Concession Price Adjustment Decision in Wastewater Treatment BOT Project

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***Abstract*—This paper proves that the minimum volume guarantee and concession price adjustment schemes are important means of the government to transfer the project risks by measuring the impact of the minimum volume guarantee and concession price adjustment schemes on the BOT project's earnings. We analyzed the risk allocation function of the different volume guarantees and concession price adjustment schemes. The results of case analysis show that the low volume guarantee level and the reasonable concession price adjustment scheme can more effectively guarantee the reasonable profits of the project. And accelerate the implementation of BOT financing mode in wastewater treatment projects.**

***Index Terms*—Wastewater treatment project, minimum volume guarantee, BOT, concession price.**

I. Introduction

The social capital participated in the construction of public wastewater treatment project takes more BOT financing mode in our country. Social capital obtains the concession through bidding and set up a project company to be responsible for the construction and operation of the project. The government department pay a wastewater treatment fee to the project company after the project company provide wastewater treatment service. According to the profit model of wastewater treatment BOT project, the wastewater treatment fee paid by the government department is the project company's source of income during the operation. Therefore the concession price and volume level are the key factors that determine the overall income level of the project. BOT project's concession period is long and it faces complex and changeable business environment in operation stage. From the perspective of the operation practice of wastewater treatment BOT project in our country, on the one hand many projects gained the minimum volume guarantee from the government department. On the other hand there is a regular concession price adjustment mechanism that is the basis of wastewater treatment fee paid by government departments considering the factors of elements' price adjustment and inflation. These agreed terms in the agreement provide an important guarantee for the project company to achieve expected return.

The concession price adjustment decision and the minimum volume guarantee directly affect the distribution of risk and profit between government departments, social capital and the social public. This paper discusses the different influences of different concession price adjustment period on the mean and volatility of project earnings based on analyzing the effect of risk allocation in different volume guarantee level. And provides decision-making basis for the government in the concession price adjustment decisions in wastewater treatment BOT project.

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II. Concession Price Decision in Wastewater Treatment BOT Project

A. Function of Minimum Volume Guarantee

Government guarantee is an effective way to transfer project risk and attract social capital to actively participate in public project investment. Under the situation of concession price is given in Wastewater treatment BOT project, whether the project achieved expected volume level and the fluctuation of the volume become the key variables that affect project revenue. In order to guarantee the project achieve the expected profit and share the risk of project operation reasonably, government departments often provide the minimum volume guarantee for social capital in the concession agreement of wastewater treatment BOT project. If the actual capacity of wastewater treatment plant doesn't reach the capacity that government guaranteed, the government will pay a wastewater treatment fee to the project company according to the capacity of the guaranteed as a payment. If the actual capacity exceeds the amount of government guaranteed, the government will pay a wastewater treatment fee according to the actual capacity. Therefore, the higher the minimum volume guarantee level, the more security the project company's earnings. But the guarantee level is too high also means that the government department assumes a greater potential risk for the payment.

Due to the minimum volume guarantee, operation income of the project is the higher of the actual operating income and the product of the concession price and guaranteed volume. Let the basic concession price of wastewater treatment is P_0, the actual volume for each operation period of the project is Q_t, the minimum guaranteed volume provided by the government is Q^*, the operating income of project company in year t as shown in equation (1)

$$OR_t = max[P_0 \times Q_t, P_0 \times Q^*] \quad (1)$$

B. Determination of Basic Concession Price

The determination of reasonable basic concession price is the premise of making effective concession price adjustment decision. Wastewater treatment service belongs to quasi-public products, for the realization of supply and demand

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equilibrium of quasi-public products and social welfare maximization, government departments must intervene the price. In the BOT financing mode, the government chooses the appropriate social capital through bidding. In the concession agreement of project, the rate of return on investment is the most important factor to achieve win-win cooperation between public and private sector. The government department makes concession price in the range of certain return on investment of the project.

Based on the above analysis, the determination of basic concession price of the project can use net present value method. As the project company take achieving expected profit as the goal, according to the determined internal rate of return, make the net present value in concession period is zero. And determine the cash inflows and calculate the reasonable range of basic concession price. Due to the minimum volume guarantee, operating income of the project is the higher of the actual operating income and the product of the concession price and guaranteed volume. The calculation of project's NPV as shown in formula (2).

$$NPV = \sum_{t=T_b+1}^{T_c} \frac{\max\left(P_0 \times Q_t, P_0 \times Q^*\right) - C_t \times Q_t}{\left(1+IRR\right)^t} - \sum_{t=0}^{T_b} \frac{I_t}{\left(1+IRR\right)^t} \quad (2)$$

The other variables in the formula represent something as follows: C_t is the cost of unit volume of operation and maintenance in year t, Q_t is the volume of the project in year t, I_t is the construction investment of the project in year t, IRR is the expect internal rate of return of the project company, T_c is the concession period. T_b is the project construction period.

The elements of pricing in the formula of determining basic concession price including the amount of investment, volume of every year, discount rate, concession period and operational costs of project. Investment and concession period is generally be ensured at the beginning of project. Volume of every year is the expected annual capacity of the wastewater treatment plant. If the water inflow is less than the maximum load of wastewater treatment plant, the capacity is the water inflow. If the water inflow is more than the maximum load, the capacity is the maximum load. The discount rate in the formula is the industry average discount rate. Operating costs include electricity, labor costs, chemical cost, daily maintenance, administrative fee, laboratory fees, sludge disposal charge, financial expense and taxes.

III. Necessity and Research Basis of Concession Price Adjustment

A. Necessity of Concession Price Adjustment

The wastewater treatment BOT project in our country is not fully market-oriented operation. The buyers of its service is the government. The concession period of the wastewater treatment BOT project is up to 30 years. In the long concession period, the social economic environment will change a lot. Inflation, the rising cost of raw material and power will influence the realization of the project company's target profit. The government should adjust the concession prices regularly based on the risk sharing in order to reduce the influence of external environment on the project incomes. The country imposed<the management method of wastewater treatment fee's collection and using> at the end of 2014 has been clear about the determination method of wastewater treatment fee's collection standard and the adjustment matters of wastewater treatment fee.

The concession price adjustment decision mainly considers the price of electricity changes and inflation risk. Electricity is the main driver of energy in wastewater treatment plant, the rise in prices will push up the project company's operating costs and reduce project profitability. Electricity prices set by the national authorities. Therefore, the government should bear the risk of cost increases caused by rising electricity prices. Inflation will make the cost of the project company rise and so as to earnings shrink. In the case of the wastewater treatment concession price is made by government, the risk of inflation should pass to the government through concession price adjustment mechanism.

B. Research Basis of Concession Price Adjustment

Domestic scholars Chen and Lu (2006) [1] proposed that the concession price adjustment principles of infrastructure PPP project are effectiveness, sustainable development, equity and incentives. And proposed three price adjustment method based on selling price, sales revenue and profit after tax. Zhao *et al.* (2006) [2] designed a restrictive concession price adjustment mechanism that allow the project company to adjust prices in the frequency and magnitude of the provisions. And it addressed the shortcomings that the project company in BOT project can't adjust concession price independently to adapt to the changing economic conditions. Wang *et al.* (2010) [3] analyzed the factors that affecting the concession price adjustment of urban transport infrastructure PPP project, and used genetic algorithms and the neural network complementary advantages principle to build a concession price adjustment model. Yang *et al.* (2008) [4] summed up the key risk factors that affect the concession price, according to the risk that the government commitment and the risk that the government and the project company share gives two price adjustment method of unit price adjustment and total price adjustment in the concession price of wastewater treatment BOT project. Yi (2009) [5] given two concession price adjustment formulas of less than and more than the minimum guaranteed capacity based on the impact of the amount of water on the concession prices, and provided a reference for the concession price adjustment decisions. Foreign scholars Tam (1997) [6] pointed out that making a reasonable concession price adjustment decision can promote the successful implementation of BOT projects, the concession price adjustment decision is related to the smooth operation of BOT projects. Subprasom *et al.* (2005) [7] argued that adjust the basic concession price once every three years.

Reasonable concession price adjustment mechanism could establish the relations of market economic agents between the project company and the government, and ensure that the project company's wastewater services get a long-term reasonable profit stably. Combined with the academics research of the early stage, this article's

concession price adjustment decision mainly consider the fixed adjustment period and amplitude of concession price that the government and the project company agreed in the concession agreement. And combined with the guaranteed and promised volume level, it analyzes the impact of different price adjustment period and adjustment range on the BOT project incomes.

IV. Case Study of Concession Price Adjustment Decision

A. Case Background

August 2011, the government of Hekou District of Dongying city Shandong province and Heilongjiang Water Treatment Co., Ltd. signed a concession agreement that authorized the Heilongjiang Water Co. Ltd. built wastewater treatment plant in Shandong Hekou blue economic development zone in BOT mode. Hekou government provided wastewater to the project as the agreed quality and quantity and payed the wastewater treatment fees. The total investment is 137.41 million CNY, the concession period is 30 years, including one year of construction period and 29 years of operation period. The project was completed and put into production in January 2014, and the project is running well. The design of capacity of wastewater treatment is 40,000 cubic metre/day, basic price is 2.82 CNY/cubic metre. Less volume is expected at the beginning of operation, the first year only 2.2 cubic metre/day, then gradually increases, up to 3 cubic metre/day in the second year, reaches 3.5 cubic metre/day in the third year, 44,800 cubic metre/day in 4th-6th years, 5.04 cubic metre/day in the 7th-13th years, at last keeps at 5.6 cubic metre/day in 14th years to the end of operation. Major operating costs of the project including electricity costs, labor costs, chemical costs, sludge transportation costs, amortization expenses, repairs and other expenses. Electricity is expected to 0.7339 CNY/kwh, labor costs 66,656 CNY/month, chemical costs include PAC 1800 CNY/ton, PAM 30000 CNY/ton, hydrochloric acid 800 CNY/ton, sodium chlorate 4200 CNY/ton, sludge transportation costs 50 CNY/cubic meter, amortization fee is the amortization of fixed assets according to 29 years of investment, repair costs charged by 1.5%, and other fees charged by the general rate 5%.

Due to large investment and long payback period, the risk of projects is large, public and private sides reached a minimum volume guarantee commitments in the concession agreement. Meanwhile, in order to ensure the normal operation of the wastewater treatment plant and a certain self-development capacity, allow the wastewater treatment plant to adjust concession price in accordance with the changes in operating costs.

B. Decision of Concession Price Adjustment

This paper uses the project's NPV measure project benefits, determines the project discount rate as 8% in accordance with the <construction project economic evaluation methods and parameters> for wastewater treatment industry average level of the discount rate. The volume and operating costs in wastewater treatment plant will fluctuate over time, since both are non-negative, defines them lognormal distribution in Monte Carlo simulations. Volatility take the volatility of stock price of Heilongjiang Water Co., Ltd. in recent years, is approximately 30%. Then calculate the impact on project benefits in these three kinds of concession price adjustment scheme under different volume guarantee level. They are adjusting once every 3 years by 3%, once every 2 years by 3%, once every one year by 3%. Guarantee level respectively take unguaranteed, 60% and 80% and 100% of design wastewater treatment capacity. To simplify the processing of problem, we assume that guaranteed level remains unchanged from the beginning to the end of operation.

By Monte Carlo simulation, through 10,000 times iterative calculations and obtain the simulation results of NPV's mean and volatility, shown in the Tables I and II, wherein the volatility represent by coefficient of variation.

TABLE I: NPV of Price Adjustment under Different Guarantee (Unit: RMB in Millions)

The mean value of NPV	Not adjusted	Adjust every 3 years	Adjust every 2 years	Adjust every 1 years
Unguaranteed	58.1552	111.2901	145.9199	266.7235
60%	63.1982	117.1319	151.0476	272.3271
80%	77.8492	131.0298	164.212	286.2643
100%	106.5111	159.2805	196.0413	318.5197

TABLE II: NPV Volatility of Price Adjustments under Different Guarantee

The volatility of NPV	Not adjusted	Adjust every 3 years	Adjust every 2 years	Adjust every 1 years
Unguaranteed	55.69%	30.61%	24.94%	16.15%
60%	48.99%	29.24%	23.58%	15.58%
80%	38.14%	24.63%	20.43%	13.98%
100%	24.22%	17.72%	15.68%	11.16%

It can be seen from the results of the impact on project's earnings in the different levels of government guarantees and the three concession price adjustment programs, shorten concession price adjustment period can make the project company's earnings almost exponential growth. Due to the concession price adjustment period shorter, the rate of mean's increases is greater than the standard deviation increases in amplitude, so the relative volatility (coefficient of variation) also becomes small.

V. Conclusion and Suggestion

Concession price adjustment makes the profit of the project to increase and stabilize. It has the same effect with the government guarantee. More frequent concession price adjust, higher the earnings and stability of the project will be. According to the results of case study, in order to promote the construction of wastewater treatment BOT project in our country and environmental protection, we propose the following three proposals.

The impact of concession price adjustment on project benefits significantly higher than the income adjustment effect of the minimum volume guarantee. With the frequency of concession price adjustment shorter, the

project company's earnings grow exponentially with the adjustment cycle, and far beyond the income level of the project under 100% guarantee level. Due to the better profit adjusting effect of concession price adjustment, in the case of double protection of minimum volume guarantee and concession price adjustment, in order to prevent the project company to obtain excessive returns, it is recommended to take the policy of adjust concession prices once every three years.

Government needs to increase social wastewater treatment fees appropriately based on concession price adjustment decisions. Government departments charged wastewater treatment fee from wastewater emission units and users based on water consumption, then pay to the project company in accordance with the concession price and settlement volume. Compared with western countries, our country charged unit price of wastewater treatment from water users is lower, the financial burden of the government is larger when pay wastewater treatment fees to the project company. The fixed wastewater treatment fees government charges from the wastewater emission units and users can't keep up with the long-term development of social economic. So it must be more subsided by the government. The wastewater treatment fees charged form water demand unites or users appropriately regulated can contribute to improve the development of social environmental protection and living environment, conducive to the development of the whole society.

Minimum volume guarantee combined with concession price adjustment decision make government departments guarantee project benefits in a relatively low cost. Minimum volume guarantee can reduce business risk of the project company in operation period. If the guarantee level is too low, it can't attract investment of social capital side. If the guarantee level is too high that the government will undertake more operational risks of the projects and bear higher payment costs. And also increase the financial burden on government departments. Concession price adjustment scheme with the modest rise in wastewater treatment fees will transfer part risk of the project to the public. So the combination of relatively low volume guarantee level and concession price adjustment scheme make the government guarantee the project's income in relatively low cost. It achieves a win-win between government departments, social capital and the public .And it promotes the development of social utility.

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