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Evaluating the Factors Influencing the Efficiency and Usage of Public Sports Services in a Chinese Province

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Abstract**—**The efficiency of public sports service of prefecture-level cities in Zhejiang from 2008 to 2012 was evaluated by applying the DEA method, then its influencing factors were also analyzed through Tobit model. Upon analysis, the results revealed the following; (i) the change in average efficiency of public sports service in Zhejiang present a smooth uptrend and at a relatively high level from 2008 to 2012 (ii) generally, the productivity of public sports service in Zhejiang improved from 2008 to 2012, the productivity efficiency varied greatly in different years, and the regional difference of production efficiency increased. (iii) The correlations for urbanization rate, aging rate, per capita GDP and the population density were significantly positive with the public sports service efficiency in Zhejiang, of which the most significant was the aging rate. However, the population density and per capita GDP had less impact on the efficiency of public sports service in Zhejiang. In addition, whether the efficiency of public sports services in different areas in Zhejiang reciprocates to overall benefits in public wellbeing in both rural and urban settings is still arguable.

Keywords**—**DEA Model, public sports service, efficiency, Tobit model, Malmquist productivity index, Zhejiang.

I. Introduction

PUBLIC sports service is a critical guarantee for the people's fitness and wellbeing [1]. In recent years, China's sports sector is deepening reform, innovation and development, and building a service oriented structure. However, problems such as ineffective, excessive and asymmetric supply in addition to demand normally hamper the intended delivery of such services. It is of great significance to actively evaluate the efficiency of government/public sports service for improving the efficiency of government administration and promoting the supply-side structural reform of public sports service. Different scholars have evaluated the efficiency of public sports service system among regions and between the urban and rural [2] areas using various methods. Some of these methods are just mere subjective evaluations, while others focus on evaluation index system construction or data envelopment analysis (DEA) model, a commonly used model [3]. However, public sports services and the input and output indicators are not normally comprehensive. Our paper increases the input and output indicators on the basis of previous studies, and sets up the factors affecting the efficiency of public sports service. We include two factors of aging rate and urbanization rate that have not previously explored. At the same time, we examine the relationship between population density, per capita GDP, urbanization rate, aging rate and the efficiency of public sports service. As a developed coastal province in Southeast China, Zhejiang's public sports service system has been at the upstream level of the whole country. The research on the efficiency of Zhejiang's public sports service is of reference and significance, especially in quest for the realization of public benefits from public sports services.

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II. DEA Model

DEA is a linear programming [4] technique used to evaluate the relative efficiency of the decision-making unit, (DMU) [4]-[6]. DEA has been used to evaluate the efficiency of non-profit organizations and public sectors [4]-[6]. It has also been applied to finance, economic project evaluation and other fields [3]. This method is also used to construct a non-parametric production frontier by the production-focused optimal production unit, and evaluate the efficiency of the DMU through comparing the actual production status of the DMU, and the gap of the production frontier. In accordance with the assumption that whether scale returns are variable, it can be divided into variable and invariable scale return method [4]-[6]. Zhejiang provides public sports of small scale and has limited investment due to certain budget constraints. Our study evaluates the efficiency of public sports service in Zhejiang based on output-oriented variable scale return method. The model of variable scale return was proposed by Eharnes et al. [7] on the basis of variable scale return, which has one more restrictive condition as $\sum_{j=1}^{n}\lambda_j = 1$ than the variable model of scale return, whose linear programming is as:

$$p\begin{cases} \max(\mu^T y_0 + \mu_0) = V_P \\ s.t.\omega^T - \mu^T y_i - \mu_0 \geq 0,\ j = 1,2,....,n \\ \omega^t x_0 = 1 \\ \omega \geq 0, \mu \geq 0 \end{cases} \quad (1)$$

where,

$$x_j = (x_{1i,} x_{2j}, ..., x_{nj})^T > 0, j = 1,2,..., n$$
$$y_j = (y_{1i,} y_{2j}, ..., y_{nj})^T > 0, j = 1,2,..., n$$

The dual programming of linear programming is

$$D\begin{cases} \min\theta = V_D \\ s.t.\sum_j^n x_j\lambda_j + s^- = \theta x_0, j = 1,2,....,n \\ \sum_j^n x_j\lambda_j - s^+ = y_0 \\ \sum_j^n \lambda_j = 1 \\ x_j \geq 0, j = 1,2,....,n \\ s^- \geq 0, s^+ \geq 0 \end{cases} \quad (2)$$

If the linear programming (P) has the optimal solution ω^0, μ^0, making μ^0 meet $V_P = \mu^{0T} y + \mu_0^0 = 1$, then the DMU j_0 is weakly DEA efficient. If it can still meet $\omega^0 > 0, \mu^0 > 0$, then the DMU j_0 is DEA efficient.

A. DEA Measuring Model of Malmquist

(x_t, y_t) is adopted to express the input-output vector of a DMU [7], [8] at t time, T^t is feasible production set at t time, so Malmquist productivity index can be expressed as

$$M(y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{D^t(x_{t+1}, y_{t+1})}{D^t(x_t, y_t)} \times \frac{D^{t+1}(x_{t+1}, y_{t+1})}{D^{t+1}(x_t, y_t)}\right]^{1/2} \quad (4)$$

where $D^t(x_t, y_t)$ represents the validity of the t-time DMU at t time; $D^{t+1}(x_{t+1}, y_{t+1})$ represents the validity of the t+1-time DMU at t+1 time; $D^t(x_{t+1}, y_{t+1})$ indicates the validity of the t+1-time DMU at t time; $D^{t+1}(x_t, y_t)$ indicates the validity of the t-time DMU at t+1 time.

If M>1, it means that the efficiency of the DMU from t to t+1 is increasing and the productivity is improving. If M<1, it shows that the efficiency of the DMU from t to t+1 is reducing, and the productivity is regressed. If M= 1, it means that the efficiency of the DMU from t to t+1 is constant, and the productivity remains unchanged. The productivity index can be divided into technical change (TC) and technical efficiency change (TEC), as follows [9]

$$M\ (y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{D^{t+1}(x_{t+1}, y_{t+1})}{D^t(x_t, y_t)}\right]\left[\frac{D^t(x_{t+1}, y_{t+1})}{D^{t+1}(x_{t+1}, y_{t+1})} \times \frac{D^t(x_t, y_t)}{D^{t+1}(x_t, y_t)}\right]^{1/2} \quad (3)$$

where,

$$TEC = \frac{D^{t+1}(x_{t+1}, y_{t+1})}{D^t(x_t, y_t)},\ TC = \left[\frac{D^t(x_{t+1}, y_{t+1})}{D^{t+1}(x_{t+1}, y_{t+1})} \times \frac{D^t(x_t, y_t)}{D^{t+1}(x_t, y_t)}\right]^{1/2}.$$

TEC is the efficiency change index of two times, indicating the catch-up effect of the DMU to the production frontier from t to t+1, so as to measure whether the production unit organizes production closer to the operating conditions of the current production frontier: When TEC is greater than 1, it indicates that the rate of production is near the production frontier, and the relative technical efficiency is improved. However, this metric is not related to the selection of the reference period t, which mainly reflects the improvement of DMU in production and management behavior, so does the TC.

The DEA-based Malmquist productivity index can be obtained through the operation of following four linear programming models. The Malmquist DEA total-factor productivity change index of the i-th DMU from the t time to the t+1time could be obtained by calculating the following four DEA-based distance function measurement models (4).

$$\left[D^t(x_{t+1}, y_{t+1})\right]^{-1} = \max_{\phi,\lambda} \phi \quad \left[D^{t+1}(x_t, y_t)\right]^{-1} = \max_{\phi,\lambda} \phi$$
$$s.t - \phi y_{i,t+1} + Y_t\lambda \geq 0 \quad , \quad s.t - \phi y_{it} + Y_{t+1}\lambda \geq 0$$
$$x_{i,t+1} - X_t\lambda \geq 0 \qquad x_{it} - X_{t+1}\lambda \geq 0$$
$$\lambda \geq 0 \qquad \lambda \geq 0$$

III. Methods

A. Selection of DMU

To evaluate the input-output efficiency of public sports service [10] using DEA model, the DMU of the DEA model should be determined first. In addition, the selection of DMU is to determine the comparative reference set. In general, three basic characteristics should be satisfied in the selection of DMU; (i) the same target and task; (ii) the same external environment; (iii) the same input-output indicators. Our paper examines the inter-regional differences regarding the efficiency of public sports service in Zhejiang, it chooses 11 regions in Zhejiang as 11 DMUs to evaluate the efficiency of public sports service in each region.

B. Indicator Selection

The DEA model is an evaluation method based on input-output data, so the selection of input-output evaluation indicators is crucial to the effectiveness of the DEA efficiency evaluation, which is also the premise to ensure the objectivity and rationality of the DEA model. According to the application of the current DEA model evaluation method in different disciplines, and supported by existing literature, [4]-[6] the selection of the DEA model indicators should follow four basic principles.

Firstly, the evaluation purpose realization principle in which the selection of input-output evaluation indicators of public

sports service, the realization of the evaluation purpose of efficiency should be taken into account. That is, the selected indicators should serve the purpose of system evaluation and indicators that have a strong logical relationship with public sports service should be included.

Secondly, the all-rounded principle in which the selection of evaluation indicators should be able to reflect the input-output characteristics of public sports service from different aspects and perspectives. Thirdly, the representative principle in which the number of input-output evaluation indicators of public sports service is varied. If the selected indicators are comprehensive, they make it difficult to collect data [11], and will decrease the evaluation function of DEA method. Therefore, one or two representative indicators should be selected from the components of public sports service. Lastly, availability and operability principles in which the selection of input-output evaluation indicators of public sports service should be considered. Whether the selected indicators can be obtained under existing conditions and whether the used data processing method is operable and easy for the implementation of evaluation is important. The input-output public sports service system is a rather complex nonlinear input-output system with multiple objectives and variables. Since it involves many elements such as people, wealth and resources, the data availability and output elements are of great significance. However, the government is the absolute custodian of public sports service, with obvious dominance and as a controlling force. The public sports service provided by the government is mainly reflected in the appropriation expenditure of public sports service, the established administrative agencies and the arranged sports personnel. Therefore, because of the data availability and the ease to measure, in terms of the input indicators of public sports service, the government's sports expenditure, the government's basic sports management agencies and the grass-roots sports personnel are mainly selected. Meanwhile, with respect to public sports service output indicators, two indicators as number of stadiums per 100,000 people and number of national fitness facilities per 10,000 people (national fitness path, basketball court, table tennis table) are selected for the sports facilities services.

TABLE I
LIST OF INPUT-OUTPUT INDICATORS OF PUBLIC SPORTS SERVICES IN ZHEJIANG

Input Indicators	Output indicators
Per capita sports expenditure (Yuan/person)	Number of sports organizations for every 10,000 people (per 10,000 people)
Number of public sports management institutions for every 10,000 people (per 10,000 people)	Number of fitness facilities for every 10,000 people (per 10,000 people)
Number of grass-roots sports personnel for every 10,000 people (per 10,000 people)	Number of stadiums for every 100,000 people (per 10,000 people)
	Number of social sports instructors for every 10,000 people (per 10,000 people)
	Number of national fitness activities (times)
	Participation rate of national fitness activities (%)
	Number of national physical fitness monitoring for every 10,000 people (per 10,000 people)
	Achieved rate of national physical tests (%)

TABLE II
DESCRIPTION OF INPUT-OUTPUT VARIABLES OF PUBLIC SPORTS SERVICE FROM 2008 TO 2012

		Input Indicators			Output Indicators							
		I1	I2	I3	O1	O2	O3	O4	O5	O6	O7	O8
2008	Maximum	33.35	0.56	0.68	5.29	6.04	1.51	18.61	3496.00	15.70	41.74	96.19
	Minimum	10.53	0.10	0.24	1.16	0.80	0.44	6.92	169.00	1.89	1.49	72.41
	Mean	18.46	0.28	0.41	3.37	2.60	1.09	12.60	657.09	6.02	15.53	88.09
	SD	8.82	0.12	0.17	1.51	1.81	0.35	4.40	963.69	4.91	10.86	6.08
2009	Maximum	33.33	0.56	0.74	6.09	16.47	1.51	23.84	2920.00	15.41	42.31	97.61
	Minimum	11.60	0.10	0.20	1.35	0.40	0.41	9.02	232.00	1.85	8.13	67.03
	Mean	18.60	0.29	0.42	4.09	3.30	1.12	15.61	658.00	5.91	22.35	86.94
	SD	8.52	0.12	0.17	1.52	4.51	0.41	5.76	774.45	3.96	11.46	8.35
2010	Maximum	59.96	0.56	0.83	6.34	13.91	1.69	26.11	2552.00	25.47	77.01	94.80
	Minimum	10.92	0.16	0.27	1.63	1.37	0.41	10.03	237.00	2.31	16.35	82.35
	Mean	24.93	0.32	0.48	4.67	4.78	1.16	17.83	706.45	8.50	34.12	88.30
	SD	14.17	0.14	0.17	1.30	4.24	0.44	6.16	659.20	6.64	16.77	3.47
2011	Maximum	67.61	0.56	0.77	7.41	5.37	1.98	31.72	2572.00	13.02	59.51	94.25
	Minimum	11.44	0.13	0.21	0.95	0.56	0.41	11.77	50.00	0.83	9.16	80.57
	Mean	27.33	0.27	0.45	3.46	2.28	1.20	20.92	612.45	7.01	32.98	88.90
	SD	16.57	0.13	0.17	1.89	1.59	0.49	7.72	700.12	4.49	14.66	3.80
2012	Maximum	53.91	0.61	0.76	10.21	12.26	1.74	45.73	3462.00	14.32	56.04	94.05
	Minimum	11.13	0.13	0.30	1.98	0.78	0.38	15.08	116.00	2.29	14.12	81.25
	Mean	27.53	0.29	0.49	5.68	2.42	1.07	25.99	1266.82	7.42	33.60	88.81
	SD	13.96	0.16	0.15	2.47	3.31	0.38	9.76	1208.74	4.22	14.67	3.94

Also, the number of sports organizations per 10,000 people is chosen for sports organization service, as an additional indicator. As to sports guidance services, the indicator of number of social sports instructors per 10,000 people is selected. For sports activity services, two indicators as number of national fitness activities and participation rate of national fitness activities are used. In addition, for the national physical fitness monitoring services, two indicators as number of national physical fitness monitoring per 10,000 people and achieved rate of national physical tests are chosen (see Table I). The main argument here is that, from the perspective of government supply, the direct performance of government public sports service resource supply efficiency is the number of public sports service resources that every citizen can enjoy, [1], [12] rather than the achieved rate of national physical tests and the improvement of sports population among other factors.

C. Description of Input-Output Indicators

The average number of public sports management institutions per 10,000 people in the streets and towns had relatively smaller changes, almost at 0.3. The average number of public sports management institutions per 10,000 people in the streets and towns showed a rising trend, increasing from 0.41 in 2008 to 0.49 in 2012.

TABLE III
TECHNICAL EFFICIENCY OF PUBLIC SPORTS SERVICE IN ZHEJIANG FROM 2008 TO 2012

	2008	2009	2010	2011	2012	Mean value	SD
Hangzhou	1.000	1.000	1.000	1.000	1.000	1.000	0.000
Ningbo	1.000	1.000	1.000	1.000	1.000	1.000	0.000
Wenzhou	0.837	0.816	1.000	1.000	1.000	0.931	0.095
Jiaxing	1.000	1.000	1.000	1.000	1.000	1.000	0.000
Huzhou	1.000	1.000	0.899	1.000	1.000	0.980	0.045
Shaoxing	0.686	0.697	0.856	1.000	1.000	0.848	0.154
Jinhua	1.000	1.000	0.871	1.000	0.933	0.961	0.058
Quzhou	1.000	1.000	1.000	1.000	1.000	1.000	0.000
Zhoushan	1.000	1.000	1.000	1.000	1.000	1.000	0.000
Taizhou	1.000	1.000	1.000	1.000	1.000	1.000	0.000
Lishui	1.000	1.000	1.000	1.000	0.909	0.982	0.041
Mean value	0.957	0.956	0.966	1.000	0.986	0.973	
SD	0.102	0.102	0.059	0.000	0.032		

TABLE IV
MALMQUIST INDEX OF PUBLIC SPORTS SERVICE IN ZHEJIANG FROM 2009 TO 2012

	2009			2010			2011			2012		
	effch	techch	tfpch	effch	techch	tfpch	effch	techch	tfpch	effch	techch	tfpch
Hangzhou	1.000	1.004	1.004	1.000	0.840	0.840	1.000	0.897	0.897	1.000	1.219	1.219
Ningbo	1.000	1.025	1.025	1.000	1.067	1.067	1.000	1.166	1.166	1.000	0.746	0.746
Wenzhou	0.975	1.034	1.008	1.225	1.101	1.349	1.000	0.885	0.885	1.000	0.950	0.950
Jiaxing	1.000	1.224	1.224	1.000	1.059	1.059	1.000	0.869	0.869	1.000	1.792	1.792
Huzhou	1.000	0.922	0.922	0.899	0.918	0.825	1.113	1.009	1.123	1.000	1.536	1.536
Shaoxing	1.017	1.128	1.147	1.228	0.921	1.130	1.168	1.145	1.338	1.000	0.855	0.855
Jinhua	1.000	0.998	0.998	0.871	1.074	0.936	1.148	0.767	0.880	0.933	1.226	1.144
Quzhou	1.000	1.397	1.397	1.000	1.011	1.011	1.000	1.117	1.117	1.000	1.046	1.046
Zhoushan	1.000	1.043	1.043	1.000	1.095	1.095	1.000	0.832	0.832	1.000	0.911	0.911
Taizhou	1.000	1.186	1.186	1.000	0.926	0.926	1.000	0.820	0.820	1.000	1.755	1.755
Lishui	1.000	1.734	1.734	1.000	0.944	0.944	1.000	0.696	0.696	0.909	1.167	1.061
Mean value	0.999	1.154	1.153	1.020	0.996	1.017	1.039	0.928	0.966	0.986	1.200	1.183

TABLE V
CHANGE RATE OF PURE TECHNOLOGY AND SCALE EFFICIENCY CHANGE OF THE PUBLIC SPORTS SERVICE IN ZHEJIANG FROM 2009 TO 2012

	2009		2010		2011		2012	
	pech	sech	pech	sech	pech	sech	pech	sech
Hangzhou	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Ningbo	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Wenzhou	0.971	1.004	1.216	1.008	1.000	1.000	1.000	1.000
Jiaxing	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Huzhou	1.000	1.000	1.000	0.899	1.000	1.113	1.000	1.000
Shaoxing	0.984	1.034	1.248	0.984	1.145	1.020	1.000	1.000
Jinhua	1.000	1.000	0.932	0.935	1.073	1.069	0.949	0.983
Quzhou	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Zhoushan	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Taizhou	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Lishui	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.909
Mean value	0.996	1.003	1.036	0.984	1.020	1.018	0.995	0.990

IV. RESULTS

According to Table II, from the angle of input, the average investment per capita in sports in Zhejiang increased from 18.46 Yuan in 2008 to 27.53 Yuan in 2012, increasing year by

year. From the perspective of outputs, the indicators of grass-roots sports personnel, number of social sports instructors, number of national fitness activities, participation rate of national fitness activities, number of national physical fitness monitoring and achieved rate of national physical tests, all presented an upward trend from 2008 to 2012. However, the indicators of fitness facilities and number of stadiums decreased.

TABLE VI
DATA DESCRIPTION

Variables	2008		2009		2010		2011		2012	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Efficiency score	0.957	0.102	0.956	0.102	0.966	0.059	1.000	0.000	0.986	0.032
Urbanization rate	0.550	0.090	0.554	0.090	0.585	0.088	0.593	0.086	0.603	0.081
Aging rate	0.159	0.015	0.165	0.016	0.170	0.017	0.177	0.018	0.183	0.020
Per capita GDP	39817.909	12347.072	46337.364	18222.836	54921.182	21774.371	64494.545	25342.998	70010.182	28011.003
Population density	0.057	0.026	0.058	0.027	0.060	0.028	0.060	0.028	0.060	0.028

TABLE VII
THE PANEL ESTIMATION RESULTS OF THE TOBIT RANDOM EFFECT OF THE INFLUENCE FACTORS OF PUBLIC SPORTS SERVICE IN ZHEJIANG

Explanatory variables	Coefficient	*P* value
Constant	0.609	0.092
lnUR	0.136	0.085
lnAR	0.105	0.091
lnPGDp	0.013	0.121
lnFD	0.017	0.136
SD of individual effect	0.0538291	0.542467
SD of random disturbance	0.0423478	0.070774
Spearman's Rho	0.58	0.61
Likelihood-ratio test	150.05	133.19
Log likelihood	233.84	208.29
Samples	55	

In this paper, the efficiency estimation of the relative efficiency of the public sports service in Zhejiang was carried out by using the DEA efficiency evaluation model. Eleven regions were selected as DMUs of the model to analyze the technical efficiency of Zhejiang from 2008 to 2012 by virtue of DEAP2.1 software solution based on the determined evaluation indicator system. Panel data of various regions were used to calculate the input efficiency of public sports service, which was the comparison of relative effectiveness of public sports service in various regions in different years and yielded the following; the technical efficiency of DEA efficiency evaluation method is integrated and operationally efficiency. The average efficiency of public sports service in Zhejiang was on the rise, indicating that the efficiency of public sports service in Zhejiang was constantly improving (as shown in Table III).

A. Efficiency of Public Sports Service in Each Region

As indicated in Table III, from 2008 to 2012, the six cities with top technical efficiency among 11 cities in Zhejiang were Hangzhou, Ningbo, Jiaxing, Quzhou, Zhoushan and Taizhou. The average technical efficiency score of these cities was 1.000. Among them, the efficiency score of public sports service in two cities in northeast Zhejiang and a city in southwest Zhejiang was always efficient, indicating that the efficiency of public sports services in northeastern Zhejiang was better than that in southwestern Zhejiang; followed by Lishui and Huzhou, with scores of 0.982 and 0.980 respectively. Jinhua, Wenzhou and Shaoxing had the lowest technical efficiency, with score of 0.961, 0.931 and 0.848, respectively, suggesting that 0.039, 0.069 and 0.152 resources in these regions were wasted respectively.

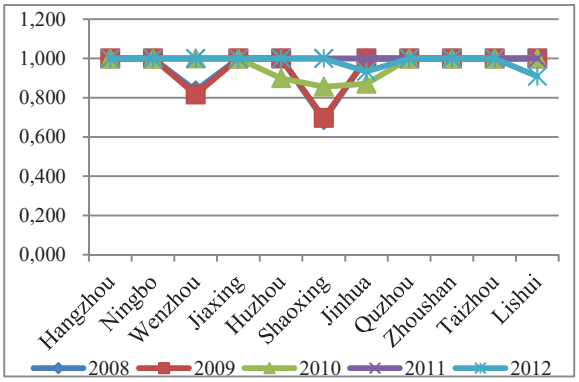

Fig. 1 Technical Efficiency of Public Sports Service in Zhejiang from 2008 to 2012

From 2008 to 2012, on the basis of the fluctuation of relative efficiency in each region, Shaoxing had larger fluctuations. Except that the technical efficiency in Shaoxing reached 1 in 2011 and 2012, it was less than 1 from 2008 to 2010, which was also lower than the mean level of all cities. The specific reason may be that the input-output structure of public sports service resources in Shaoxing is unreasonable, and the allocation efficiency is low or inefficient, causing the efficiency of public sports service not to be fully utilized.

B. Efficiency of Public Sports Service in Different Years

In both 2008 and 2009, the average efficiency of public sports service in Zhejiang was 0.957 and 0.956 respectively, and there were 9 efficient regions. There were relatively less efficient public sports service in Shaoxing and Wenzhou, in east and southern Zhejiang. In 2010, there were 3 regions with relatively inefficient public sports service, Huzhou, Shaoxing and Jinhua respectively, but the average efficiency 0.966 of public sports service was higher than that in 2008 and 2009. In 2011, all 11 regions of Zhejiang achieved totally efficient supply of public sports service. By 2012, only 9 regions achieved efficiency, while Jinhua and Lishui had relatively inefficient supply of public sports services.

The average technical efficiency of the whole province

reached 1 only in 2011, yet it was between 0.93 and 0.97 in other years in Zhejiang. The standard deviation of technical efficiency of public sports service in Zhejiang gradually decreased from 2008 to 2011 and slightly increased in 2012. Overall, it indicates that the inter-area gap in regard to the efficiency of public sports service in Zhejiang is narrowing.

Finally, although the technical efficiency of public sports service was 0.986 in Zhejiang in 2012, higher than the average level from 2008 to 2010, this did not imply that the technical efficiency of the overall public sports service in Zhejiang was better than that in 2008-2010. It just showed that the relative efficiency of public sports service in various cities was relatively higher in 2012. As a whole, the fraction of statistically efficient input-output public sports service in Zhejiang is as follows: 9 out of 11 cities in 2008, 9 out of 11 cities in 2009, 9 out of 11cities in 2010, 11 out of 11cities in 2011 and 9 out of 11cities in 2012. Although all cities failed to reach the efficiency rate in each year, all cities achieved efficient input and output, indicating that the technical efficiency of overall public sports service in Zhejiang improved.

C. Dynamic Change of the Efficiency of Public Sports Service Using Malmquist Index Model

The efficiency of the DEA method reflects the distance between the DMU and the production frontier at the same period [13]. However, there is a difference in technical progress at different times and the production frontier will also change, so the productivity of different periods measured by different frontier standards is incomparable. The previous efficiency value calculated by DEA is only a measure of the relative efficiency of public sports services in Zhejiang in each individual year and is based on static efficiency evaluations of panel data for each period. Although two periods in a certain region are outside of the efficiency frontier and the current DEA, efficiency is lower than the previous one in the region, and the absolute efficiency may be higher than the previous one. Therefore, it is more difficult to find these efficiency improvements and regression of public sports service in Zhejiang through the static DEA efficiency evaluation. By combining Malmquist, DEA can be used to calculate the Malmquist index, [14]-[18] and panel data can be adopted to calculate total-factor productivity and technology change and the effectiveness of technology, so as to measure the productivity changes in the time series of DMU to a large extent, that is, the dynamic changes of efficiency.

According to the index system of efficiency evaluation, the section used panel data-based Malmquist-DEA method to calculate Malmqulst index changes of each year in the reference group (DEA efficiency value in 2008) of public sports service data in Zhejiang from 2008 to 2012. Finally, the DEA efficiency value with continuous time comparability in all regions from 2008 to 2012 was obtained. DEAP2.1 software was also utilized to calculate the Malmquist productivity change based on the DEA efficiency frontier, using previously used categories [5], [6], [19], [20] where effch represents the technical efficiency index, techch represents the technical change index, pech represents the pure technical efficiency index, sech refers to the scale efficiency index, tfpch refers to the total-factor productivity index [19].

The Malmqulst index measures the changes in the productivity of each period. In our study, Malmquist index from 2009 to 2012 was calculated based on the sample data. This index is a comprehensive reflection of the efficiency of public sports service in Zhejiang, which can be decomposed into product of scale efficiency and technical efficiency. In 2009, the mean value of the whole province was 1.153, and overall productivity was higher than that in 2008. From 2009 to 2011, the overall production efficiency was decreasing year by year. In 2012, it recovered to 1.183. Overall, the productivity of public sports service in Zhejiang increased from 2008 to 2012. At the regional level, there were 9 regions with Malmquist index greater than 1 in 2009 and only 2 regions did not reach 1. In 2010, the Malmquist index was greater than 1 in 6 regions, exceeding 50% of the whole province, and output efficiency was the lowest in 2011, which was only 0.966. Only 4 regions saw an increase in production efficiency, with the rest having variable decreases. Although the overall level of productivity was the highest in 2012 (1.183), there were still 4 regions with lower production efficiency than in 2011, indicating widen regional differences in production efficiency. In 2009, except for Huzhou and Jinhua, productivity in the other 9 regions was improved, greater than 1. Among them, the region with the most productivity improvement was Lishui, reaching 1.734, followed by Quzhou and Jiaxing, with productivities of 1.397 and 1.224 respectively. The largest decline in productivity was 0.922 of Huzhou, followed by 0.998 of Jinhua. In 2010, the overall level of production efficiency decreased from 2009, and the decline continued in 2011 and did not ease off until 2012. The region with the largest productivity improvement in 2010 was Wenzhou (1.349) followed by Shaoxing (1.130) and Zhoushan (1.095). The largest decline in productivity was Hangzhou, just at 0.840. In 2011, the decline trend was even more obvious, with the largest decline in Lishui, only 0.696, followed by Taizhou, 0.820. Shaoxing had better improvement (1.338). In 2012, the regions with largest decline in productivity were Ningbo and Shaoxing, 0.746 and 0.855 respectively. The cities with major improvements were Jiaxing and Taizhou, which were 1.792 and 1.755 respectively. The overall productivity has been changing, but generally speaking it tended to be better. From the above analysis, it can be concluded that the reasons for the decline in production efficiency in 2010 and 2012 were due to the regression of technical efficiency. The efficiency regression caused by technical efficiency is the main reason for the productivity regression. The change rate of pure technology and scale efficiency change of the public sports service in Zhejiang are shown in Table V. Technical efficiency change is the product of technical change and pure technical change. In 2012, the rate of pure technical change of 10 regions was greater than 1, with only 1 area below the mean value. In terms of scale efficiency, during 2009-2012, the mean value was greater than 1 in 2009 and 2011. In 2012, the scale efficiency change index of 9 regions was greater than 1, and there were only 2 regions less

than 1, Jinhua and Lishui. And the change efficiency indexes were 0.983 and 0.909 respectively.

D.Factors Influencing the Efficiency of Public Sports Service in Zhejiang

We conducted regression analysis, with the urbanization rate, aging rate, per capita GDP and population density as explanatory variables and efficiency score as the dependent variable. The mean efficiency score of Zhejiang in 2008-2012 showed the trend of going up to 1 and then decreasing (Table VI). The urbanization rate showed a trend of sustained growth, from the lowest 0.550 to the highest 0.603 in 2012. According to the standard deviation results, the variation difference of data in each city decreased. Besides, the aging rate also presented a trend of continuous growth, indicating the number of people over 60 years old is increasing. Moreover, the per capita GDP showed a trend of sustained growth, from the lowest 39817.909 to the highest 70010.182 in 2012. The population density increased first and then remained unchanged, which has grown from 0.057 in 2008 to 0.060 in 2010, and has maintained since then. This increase in population density might have other implications on the delivery of public sports service. Due to the number of independent and dependent variables, the direct regression of the model with traditional linear methods could not be applied as it may obtain negative fitting values. Therefore, the influence factors of the efficiency of public sports service in Zhejiang were tested using the Tobit model of restricted dependent variables. A consistent estimate value usually cannot be acquired through the fixed effect Tobit model. Therefore, with the use of data from 2008 to 2012, our paper adopted random effect Tobit model for analysis, taking the variable efficiency score, urbanization rate, aging rate, per capita GDP and population density as independent variables. where, the variable efficiency score, urbanization rate, aging rate, per capita GDP and population density are expressed as EC, UR, AGR, PGDP and PD respectively. A model for the relationship among EC, UR, AR, PGDP and PD of 11 cities in Zhejiang was established as;

$$ec = c + \alpha^T x_{it} + u_i + e_{it}$$
$$= c + \alpha_1 UR_{it} + \alpha_2 AR_{it} + \alpha_3 PGDP_{it} + \alpha_4 FD_{it} + + u_i + e_{it}$$

The model estimation results are shown in Table VII. In this model, the standard deviation of random disturbance and of individual effect are both small. The Rho mean value was above 0.58, which indicates that the individual variation can mainly explain the change of public sports service efficiency in all regions of Zhejiang. However, it can be seen from the log likelihood that the fitting degree of the model is better. According to the estimated coefficients in the table, the urbanization rate, aging rate, per capita GDP and population density had a significant positive correlation with the efficiency of public sports service in Zhejiang, of which the most significant was the aging rate. However, the population density and per capita GDP had less positive impact on the efficiency of public sports service in Zhejiang.

From Table VII, note that *p* is the corresponding probability level of parameter estimators. The positive correlation between aging rate and the efficiency of public sports service indicates that with the accelerated aging of the population and the improved living standards, the elderly have higher requirements for life and living quality. This therefore reinforces the importance for the elderly participation in sports and fitness leisure activities. Since 2011, more than 60% of the elderly in Zhejiang have participated in physical exercise. Naturally, various sports demand of the elderly increase, and thus impacting the utilization of those public sports service resources. In turn, the government would also increase its investment in this sector.

The urbanization rate had a significant positive impact on the efficiency of public sports service in Zhejiang. For a long time, the existence of urban-rural dual social structure has caused the gap between the economic level of urban and rural residents and the low level of public sports service in rural areas, resulting in the weak sports awareness of the peasants or migrant workers. Although the integration of public sports service in urban and rural areas has been continuously promoted in Zhejiang in recent years, it is difficult to change the sports values of peasants due to natural and social environments in rural area. Yet urbanization has improved living standards, and urban sports facilities have become more complete and public sports services have increased consequently. Therefore, more urban residents get involved in physical exercise, that is, higher urbanization rate suggests greater positive effect on the efficiency of public sports service in Zhejiang.

The slightly positive correlation between population density and the efficiency of public sports service mainly indicates that changes in population density may have less impact on people participating in physical activity. The scale economic effect of the government's public finance investment in public sports service will be more significant if a larger population exists. A higher population density would be conducive for government to provide public sports services and also increase the investment efficiency of public sports service.

V. Discussions

From a national perspective, since the reform and opening up and investment in public sports is seen as an improvement in public health, [20] the national development strategy of these sporting areas has been focused on "taking economic construction as the center" and holding the notion that economic growth can solve all problems in development. Therefore, in the course of its development, there is a general GDP competition everywhere, yet the original intention that the essence of economic growth should improve people's livelihood is ignored, resulting in the mismatch between economic growth and the improvement of public services [21], [22]. For public sports services, economic growth provides the material basis for public sports services. Compared with other countries, China has incommensurate economic capacity at present with the current level of public sports service. Either from the per capita area of sports grounds or the population regularly participating in physical exercise, there is a big gap

between China and developed countries, [23], [24] quite ill-matched with China's international prestige as the second largest economy in the world. Zhejiang ranks top in China in terms of economic development, yet it fails to realize effectively simultaneous improvement of people's livelihood with the rapid economic growth. Therefore, to some extent, the change in per capita GDP will not affect the enthusiasm and participation frequency of people participating in physical exercise [25]. This is probably due to the absence of other motivating factors, that would both directly and indirect increase physical activity participation rates for all people. Also, the rapid economic growth may not necessarily contribute to the efficiency of public sports service. This may be explained by the supply of public sports services such as sports facilities, [26], social sports instructors, sports organizations, national fitness activities and national physical fitness tests, that may not necessarily coincide with the growth of economic and public financial expenditure in a balanced manner [25]. On the contrary, economic growth and increase in population density may lead to the congestion of public sports services, resulting in increased cost yet decreased efficiency. There is a possibility also that the participation in public sports services differs based on the geographical location, as always indicated by differentials in participation in rural versus urban centers, with the latter having an increased participation. [27], [28].

VI. Conclusion

Our paper uses DEA-Tobit method to evaluate the efficiency of public sports service in 11 prefecture-level cities in Zhejiang from 2008 to 2012. The following conclusions are drawn through further analysis on the evaluation results. From 2008 to 2012, the average efficiency of public sports service in Zhejiang was relatively stable, and at a higher level. Compared with the efficiency of public sports service in various regions, Hangzhou, Ningbo, Jiaxing, Quzhou, Zhoushan and Taizhou remained top six in the 11 regions from 2008 to 2012 regarding the regional technical efficiency. The efficiency score of public sports service in two cities in northeast Zhejiang and a city in southwest Zhejiang was always efficient, followed by Lishui and Huzhou, while Jinhua, Wenzhou and Shaoxing had the lowest technical efficiency. Shaoxing had the most unstable condition in terms of the fluctuation of the relative efficiency of each region. In the comparison to the efficiency of public sports service in different years, 9 regions in Zhejiang had efficient public sports service in 2008 and 2009 while Shaoxing and Wenzhou had relatively inefficient public sports service. These regions are located in eastern and southern Zhejiang respectively. In 2010, there were 3 regions with relatively inefficient public sports service, including Huzhou, Shaoxing and Jinhua. The average efficiency of public sports service was higher than that in 2008 and 2009. In 2011, the supply of public sports service in 11 regions in Zhejiang was all efficient.

Finally, the urbanization rate, aging rate, per capita GDP and population density had a significant positive correlation with the efficiency of public sports service in Zhejiang, of which the most significant was the aging rate. However, the population density and per capita GDP had less positive impact on the efficiency of public sports service in Zhejiang. Although all the indicators of efficiency of public sports services in various regions were promising, the resulting benefit in terms of people's wellness, especially in regions with different efficiency levels is not explainable in this paper. It is therefore not clear, that investment in public sports necessarily results in increased participation in exercise, especially for the special populations, that might need it more.

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