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Management Efficiency of Sport Centers Based on the Provision of Public Sports Viewpoint

Wen-Bin Lin
Taipei National University of the Arts
Richard Hsiao
Indiana University of Pennsylvania
Shao-Wei Yeh
Hunan University of Technology and Business

Abstract

This study used cross-domain research in efficiency, productivity, and sports management to investigate the management efficiency in integrating Taipei sports centers with government units, thus highlighting the importance of the public issues of sports policy and exercise, a literature review revealed a research gap involving a lack of performance assessment of those sports centers. There were two major findings: (1) The research context of "data envelopment analysis" (DEA) and "two-stage" analysis could determine efficiency factors that affected decision-making units (DMUs) in the use of research methods for measuring truncated data or censored data models (truncated regression, Tobit model); and (2) A "metafrontier model" was used to assess metafrontier efficiency for investigating the meta-technology ratios (MTRs) between different environment levels. In the second phase, truncated regression was used to investigate the environmental variables that affected operational efficiency. In the third phase, the concept of the metafrontier was used to determine MTRs. The research results provided various types of efficiency analyses of Taipei sports centers, environmental variables that affected the management efficiency of those sports centers, and MTRs. The study concluded that it is expected that the cross-domain application of performance assessment research on the public issue of sports will be able to identify and develop directions and topics in the field of diversified sports-management research.

Keywords: **efficiency and productivity, truncated regression, dummy variables, environmental vari-ables, metafrontier**

Wen-Bin Lin is with the Physical Education Center, Taipei National University of the Arts, Taiwan. Richard Hsiao is with the Department of Kinesiology, Health and Sport Science, Indiana University of Pennsylvania, Indiana, PA. Shao-Wei Yeh is with the Department of Physical Education & Research, Hunan University of Technology and Business, China. Address author correspondence to Wen-Bin Lin at winbeing@ccnia.tnua.edu.tw.

1.Introduction

At the end of August 2010, the Taipei City Government formally announced the completion of the one-sports-center-per-district sports map that had been planned over a 10-year period. According to the Taipei City Government, Department of Budget, Accounting, and Statistics (2011), the 12 Taipei sports centers had attendance of up to 10 million people (with an average monthly attendance of up to 880,000 people) at of the end of 2010. This project not only enhanced residents' demand for sports and recreation and activated public interest and welfare but also created industrial competitive advantages. This project can be described as the display of a winning policy for the city government, residents, and industry. Currently, the 12 Taipei sports centers have adopted a public-private operate-and-transfer (OT) model. The city government builds sports complexes and entrusts their daily management to the private sector, while providing supplemental features such as charitable activities, low prices, and diversified services to attract residents' participation and to achieve the goal of increasing the number of people who exercise regularly. The Ministry of Education, Sports Administration (2014) has noted that in addition to the 12 sports centers built in Taipei City's administrative districts, 6 sports centers were then built in New Taipei City, for a total of 18 different sports centers. Unlike in the past, when domestic sports complexes were government-operated, Taipei sports centers now operate pursuant to an outsourced model. Exceptional private-sector businesses were selected through open bidding to operate and manage these sports centers pursuant to a contract; those businesses unleashed their effectiveness, improving the government's past plight in operating the sport complexes.

In the future, the operation and management of civil sports centers will become an important issue. The 12 Taipei sports centers and the Xinzhuang Civil Sports Center in New Taipei City were built entirely by county and city governments, whereas the others were built with subsidies from the Ministry of Education, Sports Administration. The Ministry of Education, Sports Administration will handle advance work such as preliminary planning, design, and assessment of the feasibility of promoting participation for 32 civil sports centers in Keelung City, New Taipei City, Taoyuan County, Hsinchu City, Hsinchu County, Taichung City, Changhua County, Yunlin County, Chiayi City, Tainan City, Kaohsiung City, Pingtung City, and Yilan County (Ministry of Education, Sports Administration, 2014). The successful development of these sports centers is attracting a great deal of attention. From the perspective of the government units involved in operations, the research with the most practical and useful value related to performance assessment includes Benito, Solana, and Moreno's (2012) efficiency assessment of Spanish cities' provision of public sports facilities, Kung and Taylor's (2010) investigation of the performance management of sports centers in the United Kingdom, and Liu, Taylor, and Shibli's (2007) measurement of the operation and management of 105 sports complexes and swimming pools in the United Kingdom in 2001. It might be said that few studies are in line with the aforementioned topic and

that there is a relative lack of related studies. In reality, provided the management unit builds an efficient operating and management system, makes good use of organizational resources, acts in concert with opportunities for change and with the pulse of the times, and uses a performance-assessment system to manage people, matters, effectively, then the efficient operation and sustainable management development of sports centers can be achieved regardless of which type of operating mode is used (build-operate-transfer (BOT), build-transfer (BT), build-transfer-operate (BTO), rehabilitate-operate-transfer, build-own-operate (BOO), build-lease-transfer (BLT), etc.). Accordingly, the implementation of scientific management and the provision of effective analytical results and correct sequential implications have positive meaning.

The four major functions of management studies include the following: planning, organization, leadership and control. The concept and application of "efficiency and productivity" belong to the functional category of "control": they have already been used broadly in all types of fields and industries because of their powerful effect and function in practical use (Cooper, Seiford, & Tone, 1999; Emrouznejad, & Yang, 2018). The use of efficiency and productivity in investigating and developing the field of sports is equally impressive (Lewis, Lock, & Sexton, 2009). Efficiency has been explored in baseball (Lewis & Sexton, 2004a, 2004b; Lewis et al., 2009; Lin, & Chen, 2015; Lin, Hsu, Chen, & Chen, 2016; Lin, Yeh, & Yang, 2015; Sexton & Lewis, 2003; Volz, 2009), basketball (Beaulier, & Elder, 2011; Cooper, Ruiz, & Sirvent, 2009; McGoldrick, & Voeks, 2005; Rimler, Song, & Yi, 2010), soccer (Carmichael, & Thomas, 2008; Espitia-Escuer, & García-Cebrián, 2004; González-Gómez, & Picazo-Tadeo, 2010; Guzmán, 2006; Haas, 2003; Barros, Assaf, & Sá-Earp, 2010), golf (Fried, Lambrinos, & Tyner, 2004), American football (Einolf, 2004; Hersch, 2012), and the participating countries of mega sport events especially the Summer Olympic Games (Li, Liang, Chen, & Morita, 2008; Lin, 2010; Lin, 2015; Lins, Gomes, Soares de Mello, & Soares de Mello, 2003; Lozano, Villa, Guerrero, & Cortés, 2002; Percy, 2019; Wu, Liang, & Chen, 2009; Wu et al., 2009). The topics for investigation had become broad, and the level of application had become increasingly deep, highlighting the urgent need for development in the field of the efficiency and productivity of sports.

Research methods and concepts continue to evolve and develop. We observe the recent use of economic production theory and mathematical and statistical tools to conduct a deduction and estimation of the production frontier, thus measuring the methodology of decision-making units (DMUs) of productivity and presenting an extensive interdisciplinary reference. The evolutionary context of efficiency and productivity research is particularly worthy of continuous tracking and investigating by the field of sports management to identify the appropriate research direction, topics, and discourse. Through continuous observation and literature review, this study discovered that recent research applications in the field of efficiency and productivity involved two major research contexts and findings.

Simar and Wilson (2007) have found 801 stud-

ies related to "data envelopment analysis" (DEA) and "two-stage" analysis via Internet keyword search and 537 studies in the keyword search for "data envelopment analysis" and "Tobit." The number of related studies was very impressive, indicating this research context was flourishing and developing. However, from a methodological perspective, Simar and Wilson (2007) note that truncated regression must be used in place of Tobit regression to measure truncated data or censored data models. Only thus could the parameterized form of the likelihood function be overcome (because DEA is a non-parametric method) and the occurrence of assumption errors and the generation of inconsistent estimation be avoided. In the literature review, two important articles investigated and played a significant role in modeling the "environmental variables" that affected the subject of this study. Barros et al. (2010) have investigated the topic of competitive efficiency in professional soccer teams, whereas Benito et al. (2012) have used Spanish cities' provision of public sports facilities as the subject of research to perform an efficiency assessment on sport facilities in the public domain.

According to Farrell's (1957) original view, the concept of a metafrontier meant that manufacturers belonging to the same technology set were confronted by the same production frontier, and thus, productive efficiency could be measured by the radial distance ratio between the actual production level and the potential production level at the production frontier, allowing for cross-manufacturer comparisons. However, because individual DMUs belong to different technology sets, when confronted by different production frontiers and using efficiencies represented by the distance ratios, it would be impossible to make mutual comparisons because of inconsistent benchmarks. Therefore, Battese, Rao, and O'Donnell (2004) have proposed an estimation architecture using a metafrontier production function to overcome this restriction. They use the metafrontier of stochastic frontier analysis (SFA) in linear programming modeling to allow for comparative analysis of DMUs' efficiency based on the metafrontier. Subsequently, the distance function was converted into a metafrontier production function, and the estimation architecture of a deterministic non-parametric method (DEA) was described that further extended the concept of the metafrontier to the field of measuring the total factor productivity (TFP) index. Recently, methods using the metafrontier assessment of efficiency have received increasing attention (Battese et al., 2004; O'Donnell, Rao, & Battese, 2007). The metafrontier concept originated from an economic model. Therefore, the current status of research development is most advanced in the field of economics, followed by gradual entry into production and job management; leisure, recreation, and hospitality management; energy research; transportation research; banking operations; and other finance-related application fields and disciplines. In the field of sports management, Lin and Chen (2012) have used the metafrontier to investigate the competition efficiency of World Baseball Classic teams, comparing the efficiency frontier of the teams eliminated in the first round with the metafrontier of all participating teams, obtaining the technology gap ratios (TGRs), and proposed relevant recommendations worthy of continuing

follow-up research.

In summary, through its literature review, this study applied cross-domain efficiency and productivity to research in the field of sports management, imported research trends in national sports policy and public exercise topics, and found research gaps. Ultimately, three major phases in the management efficiency of Taipei sports centers were collected, organized, and measured.

2.The present study

2.1 Truncated regression

Benito et al. (2012) used Spanish cities' provision of public sports facilities as the subject of research to obtain an efficiency assessment of physical facilities in the public domain was published in the International Journal of Sport Finance. These studies had research value and served as a reference model for the so-called "environmental variables" under investigation in this study.

Hersch (2012) uses ordinary least squares (OLS) to determine team efficiency value and then conducts a truncated regression to investigate the effect of head coach replacements and player drafts on American professional football teams. The dummy variables used by Hersch (2012) included applications from hotel management and other leisure, tourism, and hospitality fields, providing this study with a foundational reference for investigating sports centers' environmental variables. In reality, truncated regression is already commonly applied in production and job management; leisure, recreation, and hospitality management; efficiency and productivity; and other fields.

2.2 The metafrontier model

Assaf (2009) uses a metafrontier model to analyze the technical efficiency of large and small airports in the United Kingdom, finding both that the efficiency of various types of airports showed a progressive increase and that large airports were often more technologically efficient and less wasteful than small airports. In addition, the factors of the airport's size and location, use of technology, and amount of capital affected efficiency. Kontolaimou and Tsekouras' (2010) survey of European commercial banks uses a metafrontier methodology both to discern technology gaps of various types of banks and to decompose the key elements in their input and output. That study's results show that cooperative banks were closest to the metafrontier of European banks, a dichotomy seemed to have evolved in the common banking type, and a technology gap emerged in the output cost. Assaf, Barros, and Josiassen (2010) use the concept of the metafrontier to investigate environmental factors and technological changes related to various types of hotels. Various types of hotels (according to their composition) were compared based on homogeneous technology using longitudinal data from 78 hotels in Taiwan. The study's results clearly indicate that hotels' size, ownership, and classification had an important impact on efficiency. The so-called TGR is between the group frontier corresponding to the actual production point and the metafrontier. An expansion of the TGR corresponds to a reduction in the technology gap.

2.3 Sports centers

This study aims to investigate the management performance of sports centers. The most relevant study is that of Benito et al. (2012), which uses Spanish cities' provision of public sports facilities as the research subject to perform an efficiency assessment on physical facilities in the public domain. This study used one input indicator—total cost of sports (per capita cost according to cost subfunction, including physical education, sports, and recreation)—and two output indicators—one indicator for the total surface area of the municipalities' indoor and outdoor sports complexes (surface area in square meters per capita of all of the sports installations (indoor and outdoor) owned by each municipality) and another indicator for the conservation and appropriateness of service at public sports facilities (an index built from the survey on the suitability of the service that indicates the sports installations' state of conservation). The five environmental variables investigated by this study were as follows: per capita income, comparative index of each municipality's importance to tourism, comparative index for the entirety of each municipality's economic activity, population density by urban area, and the party in power in each municipality. The importance of the public issues of sports policy and exercise were clear.

Liu et al. (2007) uses output-oriented DEA to select data from the United Kingdom National Benchmark Service database, screening operational costs, operational hours, and indoor surface area as three input variables and operational income and number of visitors as output variables. One-hundred-and-five sports complexes and swimming pools were measured in 2001; indoor surface area was viewed as a non-discretionary factor. In addition, four factors that affected efficiency value were divided into various types: (1) Complex type (divided into three categories: dry, wet, and a combination of wet and dry); (2) Complex location (divided into three areas by the ratio of the number of semi-skilled or unskilled labor); (3) Complex size (divided into three categories: less than 1,500 square meters, between 1,500 and 3,000 square meters, and 3 larger than 3,000 square meters); and (4) Management type (divided into four types: self-management and direct service, a commercial contracts system, a non-profit organization entrusted with management, and school-based management). Empirical results indicated both that management type was a significant factor in influencing management efficiency and that the efficiency value of complexes with outsourced management was better than the efficiency value of complexes with self-management.

Kung and Taylor (2010) use data on sports centers from the United Kingdom National Benchmark Service, including various categories of indicators at each center such as users, financial performance, rate of use, and degree of customer satisfaction. Empirical results indicated that even though internal management by local governments achieved a higher degree of customer satisfaction, the financial performance of internally managed centers was worse than the financial performance of centers under commercially contracted companies and trust management. In terms of the degree of customer satisfaction, the performance of centers under trust management

was between centers under internal management and centers under commercially contracted company management.

Through a literature review, this study found both a research trend and a gap in "acting on problems as soon as they are discovered" that provide managers and decision-makers of sports organization with the most effective reference information. As a trend, this issue is the future research direction for continuous investigation and study by practitioners of sports management and leisure management research, providing substantial assistance to the sports industry in improving both management efficiency and management practices.

2.4 Summary

Through continuous observation and literature review, this study discovered recent research applications and contexts in the field of efficiency and productivity research. Simar and Wilson (2007) use the Internet to search on the keywords "data envelopment analysis" and "two-stage," resulting in 801 studies; a search on the keywords "data envelopment analysis" and "Tobit" yielded 537 studies. The number of studies was very large, indicating that this research context was flourishing and developing.

In addition, the application of dummy variables in the second phase—for example, in Hersch's (2012) study of topics related to American professional football teams and Chen, Yeh, and Hu's (2012) related application aimed at hotel operations and management along with other leisure, tourism, and hospitality fields—provided a foundational reference for the environmental variables of sports centers investigated by this study. Viewed from the field of sports, although truncated regression has already become popular, there is a relative lack of research on government units and the public topic of exercise targeted by this study. Therefore, this study developed a new research context and methodology in this field. Cross-domain application from the field of efficiency and productivity research resulted in two major findings: (1) The "data envelopment analysis" and "two-stage" research context could achieve an understanding of the environmental variables that affected sports centers' efficiency; and (2) A "metafrontier model" was used to obtain the TGRs between different environmental levels. On this second point, related research in economics, management, finance, and other fields had gradually become popular, and applying this model to the efficiency analysis of various groups of sports centers make a similar contribution. The integration of the two findings with the issue of sports centers' management efficiency had not previously been seen in a field related to sports management; accordingly, this integration conferred irreplaceable advantages, added research value and initiated a new way of thinking.

3.Method

This study archived data related to 12 Taipei sports centers from 2008 to 2011. In the first phase, a management efficiency analysis was performed (Banker, Charnes, and Cooper (BCC) output-oriented model). In the second phase, the environmental variables that affected management efficiency were investigated (truncated regression). In the third phase, the meta-technology ratio (MTR) was applied, and the TGR was analyzed (metafrontier and TGR). The research objectives were as follows:

• To conduct a management efficiency assessment

of Taipei sports centers that covers recent years (2008 to 2011);
- To investigate the environmental variables that affected the management efficiency of Taipei sports centers; and
- To investigate the meta-production frontiers and MTRs of Taipei sports centers from 2009 to 2011.

3.1 Data collection

3.1.1 First phase

The topic of this study can be described both as innovative and as a reference for the relative deficiency in the literature. The four major factors of production in economics are land, labor, capital, and technology. The input and output settings in the fields of tourism and hospitality directed at hotels' operational efficiency and management mostly follow this principle. Benito et al. (2012) use the provision of public sports facilities by Spanish cities as their research subject, obtaining an efficiency assessment of public-domain sport facilities. Although Benito's study is different from this study in its scale and investigative perspective, that study had the highest correlation with this study in its use of an overall national scale to investigate the overall efficiency of sports facilities. The Benito study used an input indicator of the total cost of sports. It used the following two output indicators: total surface area of indoor and outdoor sports complexes in the municipalities and an indicator of the conservation and appropriateness of service at public sports facilities. Volz (2009) uses an output-oriented technical efficiency method of the BCC model to investigate Major League Baseball's (MLB) management efficiency by using one input (salary) and one output (games won) variable. Therefore, this study began by considering overall costs and set one input (total cost) and one output (total profit) variable to investigate the management efficiency assessment of Taipei sports centers. All of the data for the input and output indicators were obtained from the Taipei City Government, Department of Budget, Accounting, and Statistics (2011). There was only two years of operating data on Wenshan and Daan Sports Centers from 2008 to 2011.

3.1.2 Second phase

Benito et al. (2012) investigate the environmental variables using five factors: per capita income, a comparative index of each municipality's importance to tourism, a comparative index of each municipality's overall economic activity, population density by urban area, and the influence of the political party in power in each municipality. This study set district/location and facility as two major environmental variables based on the current state of the domestic environment. Eight essential factors affected sports centers' management efficiency; the details are shown in Table 1. The data on all of this study's environmental variables, such as district/location and facility, were obtained via the Taipei City government's information network.

Table 1 Aggregate table on the definitions of environmental variables that affected the sports centers

Environment Variable Definitions (Definition of variables)	
District and Location Environmental Variables (Location)	
Total population by administrative district	
Within 500 meters walking distance of a Taipei metro station	(1 = yes; 0 = no)
Facilities' Environmental Variables (Facilities)	
Attached parking lot	(1 = yes; 0 = no)
International conference hall	(1 = yes; 0 = no)
Shopping department	(1 = yes; 0 = no)
Children's recreation area/room	(1 = yes; 0 = no)
Barrier-free spaces and facilities	(1 = yes; 0 = no)
Community charity activities	(1 = yes; 0 = no)

Note: (1 = yes; 0 = no) is the dummy variable

3.1.3 Third phase

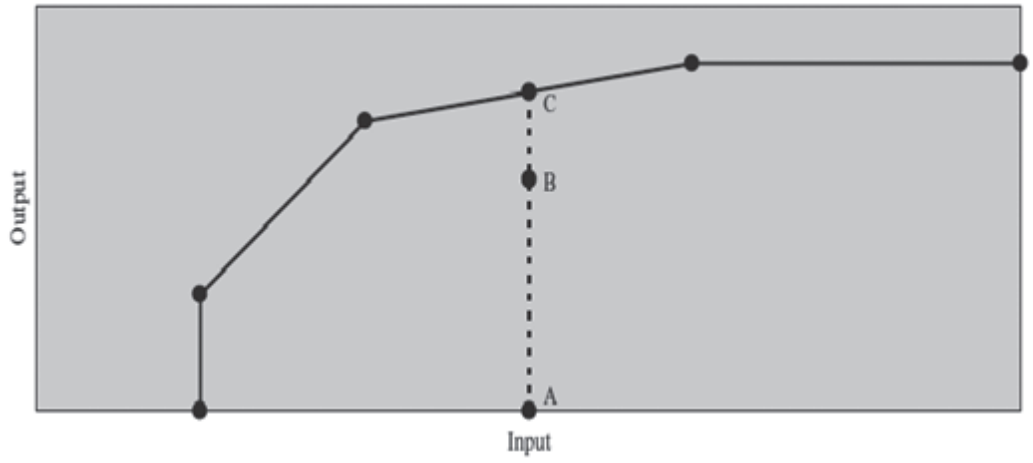
Third Phase: After the relevant data and results from the first two phases were obtained in this study, the management efficiency of sports centers was investigated in the third phase by using a metafrontier assessment method via a "metafrontier model." This method applied efficiency analysis to various groups of sports centers by the MTRs at different environmental levels (district/location, facility); this approach can be described as having research value and making a contribution (data from 2009 to 2011 because Wenshan and Daan Sports Centers had been operating for only two years).

3.2 Data envelopment analysis methodology

DEA methodology was a research method proposed by Charnes, Cooper, and Rhodes (1978) to establish a linear programming model. The idea of the DEA originated from Farrell's (1957) concept of productive efficiency. Farrell hypothesized that under constant returns to scale, a unit isoquant explained the relationship with the production isoquant frontier using actual observation points to solve for the size of the technical efficiency. The DEA methodology was used to evaluate relative efficiency between organizational units. The methodology was directed at non-profit organizations and agencies that had environments with multiple inputs and multiple outputs. The primary objective was to determine the efficient frontier of all of the units under analysis and to compare actual production efficiency with the efficient frontier, thereby measuring relative

efficiency. If the unit being tested fell on the efficient frontier, then there was relative efficiency. If the unit being tested was inside the efficient frontier, then there was relative inefficiency. This approach was called the Charnes, Cooper, and Rhodes (CCR) model. To find the cause of technical inefficiency, three scholars—Banker, Charnes, and Cooper (1984)—assumed variable returns to scale to solve for pure technical efficiency. This approach was called the BCC model. This study used the output-oriented technical efficiency method of the BCC model and adopted a one-input-one-output model to investigate the management efficiency of Taipei sports centers. The model's efficient frontier is as shown in Figure 1.

Figure 1. Efficient frontier of the one-input-one-output model.



3.3 Truncated regression

The appearance of truncated data was created because the samples were extracted from only a certain range of the parameter. Random variables usually show a normal distribution. However, in certain situations, random variables may be extracted from certain numerical values that are greater than, less than, or between normal distribution; at this time, the sample distribution of the data would form a truncated normal distribution and regression analysis would be performed in accordance with the characteristics of this distribution. Traditionally, when economists or related studies measured censored data models, most of them used the Tobit regression model (Tobin, 1958) as their primary research tool. Although the dependent variable in individual economic data might be undetectable (censored), it must still correspond to the relevant independent variable. For that reason, the distribution of the variables might show a character similar to truncation. A discussion of the cause-and-effect relationship between the variables must take into account the undetectable variable. Because the variable was undetectable, another observable variable must be found as a substitute variable. Assuming the ran-

dom variable is y, the observed variable is y^*, the inverse of the independent variable matrix is x_i^*, the parameter vector is β, and the residual term is ε, then the basic Equation (1) is:

$$y^* = x_i^* \beta + \varepsilon_i$$

$$y_i = 0, \text{ if } y_i^* \leq 0,$$

$$y_i = 0, \text{ if } y_i^* > 0. \quad (1)$$

Nevertheless, Simar and Wilson (2007) highlight from a methodology perspective that undistributed points remained in the Tobit regression. When using the DEA method to measure the efficiency of DMUs, there is no need to preset functions and parameter estimations. When using a Tobit regression, it is assumed that the DMU's efficiency error distribution term is a normal distribution. If assumption errors occur in the parameterized form of the likelihood function, then the Tobit regression's estimation equation would generate inconsistencies. Accordingly, Simar and Wilson (2007) have developed a truncated regression to overcome the aforementioned restrictions and supplement it with the bootstrap method for testing to verify the reliability. The equation is as follows:

$$TE_j = \alpha + \Sigma_{t\text{-}1}^{w} Z_{tj}\beta_t + \varepsilon_j, \text{ (j=1,…,n)} \quad (2)$$

In Equation (2), $\varepsilon_i \sim N(0 ; \sigma_\varepsilon^2)$, $\varepsilon_i \geq 1-\alpha-\Sigma_{t\text{-}1}^{w} Z_{tj}\beta_t$,α is a constant term, ε_i is statistical interference, and Z_{tj} is both the ^{tth} value of the DMUj specific observed variable and related to the efficiency value (TE_i) of the DMUs.

3.4 Metafrontier model

Battese et al. (2004) provide a solution to estimate production efficiency at the metafrontier, which O'Donnell et al. (2008) further extend to intertemporal technical efficiency and changes in TGRs under the architecture of production efficiency at the metafrontier. Figure 2 shows a simple illustration that explains the single-input-and-single-output metafrontier model. The DMUs (sports centers) in this study belonged to two heterogeneous groups. Therefore, the latter efficiency frontiers of the two groups after computation were represented by XX' and YY', respectively, and the DMU of this input-output combination was marked as A. In this study, the output-oriented model for the DMU A technical efficiency of group frontier (group frontier), XX' , and the metafrontier, MM', are computed as in Equation (3):

$$TE_{XX'}(A) = \frac{OB}{OC}, TE_{MM'}(A) = \frac{OB}{OD}. \quad (3)$$

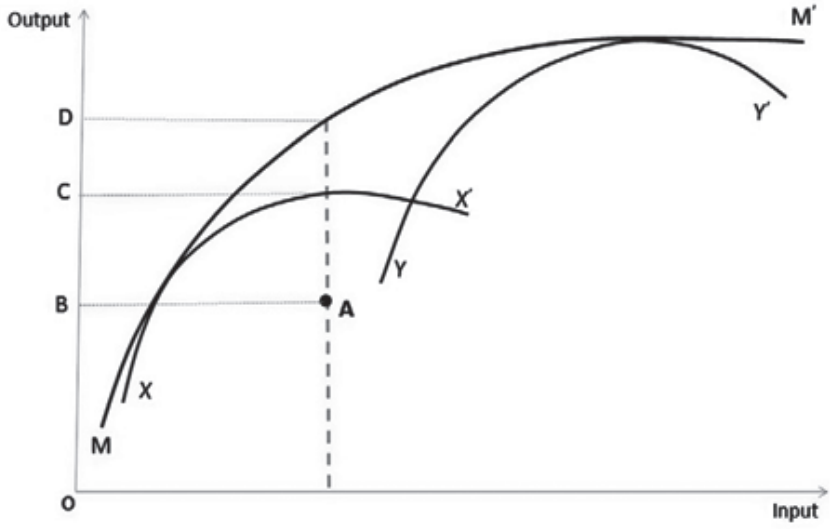
To obtain the MTR, the gap between the group frontier, XX', and the metafrontier, MM', must be analyzed. Therefore, DMU A is defined by Equation (4)

$$MTR_{XX'}(A) = \frac{TE_{MM'}(A)}{TE_{XX'}(A)} = \frac{OB/OD}{OD/OC} = \frac{OC}{OD} \quad (4)$$

The MTR measures how close the group frontier is to the metafrontier and is shown in Equation (5), following a reorganization of Equation (4). The technical efficiency of DMUA is measured as the metafrontier, which can be reorganized

as the technical efficiency frontier of group production (representing group characteristics and status) and the technical efficiency ratio of group frontier, XX' (representing the group frontier's degree of closeness to the metafrontier)

Figure 2. Illustration of the metafrontier and the group frontier (O'Donnell, et al., 2008).



$$TE_{XX'}(A) = TE_{MM'}(A) \times MTR_{XX'}(A) \quad (5)$$

For a DMU with $TE_{MM'}$=0.4 and $TE_{XX'}$=0.6, the MTR value is 0.667. This shows that the same production unit under the production technology of Group XX', using the same essential factor input combination, can only attain 66.7% of the metafrontier production technology. A greater MTR value shows a greater distance in the production technology of specific group XX', and the opposite means a smaller distance.

4.Results

4.1 Management efficiency assessment of Taipei sports centers from 2008 to 2011

Volz (2009) uses the output-oriented technical efficiency method of the BCC model to investigate MLB's management efficiency by using a one-input (salary) and one-output (games won) model. This study complied with this concept by setting one input (total cost) and one output (total profit) variable to investigate the management efficiency assessment of sports centers in Taipei City. The 12 Taipei sports centers were referred to using a code ranging from Sports Center A to Sports Center L.

The term "GDP deflator" refers to a calculation based on the gross domestic product (GDP): The ratio of the money used between nominal GDP and inflation-corrected GDP (namely constant-

price GDP or real GDP) that is the most macro measurement of price levels. The GDP deflator is also used to calculate GDP components, such as personal consumption expenditures. Moreover, the U.S. Federal Reserve switched to using the personal consumption deflator and other deflators as a reference for formulating "anti-inflation policies." GDP Deflator = (Nominal GDP/Real GDP) x 100. This study was based on the production and deflation indicators of all of Taiwan's domestic industries over the years archived by the Directorate-General of Budget, Accounting and Statistics, Executive Yuan (2012). This study used 2006 as the base period and set the arts, entertainment, and leisure-service industry as the basis by which to deflate the input and output indicators. The data were imported into DEA-Solver Version 7.0 software for calculation. Details on the management efficiency of the Taipei sports centers from 2008 to 2011 are shown in Table 2.

Table 2 Aggregate table on the operational efficiency of Taipei sports centers from 2008 to 2011.

Sports Centers	2008	2009	2010	2011
A	0.8284	0.9685	1.0000	1.0000
B	0.8991	0.9484	0.9852	0.8978
C	-	-	0.9720	1.0000
D	0.9272	0.9719	0.9522	0.7902
E	-	-	1.0000	0.9222
F	-	0.9590	0.8819	0.8040
G	1.0000	1.0000	1.0000	0.9352
H	0.9139	0.9250	0.9869	0.9149
I	-	1.0000	0.9745	0.8673
J	1.0000	1.0000	1.0000	0.8762
K	1.0000	0.9434	0.9488	0.8698
L	-	0.7636	0.9577	0.8765

4.2 Environmental variables that affected the management efficiency of Taipei sports centers

Through a literature discussion, expert interviews, and the actual use of a rule of thumb, factors that affected the efficiency of Taipei sports centers were set (environmental variable investigation). The environmental variables of this plan were divided according to differences in property: (1) Location variables – total population by administrative district, within 500 meters walking distance of a Taipei metro station; and (2) Facilities variables – community charity activities, barrier-free spaces and facilities, surface area for use, international conference hall, metro, children's recreation area/room, and shopping department.

With the exception of total population by administrative district, the items were processed using dummy variables, including community charity activities, barrier-free spaces and facilities, surface area for use, international conference hall, metro, children's recreation area/room, shopping department, etc. This study followed the recommendation of Simar and Wilson (2007) and performed a repeated sample extraction 2,000 times to reduce any errors generated by DEA in the second phase. Details are as shown in Table 3.

Table 3 Aggregate table on environmental variables that affected the operational efficiency of Taipei sports centers.

Variables	Coefficient	Standard Deviation	t Statistics
Constant	0.938***	0.065	15.707
Total population by administrative district	-0.000	0.000	1.289
Community-building events	-0.029	0.034	-0.859
Barrier-free spaces and facilities	-0.098**	0.045	-2.152
Surface area for use	0.000*	0.000	-1.686
International conference hall	-0.011	0.040	-0.282
Metro	0.002	0.029	2.507
Children's recreation area/room	0.082**	0.033	2.508
Shopping department	0.002	0.039	0.061

Note: Log likelihood function=26.399

***Indicates $\alpha = 0.01$; **Indicates $\alpha = 0.05$; *Indicates $\alpha = 0.1$ significance levels

The first result involves the transportation convenience of "barrier-free spaces and facilities": At a 5% significance level, the existence of barrier-free spaces and facilities had a significant effect on and negative correlation with the management efficiency of the sports centers. This phenomenon shows that the convenience and safety of barrier free space increased the willingness of consumer groups with mobility issues to enter the premises but had no influence on enhancing the management efficiency of the sports centers. The second result involves the "Children's recreation area/ room": At a 5% significance level, the existence of a children's recreation area and facilities had a significant and positive effect on the management efficiency of the sports centers. This phenomenon shows that the convenience and safety of children's recreation area increased the willingness of families with children to enter the premises and had great influence on enhancing the management efficiency of the sports centers. The third result involves the "Surface area for use": At a 10% significance level, the existence of sufficient space for use had a significant and positive effect on the sports centers' management efficiency. This phenomenon shows that a larger space for use increased consumer groups' willingness to enter the premises and had a strong influence that enhanced the sports centers' management efficiency. The research results on the three environmental variables of "barrier free spaces and facilities," paces and's recreation area/room," and "surface area for use" provided a reference for sports centers' senior management staff and employees in the hope of achieving the goal of enhancing management efficiency.

4.3 Metafrontier and technology gap ratios of Taipei sports centers from 2009 to 2011

When using cost to perform metafrontier measurement of organizational performance, the most important arbitration indicator is the TGR, the value of which is the group frontier stochastic cost value for measuring the sports centers with respect to the gap ratio with the metafrontier cost value. When the TGR value increases (approaching 1), the gap in cost between the group frontier and metafrontier decreases (that is, the two are becoming closer). Conversely, when the TGR value decreases (approaching 0), the gap between the two becomes larger, indicating that the distance in cost between the group frontier and metafrontier have grown farther apart. Therefore, the cost-efficiency situation of sports centers at various technology levels (or across groups) can be compared based on this gap ratio. In this study, there were only seven sports centers in 2008; the number of DMUs was insufficient, and it was impossible to differentiate among various groups and solve for the TGR value according to surface area for use. Therefore, 2009 to 2011 was set as the time limit for investigating the TGR (there were 10 sports centers in 2009). Moreover, a surface area for use of 57,309 square meters (17,340 ping) was set as the reference line for differentiating Taipei sports centers into a large-scale group (Sports Centers B, D, G, K, L, C) and a small-scale group (Sports Centers A, F, H, I, J, E). The TGR values of the 12 Taipei sports centers were aggregated. Details are as shown in Table 4.

Table 4 Aggregate table on the TGR of Taipei sports centers from 2009 to 2011.

Sports Centers	2008	2009	2010	2011
B	Large Scale	0.9484/ 0.9624 0.9855	0.9852/ 1.0000 0.9852	0.8978/ 1.0000 0.8978
D		0.9719/ 0.9810 0.9907	0.9522/ 1.000 0.9522	0.7902/ 1.000 0.7902
G		1.0000/ 1.0000 1.0000	1.0000/ 1.0000 1.0000	0.9352/ 0.9711 0.9630
K		0.9434 /0.9457 0.9976	0.9488/ 0.9881 0.9375	0.8698/ 0.8959 0.9709
L		0.7636/ 1.0000 0.7636	0.9577/ 0.9733 0.9839	0.8765/ 0.9514 0.9212
C		-	0.9720/ 0.954 0.9874	1.0000/ 0.8258 0.8258
A	Small Scale	0.9685/ 1.0000 0.9685	1.0000/ 1.0000 1.0000	1.0000/ 1.0000 1.0000
F		0.9590/ 0.9897 0.9689	0.8819/ 0.9095 0.9696	0.8040/ 0.8426 0.9542
H		0.9250/ 0.9605 0.9630	0.9869/ 0.9869 1.0000	0.9149/ 0.9238 0.9904
I		1.0000/ 1.0000 1.0000	0.9745/ 0.9745 1.0000	0.8763/ 0.8773 0.9989
J		1.0000/ 1.0000 1.0000	1.0000/ 1.0000 1.0000	0.8762/ 1.0000 0.8762
E		-	1.0000/ 1.0000 1.0000	0.9222/ 0.9868 0.9435

The TGR values of the two groups were between 0.7636 and 1.0000. The TGR mean value of the small-scale sports center group was better (0.9784), implying that most of the samples of this group were closer to the cost metafrontier (least cost). Conversely, the TGR mean value of the large-scale sports center group was lower (0.9384), indicating that most of the samples of this group were farther from the cost metafrontier; the mean cost of this group exceeded the cost metafrontier by 7%. The maximum TGR values in the two groups were 1.0000. At this time, the stochastic cost of the group frontier was at a point of tangency with the cost metafrontier, implying that the sample was located at the most efficient point.

To further understand whether the differences in the TGR values of sports centers organized by different scale groups (surface area for use) were statistically significant, this study performed the Mann-Whitney U statistical test. Details about the result of the difference test are shown in Table 5. At a 5% significance level, the TGR values of the sports centers in this study with difference scales of surface area for use showed a significant difference. Taking into consideration the improved management efficiency of sports centers, the small-scale group showed better potential, whereas the large-scale group's urgency in making great effort and improving was explained.

Table 5 TGR value difference test of various scale groups.

	Large Scale
Small Scale	.041*

*p< .05; p value based on analysis of the Mann-Whitney U test

5.Discussion

Comparing Taiwan with the developed countries, the construction of sports centers plays a role in nurturing citizens' exercise ethos and cultivating a population of people who exercise regularly. Choosing to build diversified sports facilities at convenient locations or bases would be more effective in promoting exercise (Ministry of Education, Sports Administration, 2014).

The performance assessment of the management efficiency of 12 Taipei sports centers showed that management efficiency was not significantly affected by whether the sports centers were built earlier or later. New Taipei City's sports centers in New Taipei City have been operating for less than two years, and those in other counties and cities have been operating for less than one year. Differences in regional characteristics, length of operation, and the unit entrusted with operations management will generate heterogeneous differences in the operating status and performance of sports centers in each county and city. Subsequently, Taiwan will successively build 50 sports centers. After the Executive Yuan agreed on and approved the amendment plan on November 10, 2011, the Ministry of Education, Sports Administration (2014) revised the target number of "civil sports centers" from 50 to 32 and extended the overall promotion period to six years.

In Taipei City, there are approximately 118,000 physically and mentally disabled citizens. There are approximately 401,500 people aged 65 or above. The sum of the physically and mentally disabled and the elderly population is approximately 519,500 people. The preferential policy at Taipei sports centers shows how to meet the needs of an aging society by allowing senior citizens (age 65 or above) and people holding proof of physical or mental disability to enter the premises free of charge during public hours. The results of this study corresponding to the transportation convenience of "convenience of spaces and facilities" indicated that even though the convenience and safety of a barrier-free space could not enhance the management efficiency of Taipei sports centers, they could increase the willingness of consumers with mobility issues to enter the premises. Thus, the implementation of the barrier-free policy not only responded to government policy but was also in line with a social atmosphere of providing care to minority and disadvantaged groups.

The results of this study on "on stud's recreation area/room" had a significant and positive effect on the management efficiency of the sports centers at a 5% significance level in terms of the existence of a children's recreation area and facilities. Taipei City's population of children aged 0-9 is approximately 254,000. In the environment of an industrial and commercial society, most parents are in two-income families. The convenience and safety of children's recreation space offered by sports centers increased the willingness of families with children to enter the premises. From a government perspective, in addition to enhancing the sports centers' management efficiency, this feature provided a friendly environment for Taipei City's people to take care of children while engaging with the global trend of low birth rate, creating a win-win opportunity for both the sports centers and the public.

As of January 2016, Taipei City's total area was approximately 272 square kilometers with a population of 2,704,974 people; Taipei City is the area in Taiwan with the highest population density (9,952.09 people/square kilometer). The results of this study indicated that providing sufficient "surface area for use" had a significant and positive effect on the sports centers' management efficiency, showing that a larger space would better increase consumer groups' willingness to enter the premises. Prior to the establishment of sports centers in New Taipei City, the residents of New Taipei City often crossed the district to neighboring sports centers in Taipei City to exercise and spend money. This phenomenon improved slightly after New Taipei City successively built six sports centers, indicating the public's need for a place to exercise.

To further subdivide the sports centers organized by different scale groups (surface area for use), this study compared sports centers' TGR values with various scales of surface area for use and found significant differences. To improve sports centers' management efficiency, the small-scale group with a surface area for use equal to or less than 57,309 square meters showed better management performance, thus indicating that appropriate space planning and utilization and improved site design and dynamic lines seem to be more important in Taipei City, where land is expensive. Of course, Taipei City's existing sports centers with larger operating spaces must improve space management, planning, and capacity. This situation can be an important reference for other counties and cities in Taiwan for building sports centers in the future.

5.1Limitations

- This study only investigated the management efficiency assessment of Taipei sports centers from 2008 to 2011.
- This study only investigated set indicators and variables (input, output, environmental variables). The rest were not included because they were within the scope of this study.

5.2 Suggestions and Future Studies

Four companies have obtained operating rights to the 12 Taipei sports centers. China Youth Corps operates six sports centers, Young Men's Christian Association (YMCA) operates two sports centers, Far East Steel Manufacturing operates three sports centers, and Hui Yang Bai Huo operates one sports center. According to the structure-conduct-performance theory in industrial economics, the structure of the market would affect the conduct of firms, and the conduct of the firms would in turn affect the performance of the firms. Therefore, the recommendation for future research is to thoroughly investigate either the performance of the firms operating the sports centers or the relationship between the conduct of the firms and performance.

A national sports policy and the public issue of exercise will directly guide the operating direction and efficiency of sports centers. Follow-on research topics include the following:

- An analysis of the contents of sports policies introduced by government units and the proportion of input resources;
- An investigation linking the operation and management of sports centers from a public health and national health perspective;
- The assimilation of complete demographic vari-

ables into the future planning of sports centers and policy references;

- An analysis of sports center input and output models, management efficiency, resource allocation, and management successes and failures from a more detailed performance assessment perspective; and
- A comparison of management performance assessment between sports centers managed by public institutions and those managed by non-public institutions.

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