Study of the Utilization Efficiency and Its Influencing Factors of Water Resources in Yangtze River Economic Belt

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Abstract. The Yangtze River Economic Belt has gradually become one of the regions with the strongest comprehensive strength and the greatest strategic competitiveness in China. Promoting the utilization efficiency of water resources in various provinces and cities in this region and minimizing the restraint effect of insufficient utilization of water resources on the economy can provide strong support for the development of the region from the perspective of water resources. The SBM model was used to measure the water use efficiency of 11 provinces and cities in the Yangtze River Economic Zone from 2007 to 2017 and Tobit model was used to identify the key influencing factors. The results show that the water use efficiency of the provinces and cities in the Yangtze River Economic Zone varies greatly, and the total factor productivity index of water resources shows an overall growth trend, which is mainly determined by the scale efficiency. The per capita GDP and the proportion of the first industry have a significant positive effect on the water use efficiency, while the government's investment in water resources and per capita water resources endowment have a significant negative correlation. Based on this, some countermeasures and suggestions are put forward, such as strengthening inter-regional technical cooperation, optimizing water use structure, and reasonably investing in water conservancy facilities projects.

1. Introduction
With the acceleration of the pace of building an environment-friendly society in China, it has been listed in the 13th five-year plan to grasp the high-speed economic growth and adhere to sustainable development. On the basis of rapid economic development, increasing the intensive use of resources is the key to achieve this goal, and improving the utilization rate of resources is of great significance for sustainable development [1]. The Yangtze River economic belt across the three regions of China's East, West and Middle covers 11 provinces and cities, although it only accounts for 21.39% of China's land area, but covers more than 40% of China's population, and also creates 40% of the country's GDP every year [2]. Since the reform and opening up, the Yangtze River economic belt has continuously developed into one of the most comprehensive and powerful strategic supporting areas in China. Therefore, the national level attaches great importance to the Yangtze River economic belt. In April 2018, President Xi Jinping held an important speech to further promote the development of the Yangtze River economic belt. As early as 2014, the State Council issued the guiding opinions of the State Council on promoting the development of the Yangtze River Economic Belt relying on the golden waterway (hereinafter referred to as the "opinions"), and put forward seven requirements for
the development of the Yangtze River economic belt. The "opinions" mentioned that the Yangtze River water resources should be effectively protected and utilized, and the rational utilization of water resources should be strengthened. The 13th five-year plan for China's national economic and social development also mentioned that the overall improvement of ecological environment quality should pay attention to the effective control of water consumption.

Shortage of water resources is a global problem. Scholars at home and abroad pay more and more attention to how to use water resources efficiently to alleviate the shortage of supply and demand. In terms of the problem of uneven supply and demand of water resources, improving the utilization efficiency of water resources is an effective way to solve the imbalance between supply and demand of water resources [3] - [5]. In terms of the way to improve the utilization efficiency of water resources, industrial structure will form different types of deviation for water resources consumption [6] - [7]. In terms of the way to improve the utilization efficiency of water resources, increasing investment in science and technology, rational use of capital and labor will improve the efficiency The utilization efficiency of water resources can promote [8] - [9]. From the perspective of economic development, the coordinated development of economy and environment is the foundation of building a resource-saving society. On the one hand, the main branches of the economy have an impact on the utilization efficiency of water resources [10], on the other hand, the improvement of the utilization efficiency of water resources is conducive to the local food export [11]. Therefore, quantitative analysis of the internal laws among economic development, water resource utilization and water ecological carrying capacity is particularly important for regional scientific development and sustainable development [12]. There are some particularities and differences in the study of economic development and water resource utilization efficiency of urban agglomerations. As far as China is concerned, regional economic analysis can be carried out for cities in Northeast China [13] - [14] and Sichuan Basin [15] - [16], or research on the differences among three urban agglomerations in China. This reflects that there are similarities and differences in the economic development level of urban agglomerations. In order to achieve a sustainable green economy, we should focus on the comprehensive advantages and overall needs formed in the development process of urban agglomerations, the overall layout of spatial structure and the optimization of industrial structure. In terms of the measurement method of water resource utilization efficiency, many domestic and foreign mathematicians use DEA Data Envelopment method to study water resource utilization efficiency, or analyze its utilization efficiency from the perspective of industrial water , or agricultural irrigation water, or analyze the difference of water resource utilization efficiency based on the space-time grid, or according to the location conditions and natural conditions of 31 provinces in China, combined with the scale economic effect of DEA, the utilization efficiency of water resources was quantitatively analyzed. From the data interpretation of DEA method, or from the technical efficiency and scale efficiency of DEA input-output to explain and analyze the utilization efficiency, or from the economic efficiency, or from the environmental efficiency to do empirical analysis on the utilization efficiency.

At present, the research mostly evaluates and analyzes the efficiency of water resources from the perspective of economic output of water resources utilization, neglecting the influence of other aspects. In this paper, environmental factors and policy factors are introduced to evaluate the efficiency of water resources of urban agglomeration in the Yangtze River economic belt. In order to provide data reference for building a better water-saving and sustainable development society, this paper will take the impact of various factors on the efficiency of water resources utilization as the starting point for empirical analysis.

2. SBM Model Analysis

2.1. Data Source and Model Construction

Based on the panel data of 11 provinces and cities in the Yangtze River economic belt from 2007 to 2017, this paper calculates the water resource utilization efficiency value of the Yangtze River economic belt. The input indicators are annual urban water consumption, urban social fixed asset
investment, and urban population at the end of the year. The output indicators are expected output and unexpected output. The unexpected output is annual urban sewage discharge, and the expected output is total urban national production value. The data are from China Statistical Yearbook and China Environmental Statistical Yearbook.

Table 1. Evaluation System of Input and Output.

| Input                                      | Output                                      |
|--------------------------------------------|---------------------------------------------|
| Annual urban water consumption             | Annual urban sewage discharge                |
| Urban social fixed asset investment,       | Total urban national production value        |
| Urban population at the end of the year.   |                                             |

Combing the existing literature, according to the availability of data, six indicators, namely, economic development level (EL, per capita GDP), water resource endowment (WR, per capita water resources), agricultural industrial structure (FIS, proportion of GDP of primary industry), water saving index (SW, water consumption per 10000 yuan of GDP), urban development level (CL, urbanization rate at the end of the year), and government influence (GI, proportion of relevant expenditure in public budget expenditure), are selected as independent variables. The data comes from China Statistical Yearbook and China Environmental Statistical Yearbook. This paper constructs the model as follows:

$$W_{it}=C+\beta_1\ln EL_{it}+\beta_2\ln WR_{it}+\beta_3 FIS_{it}+\beta_4 SW_{it}+\beta_5 CL_{it}+\beta_6 GI_{it}+\epsilon_{it}$$  \hspace{1cm} (1)

2.2. SBM Model Results

Use maxDEA to calculate the water resource utilization efficiency of the Yangtze River Economic Belt in 2007-2017, and get the calculation results of comprehensive technical efficiency. From the perspective of comprehensive technical efficiency, the overall average value of 11 provinces and cities in the Yangtze River economic belt is 0.791, which is at a higher level than the frontier. Shanghai has been at the forefront of production for 11 consecutive years, ranking first with an average of 1.000. The eastern region of the Yangtze River Economic Belt (Shanghai, Jiangsu and Zhejiang) also shows a high level of water resource utilization efficiency as a whole. The average of the three provinces and cities in 11 years is respectively in the first, fourth and second place of 11 provinces and cities, showing a more obvious agglomeration effect. The two provinces with the lowest average efficiency value are Anhui and Hubei, which are mainly in the middle of China; the three provinces in the west, except Sichuan, which are in the ninth place, Guizhou and Yunnan are in the forefront, which are respectively the third and fifth of 11 provinces. Several provinces with high average water resource utilization efficiency have reached the production frontier for many years, such as 11 years in Shanghai, 7 years in Jiangsu, 9 years in Zhejiang and 9 years in Guizhou, while none of the four provinces with the lowest average (Chongqing, Sichuan, Anhui and Hubei) has reached the frontier for one year, and no year has not reached 1.00 in the overall distribution of the collected time series.

In order to better analyze the sources of water resource utilization efficiency values of provinces and cities in the Yangtze River economic belt, the comprehensive technical efficiency is divided into pure technical efficiency and scale efficiency by using maxdea software. From the perspective of pure technical efficiency, Shanghai and Jiangsu have reached the forefront of technical efficiency for 11 consecutive years in 2007-2017, ranking first. Zhejiang, also located in East China, has not reached the forefront of technical efficiency in 2017, so the average value ranks third; Yunnan Province, ranking third in the comprehensive technical efficiency, ranks fourth in 2017 due to its low efficiency value; comprehensive technology The efficiency of Hunan Province is higher than that of Chongqing, and the average value of pure technical efficiency is 0.759 lower than that of Chongqing. In addition, the average ranking of other provinces is consistent with the comprehensive technical efficiency. It can be seen that Anhui and Hubei need to optimize and upgrade their industrial structure, while Jiangsu, Zhejiang, Shanghai and Guizhou Province have low industrial energy consumption.
From the perspective of scale efficiency, Shanghai still ranks the first in terms of technology frontier for 11 consecutive years, and Yunnan Province also ranks at this level, so the ranking of Jiangsu Province and Zhejiang Province has dropped by one respectively. In the western provinces and cities, the ranking of scale efficiency value of Guizhou and Chongqing is lower than that of pure technical efficiency value, which shows that such areas need to improve management level, so as to improve scale efficiency, and can learn from the model of Sichuan Province.

3. SBM Model Analysis
The calculation results of Tobit model show that the industrial structure, water resource endowment, economic development level and government influence have passed the significance test, as shown in Table 2.

| Variable | Coefficient | Standard Error | Variable | Coefficient | Standard Error |
|----------|-------------|----------------|----------|-------------|----------------|
| EL       | 0.204***    | 1.021          | SW       | -0.167      | 0.108          |
| WR       | -0.228***   | 0.016          | CL       | -0.036      | 0.000          |
| FIS      | 0.012***    | 0.002          | GI       | -0.004***   | 0.001          |

The specific results are analyzed as follows.
First, the industrial structure has a significant positive effect on the efficiency of water resources utilization. This paper adopts the proportion of the first industry, so the higher the proportion of the first industry in the local area, the higher the efficiency of water resources utilization, which shows that the local water resources utilization efficiency of the secondary and tertiary industries is lower than that of the first industry, so the higher the proportion of the secondary and tertiary industries, the lower the efficiency of water resources utilization.

Second, the water resource endowment, that is, the per capita water resource share has a significant negative effect on the water resource utilization efficiency, which is inconsistent with the research results of Ma Hailiang et al. and the research results of Zhang Zhaofang et al. This shows that the more abundant the water resource endowment is, the lower the utilization efficiency is. According to the analysis of the reasons, the more insufficient the water resource endowment is, the higher the awareness, willingness and the possibility of taking water-saving measures are. On the contrary, the lower the water resource endowment is, the lower the utilization efficiency is and the serious waste of water resource is.

Third, the level of economic development has a significant positive effect on the efficiency of water resources utilization, which shows that the more developed the economy, the higher the efficiency of water resources utilization. This is mainly because the higher the per capita GDP of the region, reflecting the more developed industry, more advanced industrialization, naturally high degree of industrial agglomeration, which is more conducive to the development of water-saving technology, production equipment, water conservancy facilities construction and other aspects, and helps to improve the efficiency of water resources utilization.

Fourth, the proportion of agricultural, forestry and water expenditure in public expenditure has a significant negative effect on water resource utilization efficiency, which is consistent with the research conclusions of Zhang Zhaofang et al, who also believe that the higher the government's participation, the lower the water resource utilization efficiency. On the one hand, due to the government's increasing expenditure on water conservancy and environment, the level of investment refinement is insufficient, and there is a decreasing effect of scale, so to a certain extent, it will naturally promote the improvement of water resource utilization efficiency, but after excessive investment, it will cause the marginal decline of resources; on the other hand, the expenditure on pollution prevention and control of fixed assets is often used for post remediation of polluted areas, most of which It is still "pollution before treatment" in different regions, rather than prevention and
control of pollution sources in advance. Therefore, even if more investment is made, it may also be used for pollution treatment with higher cost, with less effect.

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