_1, y_2 \geq 0$ we also have

$$y_1 a + y_2\, c \leq y_1 b + y_2\, d$$

Suppose we have a maximization linear program in standard form.

The transformation from Primal problem to Dual problems with optimization in DEA can be shown as

$$\max \sum_{r=1}^{s} \mu_r y_{ro}$$

$$\max_{\mu_o} \ \mu_1 y_{1o} + \mu_2 y_{2o} \cdots + \mu_s y_{so}$$

$$\min_{\mu_o} \ -(\mu_1 y_{1o} + \mu_2 y_{2o} \cdots + \mu_s y_{so})$$

S. t.

$$(\mu_1 y_{11} + \mu_2 y_{21} \cdots + \mu_s y_{s1}) - (v_1 x_{11} + v_2 x_{21} \cdots + v_m x_{m1}) \leq 0$$

$$\vdots$$

$$(\mu_1 y_{1n} + \mu_2 y_{2n} \cdots + \mu_s y_{sn}) - (v_1 x_{1n} + v_2 x_{2n} \cdots + v_{mn}) \leq 0$$

$$v_1 x_{1o} + v_2 x_{2o} \cdots + v_m x_{mo} - 1 = 0$$

$$\mu_1, \mu_{2,} \cdots \mu_s \geq 0 \ \ v_1, v_{2,} \cdots v_m \geq 0$$

$$\max_{\theta} \ \min - (\ \mu_1 y_{1o} + \mu_2 y_{2o} \cdots + \mu_s y_{so})$$

$$+\lambda_1[(\mu_1 y_{11} + \mu_2 y_{21} \cdots + \mu_s y_{s1}) - (v_1 x_{11} + v_2 x_{21} \cdots + v_m x_{m1})] + \cdots$$

$$+\lambda_2[(\mu_1 y_{1n} + \mu_2 y_{2n} \cdots + \mu_s y_{sn}) - (v_1 x_{1n} + v_2 x_{2n} \cdots + v_{mn})] +$$

$$\theta(v_1 x_{1o} + v_2 x_{2o} \cdots + v_m x_{mo} - 1)$$

$$\max_{\theta} \min_{\mu_i} \mu_1(y_{11}\lambda_1 + \cdots + y_{1n}\lambda_n - y_{1o}) + \cdots + \mu_2(y_{s1}\lambda_1 + \cdots + y_{sn}\lambda_n - y_{sn})$$

$$+v_1(\theta x_{1o} - x_{11}\lambda_1 - \cdots - x_{1n}\lambda_n) + \cdots + v_m(\theta x_{mo} - x_{m1}\lambda_1 - \cdots - x_{mn}\lambda_n) - \theta$$

$$\max_{\theta} - \ \theta = \min \theta$$

$$\text{s. t.} \ \sum_{j=1}^{n} x_{ij}\lambda_j \ \leq \ \theta x_{io} \ \ (i = 1,2, \cdots, m)$$

$$\sum_{j=1}^{n} y_{rj}\lambda_j \geq y_{ro} \quad (r = 1,2,\cdots,s)$$

$$\lambda_j \geq 0 \quad (j = 1,2,\cdots,n)$$