An Empirical Study on the Influence of Social Capital Control on China's Energy PPP Project Investment

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Abstract. In order to effectively attract the participation of social capital parties and solve the shortage of project funds, it is necessary to actively explore the factors affecting the investment of energy PPP projects. Based on the data of China Energy PPP project of World Bank from 1995 to 2018, an empirical study was conducted to explore the impact of social capital control rights on energy PPP project investment. The empirical results show that the higher the social capital control right in China's energy PPP project, the greater the investment in PPP projects; the longer the energy PPP project contract period, the less PPP project investment. The research provides a reference for social capital to participate in the energy PPP project investment decision. It is also recommended that government departments can decentralize management when implementing energy PPP projects in order to better attract investment.

1. Introduction

In the 1980s, China began to introduce the Government and social capital cooperation model (Public-Private-Partnership, hereinafter referred to as PPP) in the field of infrastructure. After decades of development, PPP model has played a positive role in continuously improving the level of infrastructure in China. Many projects in the energy industry have the characteristics of large volume, long cycle, and commonality, it is suitable for PPP mode. With the growth of global energy demand and the depletion of resources and environmental pollution caused by fossil energy consumption, renewable energy is receiving more and more attention from all countries in the world. In 2016, the National Energy Administration issued the “Notice on Actively Promoting Government and Social Capital Cooperation Models in the Energy Sector”, which clearly promotes the government and social capital cooperation model (PPP) in the energy sector, and encourages and guides social capital to invest in the energy sector, and effectively improves the level of public services in the energy sector. The energy industry has an urgent need for capital at different stages of development. As an innovative model, the energy PPP project not only can alleviate the project financing problem, but also can introduce advanced management methods to reduce the burden on the government to some extent. How to mobilize the activity of energy PPP projects is a problem that we deserve to attention.

The energy PPP project will be linked to multi-stakeholders, but the main stakeholders are the government side, the social capital side and the relevant financial institutions. The PPP model transforms the previous government-purchased construction into a partnership between the government and the social capital, and there is bound to be an allocation in project control. It is the dominant position of one said or the equal control of both sides has the greatest benefit to the investment of energy PPP projects, which is better? How will the control of social capital sides affect the investment of energy PPP projects? This are questions worthy of study. From the existing research, there are many empirical studies on the
success of PPP projects. However, there are not many investments in direct research on PPP projects, and there are fewer studies on investment in energy PPP projects alone. Therefore, this study is based on empirical data from the World Bank’s China Energy PPP project from 1995 to 2018. Exploring the impact of social capital control on energy PPP project investment, providing some reference for social capital to participate in PPP project investment decision-making, and optimizing energy PPP project investment.

2. Literature review
The control of PPP projects refers to: The government, the private sector and the public, in order to achieve the desired interests, all control rights based on the resources invested in the project, including ownership, dominance, decision-making power, management rights, etc [1]. The essence of the PPP project is the contractual network between the public and private sectors [2], in practice, the government usually transfers the decision-making power of some projects to social capital through contract clauses, thus realizing the transfer of control rights, which is beneficial to solve the problem of insufficient investment in special assets and improve the efficiency of cooperation between public and private sectors. Von Branconi and Loch found that contract flexibility is conducive to the formation of management flexibility through the transfer of control to social capital [3]. Ye Xiaosu et al. studied the key factors affecting the cooperation efficiency of PPP projects, they pointed out that the fundamental reason for the success or failure of PPP projects is the rationality of the allocation of control rights between public and private parties [4]. Cruz and Marques’s case study of the PPP project found that under certain conditions, giving social capital the right to adjust to the situation helps to increase the value of the project, especially the flexible design of the contract facility function for the project facility significantly improves the operation. The value of facility management at the stage [5]. Smith pointed out that contractors, suppliers and other professional companies have some incentives to master some of the control rights, and can effectively play their respective professional advantages, which is conducive to the quality and efficiency of the project [6]. Most studies continue the method of incomplete contract theory, treating PPP project control as a configurable single power, some scholars have used case studies to explore the allocation of control rights between public and private parties.

Luo Xia et al. explored the cooperation model of international energy PPP projects along the “Belt and Road” countries [7]. Wang Chuncheng proposed that the financial resources under the PPP model have a directional guiding role, which is conducive to attracting social capital to build a competitive mechanism, which can prompt the government to select superior projects. There are some discussions in the academic community on the factors affecting the investment of PPP projects, but basically they are all in the perspective of theoretical analysis, and the empirical test evidence is not sufficient. Hammami et al. used the World Bank's PPI database to verify that there is a strong correlation between government's ability to control corruption and PPP project investment, but the author uses the number of PPP projects rather than project investment in the empirical evidence [8]. This leaves room for the expansion of this article. At the same time, the existing research focuses on testing the linear and nonlinear relationship between PPP project investment and influencing factors. For example, Araya thinks that it is linear [9], and Zheng Zilong proposed that the impact of government governance on investor confidence and investment in PPP projects should be non-linear [10]. What’s more, Chen Xiaojuan constructed the index system for the factors affecting the investment of PPP projects, including marketization degree, financial environment, macroeconomic environment, financial constraints, degree of urbanization and so on [11].

None of the above studies directly mention the impact of social capital control on energy PPP projects, and there are only a handful of empirical studies on energy PPP projects. Moreover, there is little research in the academic community on the relationship between social capital control and investment in energy PPP projects. Therefore, the research on energy PPP project is feasible, which laid the foundation for the research of this paper. After reviewing the above literature, this study further assumes that the control of social capital sides can promote investment in energy PPP projects.
3. Research design

3.1. Data Sources
This paper uses the World Bank's PPI database to obtain data on China's energy PPP projects. It is worth noting that the amount of investment recorded in the database is not the actual investment amount, but the committed investment amount at the time of signing the public-private partnership agreement, that is, the agreed investment amount, in millions of US dollars. According to the industry practice of the PPP project, as the project may be subject to external shocks (for example, geopolitical factors), the final payment amount may be different from the initial commitment amount. Social capital control is calculated as a percentage, ranging from 0-100%. The project size is calculated in millions of dollars. The unit of the project contract cycle is the year.

Table 1. Interpretation of variables

| Variable type  | Variable name | Variable interpretation          |
|----------------|---------------|----------------------------------|
| Dependent variable | invest        | Energy PPP project investment amount |
| Independent variable | perp          | Social capital control            |
| Control variable   | capa          | Project size                      |
| Control variable   | conp          | Project contract period           |

Constrained by data integrity, this paper uses 165 valid Chinese energy PPP project data from 1995 to 2018 in the PPI database. Mainly include total investment, percent private, capacity, and contract period. In this paper, we use percent private instead of social capital control, use capacity instead of percent private. The dependent variable of this study is the investment amount of energy PPP project. The main independent variable is social capital control right. The control variables select the project size and project contract duration associated with the energy PPP project itself. The specific explanation of each variable is shown in Table 1.

3.2. Model construction and research methods
According to the content of this study, the following regression model (1) is constructed. In order to reduce the skewed distribution of the data, the dependent variable total investment is processed in logarithm, so that the percentage change is verified. The model mainly explores the impact of social capital control on investment in energy PPP projects.

\[ \ln(\text{invest}) = \beta_0 + \beta_1 \text{perp} + \beta_2 \text{capa} + \beta_3 \text{conp} + \varepsilon \] (1)

In order to eliminate the influence of heteroscedasticity, the weighted least squares method is used for estimation, and the variation variance can be the same variance. This study is implemented by stata statistical software.

4. Empirical results and analysis

4.1. Descriptive statistics

Table 2. Each variable describes the statistical result

| Variable | Observation | Average | Standard deviation | Minimum | Maximum |
|----------|-------------|---------|--------------------|---------|---------|
| lninvest | 165         | 3.8451  | 1.4534             | -1.6094 | 8.0709  |
| perp     | 165         | 76.3952 | 26.2550            | 12.5    | 100     |
| capa     | 165         | 242.4746| 581.0527           | 1.9     | 3960    |
| conp     | 165         | 29.6121 | 10.0745            | 10      | 70      |

Table 2 shows the descriptive statistics of each variable in the study. From the results, the highest control of social capital is 100%, the lowest is 12.5%, and the average is 76.39%, which indicates that in most cases, China's social capital has relatively high control over energy PPP projects. The smallest project
size is 1.9 million, the maximum is 3960 million, the average is 242.47 million, and the standard deviation is large, indicating that the scale of China's energy PPP projects is large and not concentrated. The shortest project contract period is 10 years, the highest is 70 years, the average value is 29.61 years, and the standard deviation is 10.0745. This shows that most of China's energy PPP project cycle is concentrated in about 30 years.

4.2. Correlation test
Correlation tests were performed on individual variables. The specific results are shown in Table 3. It can be seen from the results that the correlation coefficient between the variables is not large. The correlation coefficient between investment amount and project size is the largest, which is 0.5132. Secondly, the correlation coefficient between the control of social capital and the contract period of the project is 0.2601, the correlation coefficients between the remaining two each other are negative, so there will be no multicollinearity.

4.3. Regression analysis
The regression results obtained by the weighted least squares method are shown in Table 4. From the regression results, the model goodness of fit chi2(12) is 830.41, and the fitting effect is very good. The coefficient of control of the social capital side is 0.00613, greater than 0 and significant at the 1% level, with a positive contribution. The coefficient of the project size is 0.00358, greater than 0 and significant at the 1% level, and also has a positive promotion. The coefficient of the project contract period is -0.01979, which is smaller than 0 and is significant at the level of 1%, with a reverse effect.

| Variable | Coefficient | standard error | z value | P>|z| |
|----------|-------------|----------------|---------|------|
| perp     | 0.00613***  | 0.00078         | 7.84    | 0.000|
| capa     | 0.00358***  | 0.00019         | 18.65   | 0.000|
| comp     | -0.01979*** | 0.00204         | -3.93   | 0.000|
| _cons    | 4.19796***  | 0.12038         | 34.89   | 0.000|
| Goodness-of-fit chi2(12) | = 830.41 |
| Model chi2(3) | = 713.33 |
| Prob > chi2 | = 0.0000 |

Note: ****, **, and * respectively indicate that the statistics are significant at the 1%, 5%, and 10% levels.

Therefore, according to the results in Table 4, the regression equation is:

\[ Lninvest = 0.00613\, perp + 0.00358\, capa - 0.01979\, comp + 4.19796 \]

The meaning of the regression equation is as follows. For every 1% increase in the control of the social capital party, the investment amount of the energy PPP project will increase by 0.613%. Therefore, the control of the social capital side has a positive effect on the investment of energy PPP projects. From the perspective of project scale, the larger the project size, the higher the investment amount, that is, for every $1 million increase in the size of the energy PPP project, the investment amount will increase by 0.358%. However, the longer the contract period of the energy PPP project, the lower the investment amount will be, that is, the investment amount will decrease by 1.979% for each additional year of the contract period. This may be because the longer the project contract period, the more uncertain factors will exist. Then when social capital is investing, it will take into account this, and the investment will be more cautious, so the investment amount will be relatively lower.
5. Conclusion and suggestion
This paper mainly conducts empirical research on energy PPP projects in China, mainly to explore the impact of social capital control on energy PPP project investment. According to the research results, the following conclusions are drawn: The control of the social capital will have a positive effect on the investment of China's energy PPP project. In other words, the greater the control of the social capital, the more it can promote the investment of energy PPP projects. Of course, from the perspective of the project itself, the energy PPP project is large in scale, so the social capital side will naturally invest more, but the longer the project contract period, the less favorable to the investment of energy PPP projects.

Since the government is in a dominant position in the PPP project cooperation, the social capital will worry about whether the government will perform conscientiously according to the contract and whether it can decentralize the project. Therefore, the following related suggestions are proposed for this study. First of all, for the government of the energy PPP project cooperation, it is necessary to clearly understand the characteristics of the energy PPP project, and cannot firmly grasp the power not to be decentralized, should actively attract social capitalists to participate in investment in energy PPP projects. Then, for the social capital party that cooperates with the energy PPP project, when selecting an investment in an energy PPP project, it is also necessary to conduct a comprehensive analysis of the project itself and actively assume responsibility for the project.

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