Evaluation of Environmental Pollution Control Efficiency in Qingdao City And promotion countermeasures research

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Abstract. Analyze the input and output status of various environmental pollution control projects in Qingdao from 2007 to 2015, and then use the super-efficiency DEA and ML index methods to calculate the comprehensive efficiency. The results show that the comprehensive efficiency of environmental pollution control is increasing year by year, but compared with advanced cities, there is still a big gap; scale efficiency has not been optimal, and scale returns are diminishing; the efficiency of industrial waste gas, industrial waste water, sewage treatment and greening is relatively low, and the efficiency of waste and waste treatment is relatively high. The input or output scale of pollution control projects should be adjusted, the concentration of treatment should be improved, and the system improvement, technology and management level should be promoted.

1. Introduction

The beautiful ecological environment is the competitiveness of Qingdao. Constantly optimizing the ecological environment is an important means for Qingdao to gather high-end talents and capital, promote industrial and technological upgrading, and thus enhance the image and grade of the city. It is also the ultimate goal of serving people's livelihood. In this context, environmental pollution control has become an indispensable component of Qingdao's urban public governance system, and it is also the main content of environmental public services, and the various expenditures required for governance need to be protected by various funds. Under the financial hard constraints, improving the efficiency of the use of environmental pollution control investment funds is the proper meaning of sustainable environmental governance, and also an important manifestation of supply-side reform in the provision of public services.

The efficiency of environmental pollution control in this paper is the contrast between the amount of funds invested in the governance process and the amount of pollution controlled by the output, and the economic efficiency of governance. The purpose of pollution control efficiency evaluation is to achieve the maximum pollution control output with minimum pollution control input, and the role is to find ways to improve pollution control efficiency. Foreign countries have paid great attention to the study of environmental governance performance. In the 1960s, the US government established an indicator system based on the quality of environmental services, and used specific evaluation methods of specific pollution control projects to conduct performance evaluation. Some international comparative studies have found that China ranks second to last in terms of environmental governance efficiency in 31 countries in Asia Pacific. [1] More detailed calculations show that China's environmental governance
efficiency is only about one-third of the countries with high governance efficiency. [2] Around 2010, domestic research on environmental pollution control efficiency began to increase, but not for specific pollution control projects, but for the overall environmental pollution control efficiency. Some studies show The average environmental pollution control efficiency of the western provinces is higher than that of the central and eastern regions, which may not be in line with general cognition. Therefore, it is necessary to carry out objective efficiency evaluation. [3] From the perspective of specific provinces, Shandong Province has a high efficiency in environmental pollution control and is one of the top five provinces in the country. [4] Qingdao City needs to understand the status of its environmental pollution control efficiency, therefore, this The paper studies the dynamic changes of environmental pollution control efficiency. At the same time, as a sub-provincial city, a planned city and a more developed city, Qingdao should compare with the same level of cities and even higher to understand environmental pollution control. Efficiency in the location of comparable cities, find problems, and analyze the causes of the problems, and then find ways to improve, which will play a guiding role in improving the implementation level of environmental protection policies.

2. Input and output status of environmental pollution control in Qingdao

Urban environmental pollution mainly includes air pollution, noise pollution, water pollution, solid waste pollution, etc. The main causes of air pollution are industrial waste gas and automobile exhaust, as well as a small amount of domestic exhaust gas pollution. Water pollution is mainly caused by industrial wastewater and domestic sewage. Solid waste includes industrial solid waste, hazardous waste, and garbage. Environmental pollution control includes the treatment of the above pollutants. In addition, because landscaping has an aesthetic function, it also plays a positive role in reducing air pollution, reducing noise, purifying water and other pollution control. [5] Landscaping expenditures are also included in urban environmental pollution control expenditures. The input of environmental pollution control is the expenditure of various costs and expenses of governance, including two parts, one is fixed capital investment, the other is operating cost, the former is constant cost, and the latter is variable cost. The output of environmental pollution control is the amount of treatment of various pollutants. Combined with the availability of data, this paper constructs the following indicator system to comprehensively reflect the input and output status of pollution control (Sec Table 1).

| Table 1. Input and Output Indicator System for Environmental Pollution Control |
| --- |
| Environmental pollution control | output | input |
| Industrial waste water treatment capacity | Operating expenses fixed asset investment |
| Industrial waste water treatment capacity | |
| Number of processing facilities | |
| Industrial waste gas treatment capacity | |
| Industrial waste gas treatment capacity | |
| Number of processing facilities | |
| Sewage treatment | |
| Sewage treatment capacity | |
| Number of sewage treatment plants | |
| Waste treatment capacity | |
| Waste treatment capacity | |
| Number of waste treatment plants | |
| Garbage disposal | |
| Garbage disposal capacity | |
| Number of garbage disposal plants | |
| Green area | |

For comparative research, this paper selected 4 municipalities directly under the central government, Ningbo, Xiamen, Shenzhen, Nanjing, Wuhan, Guangzhou, Chengdu, Xi'an, Hangzhou, Jinan, Dalian, Shenyang, 12 sub-provincial cities, and Suzhou. The choice of 4 municipalities is because their economy is relatively developed and the degree of comprehensive development is relatively high. It is highly
representative for Qingdao. 12 cities such as Ningbo are selected because they are the same as provincial cities and economics. The level of development is close and the comparability is very strong. Suzhou was chosen because it is a prefecture-level city, but its economic scale is slightly larger than Qingdao, ranking first in the country. The sample period of this research is from 2007 to 2015. The relevant data used are from *The China Environmental Yearbook*, *THE China Urban Construction Statistical Yearbook* and *THE Qingdao Statistical Yearbook*.

From the investment situation of environmental pollution control, the proportion of the above-mentioned various pollution control expenditures in Qingdao increased from 0.3% in 2007 to 0.75% in 2012 and dropped to 0.25% in 2015. The 9-year average is 0.39%, ranking 10th among 18 cities, and the investment in pollution control is relatively low. This paper calculates other relevant indicators to reflect the detailed status of environmental pollution control inputs and outputs in Qingdao, including: average processing capacity per facility, loading rate of processing facilities, and cost per unit of processing.

Load rate and average processing capacity of various pollution control facilities

The average processing capacity per facility = processing capacity / number of facilities, reflecting the scale of pollution treatment, and scale is an important way to improve efficiency. Load rate = actual processing capacity / processing capacity, it is one of the important indicators of whether the facility is fully utilized, the high load rate of the facility indicates that its idleness is low, and the higher utilization rate helps to reduce the fixed investment of amortization, thereby improving effectiveness.

It can be seen from Table 2 that the concentration of industrial wastewater treatment in Qingdao has increased year by year, and the scale of the scale is obvious. The load rate of the facilities is also on the rise, which is conducive to the improvement of efficiency. Work The load rate of industrial wastewater treatment facilities increased from the 10th place in 2007 to the 3rd place in 2015. The load rate of sewage treatment facilities is relatively stable, with a slight increase in the vicinity of 0.7. The average processing capacity per plant has increased overall, and the scale trend has appeared. However, the rankings of the two indicators are stable and stable, and the utilization rate and scale of facilities are large. The utilization is relatively inadequate. The load of waste treatment facilities dropped first and then increased. Currently, it is close to 1, and the utilization of facilities is high, but the average per plant Processing capacity is generally declining, and ranked in the last two or three, the degree of scale is urgently needed to improve. Although the average processing capacity of waste per plant has increased, it is relatively backward compared with other cities, and the average scale is still relatively small. The processing capacity of each exhaust gas treatment facility is ranked higher before 2014, but it has declined rapidly since 2014 and is currently stable at the midstream level.

Table 2. Statistics of environmental protection facilities load rate and average processing capacity of Qingdao over the years

|                | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|----------------|------|------|------|------|------|------|------|------|------|
| Industrial waste water | 0.34 | 0.32 | 0.34 | 0.36 | 0.79 | 0.80 | 0.82 | 0.84 | 0.83 |
| Sewage | 0.68 | 0.70 | 0.72 | 0.78 | 0.74 | 0.73 | 0.79 | 0.80 | 0.75 |
| Trash | 0.92 | 0.97 | 0.89 | 0.88 | 0.87 | 0.82 | 0.79 | 0.7 | 0.95 |
| Litter | 1.17 | 1.60 | 1.84 | 1.39 | 1.18 | 1.12 | 1.5 | 1.5 | 1.9 |
| Exhaust gas | 5253 | 5036 | 6095 | 6464 | 6180 | 5928 | 4885 | 4318 | 3690 |

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Note: 1. The first to fourth lines of industrial waste water, sewage and garbage are the load rate and its ranking respectively., average processing capacity and its ranking, the average processing capacity of industrial waste water is: 10,000 tons / set The unit of facility, sewage and garbage average treatment capacity is: 10,000 tons / plant. The average processing capacity and ranking of the first and second actions of waste and waste gas, the unit of average waste treatment capacity is: ton / Factory, the unit of exhaust gas is: 10,000 cubic meters / set of facilities. 2. Due to incomplete data, only the average processing capacity of hazardous waste after 2011 is calculated. 3. load rate and average facility processing capacity ranked from high to low

3. Unit throughput cost

The cost per unit of processing refers to the fixed cost and cost of processing each pollutant per ton and building green space per square meter. It directly reflects the efficiency of various pollution treatments, that is, the ratio of economic input to environmental protection output. This article uses the operating costs in the statistical yearbook as an expense, which includes: Energy consumption, equipment maintenance, personnel wages, management fees, pharmacy fees and other expenses, etc., the total operating costs depends on the amount of pollutants processed or the number of green space construction, is a variable input. The fixed cost is the fixed asset investment that should be amortized. The cost is equal to the operating cost plus the fixed asset cost that should be amortized annually. The new tax law stipulates that the depreciation period of building construction assets is 20 years, and the equipment and equipment assets are 10 years. Since the total investment includes these two types of assets but lacks classified investment data, we use the average 15 year depreciation period to calculate the annual Fixed capital investment that should be amortized. Cost of unit throughput = unit operating cost + unit fixed input. Since the amount of exhaust gas treated in the yearbook provides the treatment capacity of sulfur dioxide, nitrogen oxides, soot and dust, the input is the fixed input and operating cost data of the total exhaust gas treatment. Therefore, after standardizing the four pollutants in this paper, The re-synthesis process adopts the max-min standardization method to linearly change the original data. The normalized value = (original value - minimum value) / (maximum value - minimum value), and the normalized value of the four pollutant treatment amounts Comprehensive summation of industrial waste gas.

| Table 3. Costs and rankings of unit treatments of various pollution in Qingdao |
|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Industrial       |      |      |      |      |      |      |      |      |      |
| wastewater       | 3.15 | 3.54 | 3.74 | 3.73 | 1.11 | 0.73 | 0.93 | 0.89 | 0.97 |
| Sewage           | 1.11 | 1.3  | 1.56 | 1.57 | 1.66 | 1.6  | 1.85 | 1.85 | 2.03 |
| Trash            | 21.45| 28.71| 34.73| 47.23| 67.37| 84.85| 114.04| 129.3 | 121.78|
| Landscaping      | 1.29 | 1.44 | 1.71 | 1.92 | 2.43 | 3.32 | 3.16 | 3.41 | 5.54 |
| Litter           | 0.83 | 0.79 | 0.67 | 0.67 | 7.99 | 37.7 | 44.61| 47.64| 65.17|
| Exhaust gas      | 0.28 | 0.10 | 0.10 | 0.11 | 0.08 | 0.11 | 0.11 | 0.15 | 0.15 |

Note2: The first line of data for each pollution treatment is the unit cost. Except for waste gas and greening, the unit is: yuan/ton. The unit of waste gas is: yuan/ton comprehensive treatment volume, and the greening unit is : yuan / square meter; the second row of data is the ranking of Qingdao in 18 cities, ranking from unit cost to low.

As can be seen from Table 3, the cost per ton of industrial wastewater in Qingdao has been declining year by year, and the ranking has risen year by year, and the efficiency has increased. Cost per ton of
sewage treatment from 2007. The annual increase of 1.11 yuan to 2.03 yuan in 2015 is ranked lower in comparable cities, and the treatment efficiency is relatively low. The cost per ton of waste disposal increased from 21.45 yuan in 2007 to 121.78 yuan in 2015. The increase was much higher than the price increase in the same period, and the ranking was stable and moderate, and it is currently in the middle. The cost per square meter of greening has risen rapidly and the ranking has declined. This may be an increasing emphasis on the investment in green space construction in Qingdao. The quality or gold content of green space is increasing, for example, it may be a higher-priced green variety; It is the decline of investment efficiency, and it takes more money to build every square meter of green space. The efficiency evaluation of this paper uses the latter explanation. The cost per ton of waste treatment began to surge in 2011. This is because wastes included general waste and hazardous waste before 2011. Only hazardous wastes were included after 2011. The cost of hazardous waste treatment is much higher than that of general waste, so we only examine it. Horizontal ranking, the ranking is relatively stable and belongs to the lower middle level. The cost of exhaust gas is generally maintained between 0.1 and 0.15 yuan per unit of comprehensive treatment. The ranking has risen steadily and is now at the forefront.

4. Conclusion
There is still a big gap between the efficiency of environmental pollution control and advanced cities. From 2007 to 2015, Qingdao's environmental pollution control efficiency has improved in the ranking of comparable cities, but it is still in a lower position. In terms of overall efficiency, Qingdao has risen from 14th to 10th in 18 comparable cities, but it is still in the second half of the echelon. Compared with cities such as Shenzhen, Hangzhou and Xi'an, there is still a big gap.

Promote the improvement of the system of environmental pollution control. An important reason for the diminishing returns on scale is that institutional improvement and technological progress need to be improved. As the main responsibility of pollution control, the government must give full play to the role of supervision, conduct more effective regulation of urban pollution control, and implement more effective rewards and punishments. In particular, it is necessary to strengthen the supervision and management of the cost of public utilities engaged in pollution control. Output accounting, as well as environmental supervision of polluting enterprises; second, it is necessary to carry out institutional innovation and implement reform of the supply side of environmental protection services.

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