Study on Financing Strategy for Environment and Air Pollution Governance Projects on the Basis of PPP Financing Model

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Abstract

With the deterioration of the environmental issues, air pollution has become the priority faced by Chinese government. Resultantly big financing gap perplexes the environment and air pollution governance projects in our country. Government investment is far from meeting the requirement for the environment governance. This thesis will study the financing issues for the projects of this nature. First of all it briefly introduces the theories and practices for PPP financing model. Through functions it analyses the relationship between private investors and government departments in PPP financing model, and relevant pricing mechanism is constructed. Air pollution in province A is employed to analyze and verify the effectiveness of this model.

Keywords: Air Pollution, PPP financing Model, Strategy Study.

1. STUDY OVERVIEW

1.1 Study background

Under the influence of scientific, economic and social factors, humans face enormous challenges in their life. Health damage and the environment pollution have become paramount concern of people. Meanwhile the concept of sustainable development is highlighted gradually by more and more countries. To protect the environment while maintain economic development, a new type of green economic revolution is triggered in every country around the world. Environmental protection industry has been born and become a new industry. However this new industry has unbalanced development due to the differential investment by different governments and different start time (Wang, 2016). In China, the environmental protection industry starts late and no sound financing mechanism is in place to provide required finance. And this has become the major problem for the environment and air pollution governance industry in China.

1.2 Study purpose

In spite of recent great progress made for the environmental protection industry in our country, two problems are still prominent in the governance field. The first is the low investment efficiency which falls short of the expectations to realize the environment governance. The second is the insufficient finance input for the environment and air pollution governance projects. The input cannot sustain the normal execution of the projects. In this thesis, the environmental protection industry is studied. PPP financing model is applied to the aforementioned projects, which provides solutions to such problems as low financing utilization and mono investor (Li, 2016).

2. RELATED CONCEPTS

2.1 Theories and practices of PPP financing model

PPP model was originated in Europe and its full name is “Public-Private Partnership.” This model is usually applied for the construction of infrastructure such as subways, roads, railways, etc., which lowers the potential risks incurred by mono investment to a large extent.

International economic organizations’ definitions of PPP differ greatly. Based on common acknowledgement of PPP model and by referring to some Chinese study findings, Chinese scholars give a definition that is suitable to
China and with its own characters: partnership which is compatible with public policies and stipulations and formulated by government and related governmental departments to attract private capital for the public infrastructure construction (Cheng, 2016).

2.2 Features of PPP financing model

PPP model is positioned in “multi-win” and “win-win” concepts. It is a new financing partnership model that is scientific and forward-looking. Its major features are as below: 1) advanced financing model. Many a private investment is attracted through public infrastructure construction projects, which expands channels for government financing and improves the utilization of social capital; 2) minimize the investment risks (Fan, 2015). PPP model is a public-private partnership financing model with many parties involved. The involved parties bring check and balance and complement each other. The capital shortage during the project execution is overcome, the occurrence of potential risks lowered and investment risks minimized. At last, the model helps to increase the public’s satisfaction of the construction projects. Since PPP model is able to involve private enterprises in the confirmation, design, improvement, and other works for the construction of public projects, advanced and mature private project management methods are introduced for completing the projects. Figure 1 is PPP Financing Model Diagram.

![Figure 1. PPP Financing Model Diagram](image)

2.3 Practices of PPP financing model

At first PPP model was used for the construction of prisons and stadiums, and then for other public infrastructure construction in the field of transportation. For instance, works for the pay service of Washington highway and renowned SR.91 project are usually used by Chinese scholars as successful PPP case study. In China, progress in big stride has been made for the application of PPP model. Since the success of the first BOT project, the number of PPP projects has risen up to above 7000. Among them, more than 1000 are health projects, above 2000 are municipal road projects and above 2000 are fuel gas projects. Moreover municipal sewage treatment, environmental protection and urban planning projects begin to be built. Thus it can be seen that there is a very broad future for the application and practicing of PPP projects (Zhuang, 2015).

2.4 Air pollution concept and background

Air pollution is mainly refers to the phenomenon that due to natural processes or human activities some harmful substances get into the air for a long time and thus endanger the environment and human health. As per their state, air pollutants can be divided into gas state pollutants and aerosol state pollutants. The gas state pollutants are mainly nitrogen oxides and sulfur oxides, and aerosol state pollutants mainly include suspended solids, dust fall, dust, etc. The main air pollutants in most cities are carbon dioxide, nitrogen dioxide and photochemical smog, etc. In addition, the air pollutants include mixed contamination and photochemical contamination.
Human and natural factors are the major causes leading to the air pollution. At present, the air pollution in most areas in our country is incurred by the human factors which mainly include transportation pollution, household stove pollution and industrial pollution. With the continual improvement of people’s life, the air pollution deteriorates. The prevention and control of the air pollution has been weighing heavily on the environment in our country. China’s government has put in place relevant environmental protection regulations, and it has been endeavoring vigorously to solve the problem of the air pollution to safeguard people's life and health.

3. STUDY OF PPP FINANCING MODEL FOR ENVIRONMENT AND AIR POLLUTION GOVERNANCE PROJECTS

3.1 Operating process of PPP financing model for environmental protection industry

PPP financing model for the environment and air pollution governance projects operates in four stages, including preliminary preparation, bidding, contract negotiation and signing, project construction and operation. Please refer to Figure 2 for its operation in details.

![Figure 2. PPP Financing Model Operating Diagram](image)

The preliminary preparation stage covers project preparation works and feasibility study. PPP model has specific requirement on profitability model and project nature, hence related governmental departments needs in the first place to confirm whether to adopt PPP model or not. Then the next-phase specific work can be conducted (Wang, 2015). In addition, the related government departments may subcontract the preparation work to competitive enterprises, completing bidding preparation, and project proposal review and approval. At the bidding stage, similar to most PPP projects, relevant work needs to be conducted for PPP environmental protection industry projects, i.e. experts and management personnel from government shall review the bidding proposal from the perspective of technical level and the bidder potential. The aim is to nail down the final bid winner.

The execution period for PPP financing model for the environmental protection industry is long and the scale large. The industry is newly emerged and the market prospect and profitability model are less than stable. Therefore the contract negotiation for the environment and air pollution governance projects takes long time. Related people need to make negotiation on how to share project risks, term of contracts, investment methods so as to guarantee the normal execution of the projects. After the signature of the contracts, the project companies dedicatedly established for the projects will commence related works as per the contracts. At the final stage where the projects are executed, the supervising departments of the government will monitor the projects during its construction. After the projects are completed, the project companies may operate the projects within the concession period designated by the government to reap profits (Nuo, 2015).

3.2 Relationship between private investors and environment and air pollution governance projects

3.2.1 Model assumption

For the establishment of government supervision mechanism, the relationship between private investors and the environment and air pollution governance projects shall be defined. Based on this, the proper supervision scale
and methods can be adopted. This thesis probes into this relationship and establishes the function between the private investors and the government departments.

\[ Y = (T_n + B_n)k \]  

Whereof, \( Y \) refers to social benefits; \( K \), government supervision scale; \( B_n \), consumer surplus; \( T_n \), direct project benefit.

The project actual benefit model is as below:

\[ Y = R*I*a + U*k + M \]  

Whereof, \( M \) is the benefit change due to the influence of market factors; \( U \), government supervision benefit; \( a \), private parties’ efforts; \( I \), project investment; and \( R \), project benefit rate.

Based on the above mentioned two models, the cost for private investor efforts is:

\[ C_n = \frac{1}{2}R_x a^2 \]  

and the government supervision cost is:

\[ C_m = \frac{1}{2}R_y k^2 \]  

Whereof, \( R_x \) and \( R_y \) respectively represent private investor function and government department function.

3.2.2 Model establishment

Based on the above model, this thesis establishes corresponding private investor utility function and government department utility function. The private investor utility function is:

\[ E(U_a) = (T_n + B_n)k + D(1 - a) + Y_j - \frac{1}{2}R_x a^2 \]  

And the government department utility function is:

\[ E(U_g) = R*I*a + V(1 - a) - (1 - a) - \frac{1}{2}R_y k^2 \]  

3.2.3 Model analysis

Under PPP financing model, the private investors are mainly the winners of the bidding. The government and the private investors will perform their obligations as per contracts: the government is to supervise the execution of the projects, and the private investors are responsible for the construction and operation of the projects. The private investors determine their scale of efforts \( (\alpha) \) by referring to the government supervision scale and methods and the contracts signed. Meanwhile the government decides its supervision scale \( (k) \) as per the private investors’ performance (Cai, 2014).

Moreover based on the private investor utility model \( \frac{\partial a}{\partial r} > 0 \). From this, we can see that the more benefits that the private investors reap from the government projects, the more efforts they will take and the less they will speculate. Hence, the government shall amplify incentives to the private investors, strengthen its supervision and establish corresponding rewards and punishment system so as to promote the initiative of the private investors and motivate them to endeavor voluntarily. Resultantly PPP projects can be executed normally.

4. STUDY ON PRICING MECHANISM FOR PPP FINANCING MODEL IN ENVIRONMENT AND AIR POLLUTION GOVERNANCE PROJECTS

4.1 Basic pricing methods

4.1.1 Average cost pricing
This pricing method aims to make both ends made for the private investors on the basis of maximizing the social welfare. Its difference with the marginal cost pricing lies in the fact that the average cost pricing can generate excess profit and meanwhile save the private investors from operation loss. What’s more, the average cost pricing makes the marginal cost of the private investors lower than the average cost. If the price lowers, the social welfare improves; while on the other hand, if the price goes up, the private investors’ profit rises. From this we can say that the average cost pricing is the best choice under the constraints of break even and increasing returns to scale (Lu, 2014).

4.1.2 Two-part pricing

This pricing method is constituted of two elements: one is quantity-based expense. It is a method that combines variable price and fixed price; the other is basic expense. The expense has no direct relevance to quantity. It is the expense paid by consumers for obtaining products. The two-part pricing is usually applied to the construction of municipal infrastructure such as telephone, public utilities, sewer pipeline, etc. To put it in a simple way, the private investors may make up their loss incurred due to the marginal cost by way of the two-part pricing. In this way they not only keep their turnover but also maintain service and product quantity at the same time (Wang, 2014).

4.1.3 Marginal cost pricing

Compared with the other two pricing methods, the marginal cost pricing is optimal. According to the economic principles, the allocation of social resources is the most efficient at the optimal Pareto. Hence its marginal cost is lower than the price level. For the environment and air pollution governance projects, the private investors provide services when the average cost is lowering. With the growing of the service amount, their marginal cost lowers as well. This makes the average cost for the projects higher than the marginal cost. At this time, the private investors are in the red. Therefore the government needs to provide relevant subsidy to the private investors to let them keep their normal producing activity and reap expected profits (Pu, 2014).

4.2 Price regulation factors that affect PPP model for environment and air pollution governance projects

4.2.1 Factors to be considered for projects

Regarding price regulation for PPP model for the environment and air pollution governance projects, the following affecting factors need to be considered: the first is policy subsidy and national tax policy; the second is the average profits for the industry. The sustainability and profitability of the private investors need to be safeguard; the third is to highlight service and product quality. Quality directly affects the realization of economic, environmental and social benefits. Without good quality, it will be a waste of resources no matter how low the cost is. Therefore the government shall use sound measures to promote product quality and service. The last is the operation cost and investment projects. There exist huge gap for operation cost of different investment projects. Cost is the basic factor that every private investor takes into account (Li, 2014).

4.2.2 Comparison of different pricing method

To price the projects, there are different methods and every method is unique in their characteristics. This thesis has compared the aforementioned three methods and come to the following conclusion: the average pricing is the optimal pricing method but it may results in some social welfare losses. The two part pricing can ensure the profitability of enterprises but reduce the redistribution effect. If the marginal cost pricing is used, Pareto optimum can be achieved, but it can cause losses to the private investors to a great extent (Wang, 2012). Table 1 shows the analysis of the three pricing methods.

<table>
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<tr>
<th>Pricing methods</th>
<th>Considerations</th>
<th>Characteristic</th>
</tr>
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<tbody>
<tr>
<td>Average cost pricing</td>
<td>Balance of profit and loss enterprise cost</td>
<td>The optimal pricing method, however, results in some social welfare losses</td>
</tr>
<tr>
<td>Two part pricing</td>
<td></td>
<td>Ensure the profitability of enterprises, but also reduce the redistribution effect</td>
</tr>
<tr>
<td>Marginal cost pricing</td>
<td>Resource allocation efficiency</td>
<td>The Pareto optimum can be achieved, but it can cause losses to the private investors to a great extent</td>
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4.2.3 Empirical analysis

4.2.3.1 Sample selection

To verify the abovementioned model, this thesis selects province A as the study subject. In province A, the average emission of industrial waste gas, industrial sulfur dioxide, industrial dust, industrial fumes are as below respectively: 9 tons, 5.23 tons, 4.03 tons, and 4.56 tons. The per capita GDP is 9.76 yuan/person, and the gross capital formation is 987 million yuan and the tertiary industry proportion is 34.4%. The initial investment in the environment and air pollution governance is 90 million yuan, the proportion that the private investors accounts for in social welfare is 0.4, the industry rate is about 5%, the annual fixed cost is 3 million yuan, and the return on invested capital is 7%. Figure 3 is the air pollutant proportion.

![Air Pollutant Proportion](image)

**Figure 3 Air Pollutant Proportion**

4.2.3.2 Study on Pricing Mechanism under PPP Financing Model for Environment and Air Pollution Governance Projects in province A:

The presumed cost for air pollution governance is:

\[ C_i = \frac{3}{\sqrt{M}} * Q * k + L \]  

The marginal cost is:

\[ C_i = \frac{3}{\sqrt{M}} * k \]  

Whereof, \( M \) is service quality level, the actual cost parameter \( k \) is 0.85. From the above formula, the service quality level \( M = 1.2 \). Based on \( P = \frac{3}{\sqrt{M}} * k \), the governance price is 1.05yuan/m\(^3\). And the governance transfer payment is:

\[ Y = R*I*a + V*(1-a)M = RMB \ 5.73 \ million \ yuan \]  

The average profit of the private investors is:

\[ R = (T_n + B_n)k + D(1-a)M = RMB \ 5.6 \ million \ yuan \]  

The above analysis shows that the abovementioned model is feasible in the environment and air pollution governance projects. The shortcomings of the original cost pricing mechanism can be made up. However, to bring the model in better play and to promote the effectiveness of the model, it is necessary for the government to have capability to analyze the quality level of the private investors and to master more information regarding quality (Li, 2005).
5. CONCLUSIONS

The governance of environment and air in China starts late, the capital utility rate is low, the financing channel is mono and the total investment is not sufficient. These issues hamper the environment protection development in our country to a great extent. In recent years a new financing model, PPP, has attracted the attention of scholars in every country in the world. The model has largely increased the government supervision rate (Wu, 2010). This thesis probes into the environment and air pollution governance projects under PPP financing model and proposes relevant suggestion.

Firstly, to introduce PPP financing model to the environment and air pollution governance projects, strict government supervision is necessary. The model is highly feasible for China’s environment and air pollution governance projects, and it can resolve the money problem and guarantee the normal execution of the projects. Secondly, the thesis makes studies based on the existing pricing methods and proposes the pricing mechanism for the environment and air pollution governance projects under PPP financing model. This lays a foundation for the normal running of the governance projects.

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REFERENCES