Research on the Realization of Risk Sharing of Changing Market Demands in PPP Projects of Sewage Treatment

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Abstract. Through literature analysis, the minimum demand guarantee is identified as the main way to realize the risk sharing of market demand changes in PPP projects of sewage treatment including two price structures, namely the total cost and the two-part charging structure. Firstly, three representative cases are selected from the project database; Secondly, the composition of the service fee settlement price of the three water quantity intervals is comparatively analyzed, that is, the actual treated water quantity is less than or equal to the basic water quantity, between the basic water quantity and the designed water quantity, and is larger than the designed water quantity. Finally, on this basis, three management implications are proposed for the PPP-related practice departments.

1. Introduction
As PPP model is widely used in the field of sewage treatment, and the operation is relatively mature, the government requires new projects in various regions to apply this model based on the file of Finance [2016] No.90. The basic condition for the smooth cooperation between the public and private parties in the PPP project is that the private sector receives a reasonable return on investment, and the return on investment of sewage treatment projects depends mainly on its market demand, that is, the quantity of sewage treatment. However, due to many factors, its market demand is unstable. For example, the shutdown of chemical companies has led to a decline in water inflows, and regional development and population growth have led to a surge in water inflows[1]. The instability of the market environment leads to the differences between the market forecast and the actual demand, which leads to risks. According to the file of Finance [2014] No.113, the minimum demand risk is borne by the government, whose purpose is to make the government share certain demand risk, increase the financing ability of the project and stimulate social capital. Both public and private parties cannot control the occurrence of market demand risks and bear the losses caused by them alone[2], so it is more fair and reasonable for both parties to share the demand risks of market changes[3], which is also
in line with the principle of “risk sharing and revenue sharing” of PPP projects. The document does not address the specific circumstances of the reasonable setting of the minimum requirements guarantee, and there is little literature on its in-depth study. Therefore, this paper will refine this issue.

2. Literature analysis

2.1 minimum demand guarantee

Through the literature analysis of market demand changes, for PPP projects that are paid for usage, the government and social capital share the risk of market demand change mainly by providing minimum demand guarantee of government. For example, Chunzhi Ou and Kang Jia [4] pointed out that in order to prevent the unpredictable objective factors of both parties, that is, the market demand is seriously overestimated and the project is bankrupt, the government generally provides the minimum demand guarantee to the social capital, so that the project's income can cover the cost. The research on minimum demand guarantee mainly includes the following two aspects based on further search for literature of minimum demand: ① Set minimum demand usage. Some scholars calculate the minimum demand through establishing model. Zuxiang Peng et al. [5] build model of government subsidy minimum demand calculation model by using the option pricing method and the net present value method, and propose the calculation idea of the minimum demand; while others take the pre-project forecast quantity as the reference value of the minimum demand. Mohamed Marzouk [6] thinks that the base inflow can be used as a reference to calculate the minimum flow guarantee through the case study of sewage treatment; ② Adjust unit price based on different intervals of demand. The research results of Ling Gao et al. [7] indicates that when the demand decreases, effective demand compensation requires the government to reset the reasonable price ceiling, and the corresponding conditions are obtained by constructing the model of private sector and consumer surplus.

2.2 the price structures of PPP projects of sewage treatment

“Sewage treatment service fee”, “PPP projects of sewage treatment pricing / price adjustment” are used as the “subject” to search relevant literature on CNKI, we can know that the academic community has basically reached a consensus on adjusting the unit price of sewage treatment service fee by using the price adjustment formula method. However, according to different cost basis, there are the following two kinds of charge price structures: ① unit price of sewage treatment service fee based on total cost [8]; ② settlement based on the two-part charging structure which includes two parts, one is the basic cost unrelated to the amount of sewage treatment, ie the fixed cost; the other is the variable cost paid according to the sewage treatment quantity [9].

In order to better realize the reasonable risk sharing of changing market demand between public and private, the government should set the corresponding unit price according to the actual treated water quantity. Existing studies have not reached a consensus on this. In view of this, this paper will use the case analysis method to conduct further research on it.
3. Case study on PPP projects of sewage treatment

3.1 Case selection criteria

This paper will select corresponding cases to study according to the above two price structures. The selected cases must satisfy three conditions simultaneously: ① The cases are representative and exemplary[10]. The sources of projects are limited to the 13 typical PPP projects published by the national development and reform commission, or the national demonstration projects in the project management database of the government and social capital cooperation center of the ministry of finance, or the PPP projects with great significance involving authoritative consulting institutions such as Jibang and Dayue; ② The selected cases include two fee price structures; ③ The availability of case data is high, which is convenient to provide the information needed in this paper. After case screening, three cases that meet the requirements are selected, as shown in table 1.

| Number | Project                          | Price basis of sewage treatment fee | Mode of operation | Total investment | Return mechanism  | Period of cooperation | Minimum demand risk taker |
|--------|----------------------------------|-----------------------------------|-------------------|------------------|-------------------|------------------------|--------------------------|
| 1      | Dawu county sewage treatment facilities PPP project | total cost | BOT               | 249.25 million | Government Pay    | 25 years               | Government               |
| 2      | Xianlin sewage treatment PPP project | two-part pricing structure | TOT               | About 500 million | Government Pay    | 30 years               | Government               |
| 3      | Wuyi county sewage treatment plant TOT project | two-part pricing structure | TOT               | 110 million     | Feasibility gap subsidy | 25 years               | Government               |

3.2 Case comparison and analysis

Can be seen from table 1, generally, the government should bear the minimum demand risk of PPP projects of sewage treatment so as to share the market demand risk with social capital. However, the price bases of the above three projects are different. Due to the change of market demand, the price of sewage treatment service fee needs to be set according to different water quantity intervals, the public and private parties usually set the basic water quantity of cascade growth based on the designed treatment scale in practice. Basic water quantity is also called “guaranteed water quantity” and “minimum water quantity” which is the minimum demand guarantee quantity agreed by the government and social capital. When the actual water quantity treated is lower than the base amount, it is still paid according to the base amount. Designed water quantity refers to the daily amount of water
treated in accordance with the designed size of the sewage treatment plant in normal operation. The basic water quantity in the first few years of operation is generally set in accordance with the percentage of the designed water quantity until it reaches the maximum basic water quantity, that is, designed water quantity in some year. In order to clearly deconstruct the setting methods of the two sewage treatment prices, the above three cases are taken as examples to analyze the composition of settlement unit price of different water quantity intervals, as shown in Fig.1.

In Fig.1 below, ① the basic unit price: the unit price of sewage treatment service fee calculated on the basis of the total cost and reasonable income; ② the overadvance unit price (b): 50% of the basic unit price; ③ the insufficient unit price: 60% of the basic unit price agreed by both parties. If the actual water input is lower than the basic water quantity, the lower part will only be paid at fixed cost; ④ the overadvance unit price (d): 40% of the basic unit price. If the actual water input is higher than the basic water quantity, the higher part will only be paid at variable cost; ⑤ the variable cost unit price is agreed by both parties to be 0.20 yuan per cubic meter; ⑥ maximum quantity of water: it is agreed in the franchise agreement of Dawu county to be 110% of the production capacity, while the other two projects are not clearly agreed.

3.3 Case discussion

Since the three projects are divided into corresponding intervals based on different sewage treatment quantity and set corresponding unit prices to conduct segmented settlement, therefore, different water quantity intervals will be divided below for discussion.

(1) actual treated water quantity<basic water quantity

Can be seen from Fig.1, ① Dawu county sewage treatment facilities PPP project is directly calculated by basic unit price and basic water quantity. The basic unit price is calculated on the basis
of the total cost and reasonable rate of return, including fixed costs such as wages, welfare, laboratory inspection, and basic electricity costs, as well as variable costs such as variable electricity costs, pharmaceutical costs, sludge treatment transportation costs. ② While the other two PPP projects have adopted different paid methods for this. They add insufficient unit price and variable cost unit price based on the difference between the basic water quantity and the actual treated water quantity which are both adjusted according to the basic unit price measured at the total cost. The setting of the insufficient unit price of Xianlin sewage treatment PPP project is mainly based on the classification of fixed costs. The parties agree that the variable cost unit price of Wuyi county sewage treatment plant TOT project is 0.2 yuan/cubic meter, which is mainly determined on the basis of operation and maintenance cost.

In order to fulfill the commitment of the minimum demand guarantee and guarantee the reasonable return of social capital, the above three projects are calculated at the basic unit price for the part of actual water quantity. The main difference between them is the unit price of insufficient water quantity. ① Dawu county sewage treatment facilities PPP project is still in the basic unit price calculation, simple and convenient, is advantageous for the bidding companies and regulators estimates, observation and comparison, lowering the cost of the two sides negotiated settlement and management costs, but also that of social capital in any business is good or bad, can again on the basis of pay a revenues may reduce its efforts to improve management, reduce the cost of the two sides negotiated settlement and management costs, but also that of social capital in any business is good or bad, can again on the basis of pay a revenues may reduce its efforts to improve management, reduce the cost of enthusiasm [11]; ② Xianlin sewage treatment PPP project with inadequate old pricing method is introduced into the unit price, only with a fixed cost settlement, the cost in the sewage treatment not too big relations, as long as the scale of sewage treatment, its basic won't change, when the sewage treatment plant operation should be compensated fixed costs, the main body project investment cost and reasonable profit (including tax) [12], but this set of refinement would increase the cost of the talks; ③ In the PPP project of Wuyi county sewage treatment, the variable cost is deducted by the basic unit price, which is only calculated at the fixed cost. To sum up, the insufficient unit price setting of Xianlin sewage treatment PPP project not only guarantees the normal recovery of the project company's capital investment, but also maintains the reasonable interests of the government, which is relatively reasonable.

② basic water quantity ≤ actual treated water quantity ≤ designed water quantity

The figure 1 shows that exist in the practice project two set super water inflow ways: ① more than part of super water inflow, Dawu county sewage treatment facilities PPP project and Wuyi county sewage treatment PPP projects for more than the basic part of the water but not more than design is still in basic unit price calculation, calculate according to the total cost for untreated water, may lead to social capital gain excess returns and weaken its lower costs, improve the management level of enthusiasm, damage the interests of the public and the government; ② more than water is the basis of any operating year as agreed upon by both parties as super into the water, with super into the unit price calculation, although Dawu sewage treatment PPP and Xianlin sewage treatment PPP projects is set into the unit price of two ways, but fell short of the basic unit price, is closely related to the variable cost of the project, so the social capital will have an incentive to improve sewage treatment factors the influence of objective factors, to reduce operating costs, such as improve operational maturity by personnel training, strengthen its management ability, etc. To sum up, it can be concluded that, according to the stepped basic water volume agreed by both parties, the over-advance unit price of the basic water volume exceeding any operating year can reasonably protect the interests of all parties,
and conforms to the principle of "risk sharing and revenue sharing" in PPP projects.

(3) actual treated water quantity > designed water quantity

The price setting of excess water quantity is mainly to avoid excessive profits of enterprises. According to the principle of "risk sharing and income sharing" in PPP projects, the profit of excess water quantity should be shared by both parties. The higher the management level of social capital is, the better the variable cost will be controlled [11]. The setting of excess advance unit price can promote the innovation of sewage treatment technology through bidding competition, so as to reduce the cost and bring greater welfare to the public. The following two Settings: ① Xianlin sewage treatment the PPP project unit price mainly embodies the variable cost and reasonable profits of the project, so only the production operation and maintenance costs associated with sewage process to carry on the reasonable compensation, the way to the division of science, the project cost deduction is not operating costs, is advantageous to the realization of the government, social capital and the public multi-win-win situation; ② the PPP sewage treatment project in Dawu county simply takes 50% of the basic unit price as the over-advance unit price, which not only prevents excessive profits of social capital, but also reduces the cost negotiated by both parties. However, when the project operation period is short and fixed cost accounts for a large proportion, social capital lacks the motivation to improve its management level and innovative technology. To sum up, it is more scientific and reasonable to set the unit price of excess water volume with the two-part pricing method.

4. Conclusion

Through the above literature analysis and case discussion, the research results of this paper have the following three management implications for PPP practice departments. ① There are many risks that need to be shared by both public and private parties in PPP projects, and the risk scope and specific realization mode should be clarified in the relevant provisions of the PPP contract, so that both parties can perform in strict accordance with the contract in the project implementation process, which is conducive to the realization of project objectives. If the two parties only agree on the sharing of risks but fail to make specific agreements on how to realize the sharing, once the sharing of risks occurs, the two parties may shift responsibility to each other and get into renegotiation and disputes, thus increasing project costs and affecting the cooperation between the two parties; ② The improvement of performance of PPP projects or even the success of the project requires a good cooperative relationship, which is based on the premise of improving the fair perception of social capital. The realization of Shared risks in PPP projects should also follow the fairness principle. Once social capital feels unfair, it will take countermeasures or even opportunistic behaviors to protect its own interests and make up for losses, which is not conducive to the success of PPP projects; ③ The fundamental purpose of PPP project investment and construction is not to make profits, but to provide services for the public, who are the end users and stakeholders. Therefore, the results of the negotiation between the two sides must be accepted by the public. The government should guide social capital to make voluntary efforts to maximize the public interests while ensuring the attractiveness of the project [13].
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