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Forest park Efficiency and Influencing Factors in Fujian Province -- based on Dynamic Network DEA and Micro Data

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Abstract:

With the construction of China's ecological civilization and high-quality development, improving the efficiency of China's forest park has become an important issue. Based on the production characteristics of tourism products, the overall efficiency of forest park is divided into production efficiency and service efficiency. With the statistical data in Fujian province of China, dynamic network DEA was used to calculate the specific overall, production and service efficiency of 24 forest parks of Fujian province. Then, regression model based on panel data was constructed to assess and distinguish the causal factors of affecting the overall, production and service efficiency. Study shows that: 1) From 2011 to 2019, average score of service efficiency (0.280) was lower than the average score of production efficiency (0.508), while the service efficiency is more dispersed (St.D =0.316) than service efficiency. 2) Investment density, tour road density, urban population and location have significant impact on production efficiency. 3) Tour road density, urban population, GDP per capita, urbanization level and location have significant impact on service efficiency. 4) All the factors above have no significant impact on service efficiency. What are the factors affecting service efficiency need further research.

Keywords*: Forest park efficiency, influencing factors, dynamic network DEA, Fujian province of China*

I. INTRODUCTION

The utilization of forest resources produces a variety of benefits such as ecological, economic, and social benefits, etc. To realize the value of multi-function of forest resources, especially the ecological value, China began building forest parks and developing forest tourism after 1978. During the past forty years, Chinese government issued a series of policies[1] to promote the development of forest parks. By the end of 2019, the number and area of forest parks of China reached 3,564 and 18.61 million hectares, respectively. In 2019, the number of forest tourists in China exceeded 1 billion; generating total revenue of nearly ￥96.4 billion , about $ 14 billion; increasing afforestation area 61.8 thousand ha [2].

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In recent years, with the increasing tension of Chinese forest resources and the construction of Chinese ecological civilization, forest park efficiency has become a hot topic of academic research. There is a large number of application studies on forest parks efficiency[3]. For example, Peng et al[4] have investigated the efficiency status of each province . Ding & Huang[5] , Su & Ji[6] have studied the spatial and temporal distribution and development characteristics of efficiency of forest parks from provincial. Huang & Lin[7], Huang et al.[8], have explored the reasons for efficiency formation or loss from the provincial level. Internationally, forest resource efficiency has also received more scholars' attention. Bosetti & Locatelli[9] applied DEA to measur the efficiency of 17 National Parks in Italy, by taking management costs, management costs, area extension as inputs, number of annual visitors, historical buildings, protected species, parks employees and so on as outputs, CCR as the basic model. Rusielik and Zbaraszewski[10] calculated the efficiency of scientific and tourism activity of Polish National Parks during 1990s using output-oriented CCR model by choosing the number of scientific works, tourists and educational events as output variables.

Although there are many above papers that focused on forest park efficiencies, existing studies have many limitations.The first is, they all measure the efficiency from the point of provincial level, taking the forest parks of a province as a unit, missing the assessment of efficiencies of forest parks from the point of a single forest park, which will loss the effects affecting the efficiency of forest parks coming from the micro-level. The second is, all these studies use the traditional DEA model to measure the efficiency of forest parks which takes the forest park agency as a black box, which neither can distinguish the causes for the inefficiency from the production side or consumption side [11], nor can capture the dual-effect of some variables in evaluating cross-period dynamic change of efficiency [12].

In resent years, a large of studies across different fields have been carried out using the dynamic network DEA model. For instance, dynamic network DEA has been widely used in manufacturing [13], bank[14], transportation[15], public service[16], etc. These studies used the dynamic network DEA models to obtain new findings that could not be obtained using traditional DEA models. However, to our best knowledge, the dynamic network DEA model has not yet been utilized in studies of forest park efficiency analysis and other tourism efficiency analyses from the point of single forest park.

Fujian Province is rich in forest resources, with a forest coverage rate of 66.8%, ranking first in China for 42 consecutive years. In 2014, it became the national pilot demonstration province for ecological civilization construction. The ecological protection function of forest resources has been paid great attention.Forest park construction and forest tourism development have been in the forefront of 31 provinces of China. In 2019, the number of forest parks reached 176 and the forest park area reached 238,317 ha. So, the paper, taking the forest parks of Fujian province as an object, is the first attempt to study the efficiency of forest parks from the micro point, and divide the efficiency of forest park into production efficiency and service efficiency. The remainder of the paper is organized as follows. Section 2 establishes a dynamic network efficiency model. Section 3 outlines the methodology leading to our analysis. Section 4 describes empirical findings and Section 5 concludes.

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II. EFFICIENCY FORMATION THEORETICAL AND MOEDL ESTABLISHMENT

Tourism products and services have typical characteristics such as intangibility, heterogeneity, inseparability, simultaneity and perishability which made it difficult to synchronize supply and demand [17-18]. Demand is not only decided by inside factors of the provider of tourism products or services, such as the quality of tourism product or service, marketing, etc, but also affected by outside factors, such as the economic climate, consumer preferences, the industrial environment, etc., most of which are not controlled by the provider of tourism products or services. Due to the simultaneity and perishability of tourism products and services, when evaluating forest parks performance, if not distinguishing between the tourism service provisions and consumption, we will be difficult to find the real cause leading to loss of efficiency of forest park. So, depending on the tourism product formation theory provided by Stephen[19], we split forest tourism production into two stages including production process and service process. To overcome the limitations of black-box-based DEA and capture all the effects of forest park behavior on the efficiency, referring to the analytical framework of the dynamic network DEA model established by Tone&Tsutsui [12], we form a theoretical framework for the efficiency evaluation of tourism products in forest parks (Fig 1). The overall efficiency of a forest park decomposes into production efficiency and service efficiency.

Depending on the producing theory of tourism products, during the production process, forest parks need to transform the investment funds into forest tourism facilities. Under the same capital investment, the more forest tourism facilities, the greater the potential of forest tourism reception, the greater the production efficiency of a forest park. So, we choose the land area, annual capital investment and ecological protection funds of each forest park as the initial input variables, the tourism facilities (length of tour roads, number of vehicles and ships, number of meals, and number of beds as the output variables(intermediate). At the same time, forest parks also need investing to protect forest resource and environment by afforestation and reforestation which will increase the ecological benefit of this period, and attraction of nest period. So,we choose the accumulated afforestation and reforestation as carry-over

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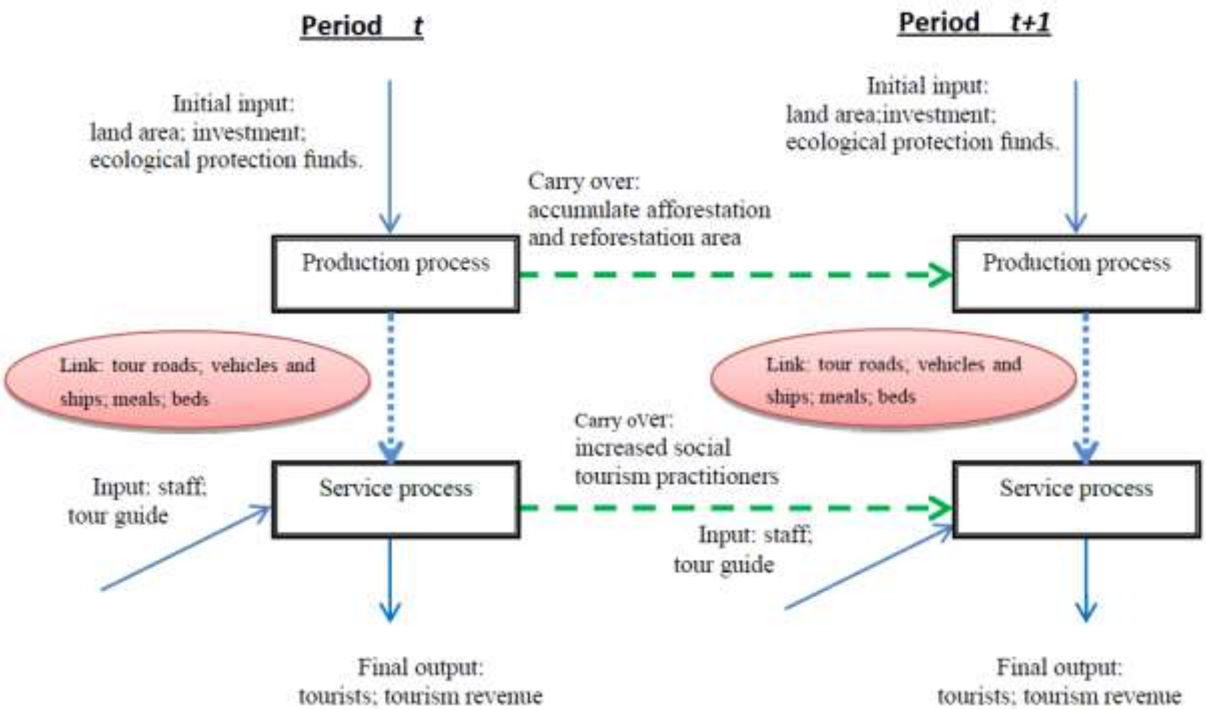

variables.

Fig 1: efficiency formation structure of a forest park

During the service process, besides the intermediate output variables, the forest park also need labor providing services to visitors. Therefore, staff and tour guides are the intermediate input variables. Increased social practitioners in last period will increase the service supply of this period. So, the increased social practitioners in last period is taken as carry-over variables. Depending on the main functions of forest parks in China, the final outputs include ecological benefits, social benefits, and economic benefits. Ecological benefits are mainly manifested in the increment of benefits brought by the ecological protection of forest park, and so we express them with the cumulative afforestation and reforestation area. Economic benefits are directly expressed by the economic revenue received by forest park. Social benefits are manifested as how many tourism opportunities brought to citizens, directly expressed by the number of tourists.

III. MATERIALS AND METHODS

In this part, we first use the dynamic network DEA model to establish the evaluation of forest park efficiency, then build the regression analysis model that affects the efficiency of forest parks, and illustrate the data sources needed for parameter estimation.

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3.1 Efficiency assessment

Assume there are K forest parks, i.e., $DMU_k(k=1,2,\cdots,K)$, and each forest park conducts both production and service process. During the production process, specific factors $x_{vk}^{P}(v=1,2,\cdots,V)$ are used to produce intermediate outputs $z_{rk}(r=1,2,\cdots,R)$ which immediately become inputs associated with specific inputs x_{hk}^{S} $(h=1,2,\cdots,H)$ for the service process to produce the final outputs $y_{jk}^{S}(j=1,2,\cdots,J)$. In addition, both production and service processes involve c_{gk}^{P} $(g=1,2,\cdots,G)$ and c_{fk}^{S} $(f=1,2,\cdots,F)$ items that were not finished in the previous period, taken as cover over variables.

Under variable returns to scale (VRS), following the SBM-DN-DEA framework proposed by Tone & Tsutsui (2014) [12], we not only deal with multiple divisions connected by network structure links within each period but can also consider the dynamic effects of interconnecting activities on forest park agency performance.

The production efficiency score of park forest agency k for period t is given by

$$PE_k^t=\frac{1-\dfrac{1}{V+G}\left(\sum_{v=1}^{V}\dfrac{s_{vk}^{t-*}}{x_{vk}^{P,t}}+\sum_{g=1}^{G}\dfrac{s_{gk}^{t-*}}{c_{gk}^{t,t+1}}\right)}{1+\dfrac{1}{R+G}\left(\sum_{r=1}^{R}\dfrac{t_{rk}^{t+*}}{z_{rk}^{t}}+\sum_{g=1}^{G}\dfrac{s_{gk}^{t+*}}{c_{gk}^{t,t+1}}\right)},t=1,2,...T \quad , \tag{1}$$

The service efficiency score of park forest agency k for period t is given by

$$SE_k^t=\frac{1-\dfrac{1}{H+R+F}\left(\sum_{h=1}^{H}\dfrac{s_{hk}^{t-*}}{x_{hk}^{M,t}}+\sum_{r=1}^{R}\dfrac{t_{rk}^{t-*}}{z_{rk}^{t}}+\sum_{f=1}^{F}\dfrac{s_{fk}^{t-*}}{c_{fk}^{t,t+1}}\right)}{1+\dfrac{1}{J+F}\left(\sum_{j=1}^{J}\dfrac{s_{jk}^{t+*}}{y_{jk}^{S,t}}+\sum_{f=1}^{F}\dfrac{s_{fk}^{t+*}}{c_{fk}^{t,t+1}}\right)},t=1,2,...T \tag{2}$$

The overall efficiency score of forest park agency k for period t is given by

$$OE_k^t=w_k^P(t)*PE_k^t+w_k^S(t)*SE_k^t \quad , \quad t=1,\ldots,T\,. \tag{3}$$

3.2 Establishment of regression model

Forest parks provide a spatial carrier for tourism services.Whether this space can translate into benefits is affected by multiple factors. Capital investment of the forest park is the first important affecting element. Generally speaking, the more capital investment, the more perfect the tourism facilities, the higher the quality of the facilities. Related studies showed that the level of capital investment in forest parks has significant effects on forest park efficiency (Ding et al., 2016).In addition, Huang et al.(2017), Qin &

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Cheng (2020) concluded that ecological protection investment has a significant positive impact on the development and efficiency of forest parks.

Using the method of regression analysis to identify the factors influencing the efficiency of forest park. The paper refer to the relevant research, choose the capital investment density, tourism road density of forest park as influencing factors; The location, per capita GDP, population, urbanization rate of the city that the forest park located as control variable. Per capita GDP and urban population adopt logarithmic form. Since there are 9 cities in Fujian, Zhangzhou city is taken as the basis for comparison, and 8 dummy variables are set for the other 8 cities. The model is established as follows.

$$Y = \beta_0 + \beta_1 invd + \beta_2 trd + \beta_3 \ln gdpp + \beta_4 \ln pop + \beta_5 urbr + \sum_{i=1}^{8} \gamma_i d_i + \varepsilon \qquad (4)$$

Y stands for the efficiency score of OE, PE, SE, invd stands for annual investment density of forest parks (1000 ￥/ha), *trd* stands for tour road length of forest parks (km), *gdpp* stands for per capita GDP(CHY), *POP* stands for urban population (ten thousand person), urbr stands for urbanization rate (%), and *di* (i=1,2,...8) stands for urban Dummy variable, βi (i=1,2,...5), γi (i=1,2,...8) is the parameter needs to be estimated. ε is stochastic disturbance.

Because the dependent variable is efficiency value which is between 0 and 1 and the data is panel data, the panel data Tobit model estimation method is adopted to estimate the parameters.

3.3 Sample selection and data collection

Fujian had 138 forest parks in 2011, increased to 176 in 2019. Based on the representation of the forest parks and the continuity and availability of the data, 24 forest parks were selected for the study, which are distributed in nine cities of Fujian province, and include 23 national forest parks and one provincial forest park. The input and output data of each forest park comes from the annual statistics of the Forestry Department of Fujian province. The data of *gdpp*, *pop* and *urbr* comes from yearbook of Fujian statistics from 2012 to 2020. The specific information of each forest park is shown in TABLE 1. A statistical description of these data is shown in TABLE 2.

TABLE 1.The specific information of the 24 forest parks

CODE	NAME	RANK	CITY	AREA (HA)	CONSTRUCTION TIME(YEAR)
A1	Fuzhou National Forest Park	national	Fuzhou	2891.3	2000
A2	Fuqing Lingshi	national	Fuzhou	2275	2001

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	Mountain National Forest Park				
A3	Longyan National Forest Park	national	Liongyan	2200	2000
A4	Shanghang National Forest Park	provincial	Liongyan	4894.92	2003
A5	Yongding Wangshoushan National Forest Park	national	Liongyan	1535.2	2009
A6	Changting State Forest Park	national	Liongyan	226.73	2006
A7	Wuyishan National Forest Park	national	Nanping	3085	2004
A8	Fujian Kuangshan National Forest Park	national	Nanping	2175.13	2009
A9	Pingnan Tianxing Mountain National Forest Park	national	Ningde	1861.9	2008
A10	Ningde Zhitishan National Forest Park	national	Ningde	2299.93	2006
A11	Putian Jiulong Valley National Forest Park	national	Putian	1091.5	2008
A12	Dehua Shiniushan National Forest Park	national	Quanzhou	8411	2003

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A13	Sanming Fairy Valley National Forest Park	national	Shanming	1488	2003
A14	Sanyuan National Forest Park	national	Shanming	4572	2000
A15	Kowloon Bamboo Sea National Forest Park	national	Shanming	1704.6	2008
A16	Tianjie Mountain National Forest Park	national	Shanming	939	2003
A17	Fujian Maoershan National Forest Park	national	Shanming	2560	2000
A18	Fujian Minjiang Source National Forest Park	national	Shanming	1182.52	2008
A19	Xiamen Lotus National Forest Park	national	Xiamen	3824	2003
A20	Changtai Tianzhu Mountain National Forest Park	national	Zhangzhou	2983	1995
A21	Hua'an National Forest Park	national	Zhangzhou	8153.33	2000
A22	Zhao'an Wushan National Forest Park	national	Zhangzhou	6920.2	2004
A23	Dongshan	national	Zhangzhou	874.6	2002

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	National Forest Park				
A24	Nanjing Tulou National Forest Park	national	Zhangzhou	2233.83	2010

TABLE 2. Descriptive statistics of input and output variables of 24 forest parks.

PROCESS	VARIABLE TYPE	VARIABLE NAME	MAX	MIN	MEAN	STANDARD DEVIATION
PRODUCTION PROCESS	Input	Land area (ha.)	8411	226.73	2932.61	2204.53
		Investment (10000 CNY)	17974.64	6.89	1485.93	3718.52
		Ecological protection funds (10000 CNY)	2269.33	0.00	185.23	465.75
	Output (carry over)	Accumulated afforestation and reforestation area (ha.)	5582.62	8.44	398.81	1125.88
	Output (link)	Vehicles and ships (unit)	106.67	0.00	15.38	24.22
		Tour roads (km)	453.33	4.22	41.30	89.05
		Reception beds (unit)	1036.67	0.00	214.90	262.94
		Reception meals (unit)	6700	0	779.66	1381.00
SERVICE PROCESS	Input (link）	Same as input (link)				
	Input	Tour guide (person)	64.33	0	14.61	18.78
		Staff (person)	180	0	57.22	49.98
	Output	Tourists (CNY 10000 person)	467.85	0.51	47.06	101.09
		Tourism revenue (10000 CNY)	34623.33	0	2892.86	7354.06
	Output (carry over)	Social tourism practitioners (person)	6300	0	621.83	1397.77

IV. EMPIRICAL FINDINGS

By calculating the overall efficiency,production efficiency and service efficiency using the model (1), (2) and (3), the spatial-temporal features of efficiencies of 24 forest parks are summed up. Then, by estimating the parameters of regression model (4), the main factors of overall efficiency, production efficiency and service efficiency are derived. The main outcomes are as follows.

4.1The Outcome of efficiency calculating

4.1.1 Large difference and variation of efficiency scores between forest parks

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The overall efficiency score (OES), production efficiency score(PES) and service efficiency score (SES) of 24 forest parks are described in Fig 2. Overall, the average score of service efficiency (0.280) was lower than the average score of production efficiency (0.508), while the service efficiency is more dispersed (St.D =0.316) than service efficiency (St.D= 0.232) (Fig 3, Fig 4). The average level and fluctuation of overall efficiency score is between the production efficiency score and service efficiency score.

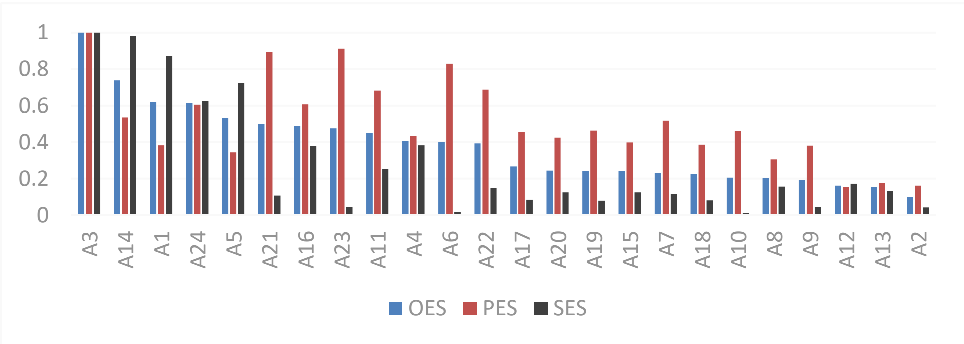

Fig 2 Efficiency comparison of each forest park

Fig 3. The box plot of the efficiency scores

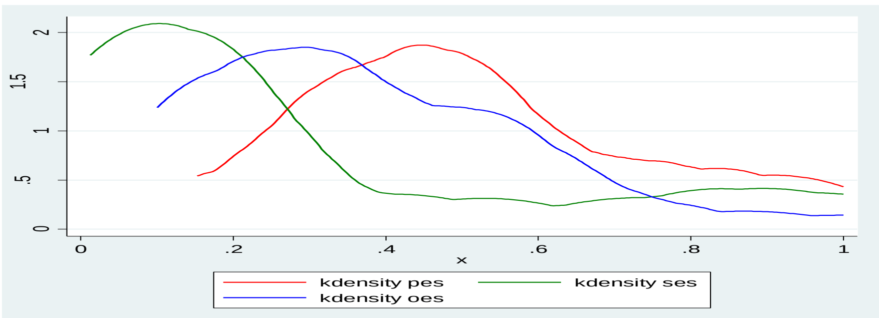

Fig 4. The Kernel density plot for the efficiency scores

Compare the efficiency score of each forest park, we know that, there are great variation. The

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efficiency varies greatly between forest parks, and most forest parks have inconsistent scores in the two stages.The production and service processes of A3 have been effective from 2011 to 2019, with a total efficiency value of 1. A24 also has high production efficiency and service efficiency, and relatively balanced development and high overall efficiency. In addition, the production and service efficiency of other forest parks are very inconsistent. A6,A21, A23 have high production efficiency (PES>0.8) and low service efficiency(SES<0.1); On the contrary, A1, A5, A14 have high service efficiency(SES>0.7) and low production efficiency(SES<0.4). However, the overall, production and service efficiency score of A2,A12,A13 are very low,all less than 0.2.

4.1.2 Efficiency rises steadily and slightly with time

The variation of efficiency with time from 2011 to 2019 is show in Fig 5.

From the average of efficiency, production efficiency showed a significant steady growth trend from 2011 to 2017. PES increased from 0.4 in 2011 to 0.58 in 2017, but showed a downward trend in recent two years, dropping to 0.49 in 2019. Service efficiency showed a slight downward trend from 2011 to 2014. SES decreased from 0.31 in 2011 to 0.25 in 2014, and then began to rise, reaching 0.32 in 2019, slightly higher than the level of 2011. The combined changes in production efficiency and service efficiency resulted in a steady small increase in total efficiency, with OES increasing steadily from 0.35 in 2011 to 0.39 in 2019.

From the standard deviation of efficiency, the changes of production efficiency, service efficiency and total efficiency basically remain stable from 2011 to 2019. The standard deviation of production efficiency has been maintained at 0.25-31, the standard deviation of service efficiency at 0.30-0.35, and the standard deviation of total efficiency at 0.2-0.25.

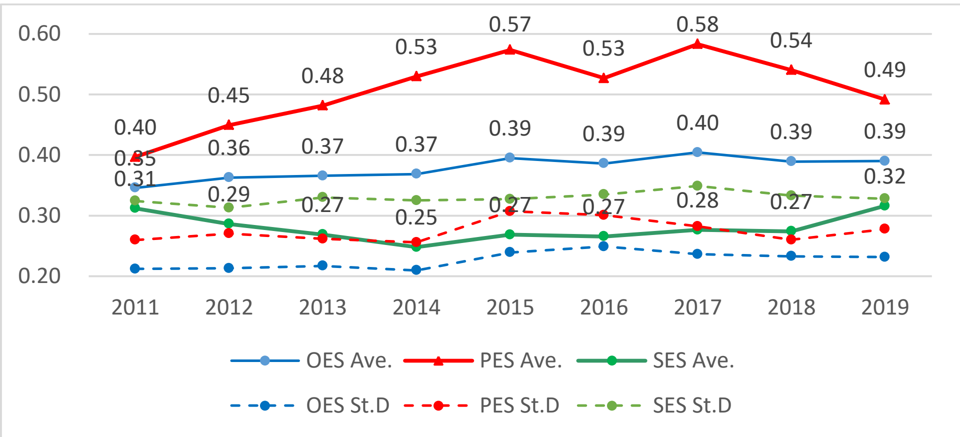

Fig 5. The Average and St.D of OES, PES and SES in 2011-2019

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4.2 The Outcome of regression

By tobit estimation method based on panel data, the estimated results are shown in TABLE 3. The estimates of some factors are basically in line with our expectations, and some factors have a certain gap with our expectations, which requires further investigation.

TABLE 3. The estimated results of regression model

DEPENDENT VARIABLE	PES			SES			OES		
	Coef.	z	P>|z|	Coef.	z	P>|z|	Coef.	z	P
invd (100 thousand yuan/ha)	-0.13**	-2.13	0.033	0.06	1.33	0.183	-0.02	-0.59	0.554
trd (km/10 thousand ha)	0.126***	6.66	0	-0.007	-0.79	0.429	0.033***	5.9	0
ln*gdpp*	0.0223	0.15	0.884	-0.1258	-1.14	0.254	-0.1253*	-1.8	0.071
ln*pop*	0.2450***	3.05	0.002	-0.4258	-0.72	0.473	0.7056*	1.89	0.059
urbr	0.0027	0.22	0.822	0.0119	1.35	0.177	0.0133***	2.4	0.016
d1	-1.3879***	-4.02	0	0.3128	0.93	0.355	-0.4753**	-2.18	0.029
d2	1.5358***	2.82	0.005	0.1720	0.39	0.698	0.6585**	2.35	0.019
d3	1.3850***	2.65	0.008	-0.3478	-0.78	0.434	0.2514	0.89	0.376
d4	1.0867**	2.36	0.018	-0.4067	-1	0.318	0.1556	0.6	0.55
d5	1.4506***	3	0.003	-0.2183	-0.47	0.636	0.4107	1.38	0.167
d6	-1.7339***	-3.88	0	0.1191	0.27	0.787	-0.6948**	-2.45	0.014
d7	1.4594***	2.59	0.01	-0.1850	-0.42	0.678	0.4203	1.49	0.137
d8	0.2898	0.69	0.49	-0.5009	-1.18	0.239	-0.3282	-1.2	0.232
_cons	-15.1091	-3.25	0.001	3.5829	1.04	0.296	-3.3549	-1.55	0.12
sigma_*u*	0.1481	5.63	0	0.2889	6.55	0	0.1904	6.53	0
sigma_*e*	0.1414	18.61	0	0.1041	18.87	0	0.0657	19.27	0
rho	0.5233			0.8851			0.8937		
Wald chi2	100.61 (P=0.0000)			12.19 (P=0.5121)			66.90（P=0.0000）		

From the rho, we known that, the estimation results using panel Tobit method are better than those without panel Tobit. However, according to Wald Chi2 value, ESE model is not significant in terms of organization given significance level a =0.1, indicating that the variables selected in the model cannot explain the source of service efficiency. PES model and OES model are significant on the whole, indicating that the variables selected in the model can significantly explain the sources of production efficiency and overall efficiency.

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From the PES regression model, investment density (*invd*) has a significant negative impact on PES at the level of 0.05, while tour road density (*trd*) and urban population (*pop*) have a significant positive impact on PES at the level of 0.01 The coefficients of multiple d_i are significant at the level of 0.01, indicating that the location of forest park in the city has a significant impact on production efficiency.

The regression model of OES shows that tour road density (*trd*) and urbanization level (*urbr*) have significant positive effects on OES at 0.01 level, and urban population (pop) has significant positive effects on OES at 0.1 level. GDP per capita (*gdpp*) has a significant negative impact on OES at the level of 0.1, which is inconsistent with the general cognition, but consistent with the empirical results of several scholars. Multiple di coefficients are significant at the level of 0.05, indicating that the location of forest park in the city has a significant impact on the overall efficiency.

From the specific regression coefficient, for the PES, the other factors remain unchanged, forest park investment density has increased by 100,000 yuan per hectare, production efficiency will fall by 0.13; Adding 1 kilometer of per hectare of tour road density will increase production efficiency by 0.126; Urban population grew by 1%, will increase production efficiency by 0.2450. For OES, while the other factors remain unchanged, adding the tour road density for 1 km per 10,000 hectares, will increase the overall efficiency by 0.033; Per capita GDP has increased 1%, will reduce the overall efficiency by 0.1253; Population has increased 1%, will increase the overall efficiency by 0.7056; Urbanization has increased by 1%, will increase the overall efficiency by 0.0133.

V. CONCLUSION AND FURTHER RESERACH

From the study we get some important conclusions.

First, on the whole, the average level of production efficiency is higher than the average level of service efficiency. The efficiency of forest parks varies greatly among individuals. Second, from the perspective of time trend, the production efficiency of forest parks shows a relatively stable and small upward trend, but the upward trend of service efficiency is not obvious.

Third, the investment density of forest parks has a significant negative impact on the production efficiency of forest parks, while the density of tourism roads and urban population have a significant positive impact on the efficiency of forest parks.

Fourth, the density of tourism roads of forest parks,urban population and urbanization level have a significant positive impact on the overall efficiency of forest parks, and per capita GDP has a significant negative impact on the total efficiency of forest parks.

Urban per capita GDP, urban population, urbanization level and so on are not the influencing factors of service efficiency of forest park. The formation mechanism of service efficiency is different from the production efficiency. What factors affect the service efficiency of forest park? Maybe the quality of tourism product, the competitive of tourism product, the price, the marketing behavior or other factor. But because we have not any official statistics on these variables, we do not included these variables into the regression model. Getting data of these variables through other ways to identify factors affecting the service efficiency of forest park will be the key point of our next study.

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REFERENCES

[1] Luo F,Brent D M ,Bao J G , et al. 2016. The role of institutions in the production of space for tourism: national norest parks in China. Forest Policy and Economics,70(1):47-55.

[2] China Forestry Information Network. forest park construction. www.lknet.ac.cn. 2021.

[3] Qin, G. Y., Cheng, B. D., (2020). Can protective investment promote tourism development of forest parks? an empirical study at the forest park level in China. Chinese Rural Economy, (2),100-117.

[4] Peng H S , Zhang J H , Lu L , et al. 2017. Eco-efficiency and its determinants at a tourism destination: A case study of Huangshan National Park, China. Tourism Management,(60): 201-211.

[5] Ding Z M,Huang X J. 2016. Capital input effects on the tourism efficiency of forest parks in China. Resources Science,38(7): 1363-1372. In Chinese

[6] Su L,Ji X R . 2021. Spatial-temporal differences and evolution of eco-efficiency in China's forest park.Urban Forestry & Urban Greening,57: 126894.

[7] Huang X J, Lin X Z. 2015. Tourism efficiency and influence factors of Chinese forest parks. Scientia Silvae Sinicae, 51(2): 137-146.

[8] Huang A S, Lan S R, Zou H B. 2018. Research on factors influencing the provincial technical inefficiency of forest parks under multi-output targets in China.Resources Science,40(8): 1595-1607. In Chinese

[9] Bosetti, V., Locatelli, G. , (2006). A Data envelopment analysis approach to the assessment of natural parks economic efficiency and sustainability,The case of Italian National Parks. Sustainable Development, 14(4), 277-286.

[10] Rusielik,R., Zbaraszewski,W. (2014).The efficiency of scientific and tourism activity of Polish National Parks with use DEA method.Economic and Environmental Studies, 14(3), 283-297.

[11] Kao C. 2020. Decomposition of slacks-basmeal efficiency measures in network data envelopment analysis. European Journal of Operational Research, 283: 588–600.

[12] Tone, K., Tsutsui, M., (2014). Dynamic DEA with network structure, A slacks-based measure approach.Omega, 42 (1), 124-131.

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[13] Lu, C. C., Dan, W., Chen, X., et al., (2021). Evaluation of the operating performance of Taiwanese machine tool industry with the dynamic network DEA model. Enterprise Information Systems, 15(1),87-104.
[14] Wanke, P., Azad, M. A. K., Emrouznejad, A., et al., (2019). A dynamic network DEA model for accounting and financial indicators, A case of efficiency in MENA banking. International Review of Economics & Finance, 61(C), 52-68.
[15] Losa, E. T., Arjomandi, A., Dakpo, H., et al., (2020). Efficiency comparison of airline groups in Annex 1 and non-Annex 1 countries, A dynamic network DEA approach.Transport Policy, 99,163-174.
[16] Barrio-Tellado, D., José, M., Gómez-Vega,M., et al. , (2021). Urban public libraries, Performance analysis using dynamic-network-DEA. Socio-Economic Planning Sciences, 74, 100928.
[17] Zeithaml, V. A., Parasuraman, A., & Berry, L. L. (1985). Problems and strategies in services marketing. Journal of Marketing, 49(2), 33–47.
[18] Yu M M, Lee B C Y, (2009). Efficiency and effectiveness of service business, evidence from international tourist hotels in Taiwan. Tourism Management, 30: 571-580.
[19] Stephen L J S. , (1994). The Tourism product. Annals of Tourism Research, 3(21):582-595.