

## RESEARCH ON "THE BELT AND THE ROAD" PPP FINANCING MODEL BASED ON GAME THEORY PERSPECTIVE

Lu Guixian & Yao Yuan  
University of Henan, Kaifeng, CHINA

### ABSTRACT

"the Belt and the Road" is an important international strategy of China in the 21st century. Infrastructure construction is of great significance to promote the strategy of "the Belt and the Road". There is a huge funds gap to build infrastructure, so it is urgent to finance from domestic and foreign investors. This paper first analyzes the theoretical basis and practical needs of the application of PPP financing model in the construction of "the Belt and the Road", and then analyzes the mechanism of PPP financing based on the perspective of game theory. The results show that there are Nash equilibrium solutions for domestic and foreign investors to participate in PPP projects, and in this case the total utility of social public goods is Pareto optimal. Finally, a few suggestions on how to better introduce the PPP financing model are proposed.

**Keywords:** The Belt and the Road, PPPmode, game theory.

### INTRODUCTION

The "Silk Road Economic Belt" and the "Silk Road of the 21st Century", also called "the Belt and the Road", are the major initiatives that Xi Jinping has made during his visit to Central Asia and Southeast Asian countries in 2013."The Belt and the Road" construction path includes the east to the Asia-pacific economic circle and the west European economic circle,But there are big differences in the level of economic development between the countries and regions involved in the east and west of the economic circle.It shows the two sides of the region economic are developed, and transportation isconvenient, but the middle of areaconditionsispoor.To promote the implementation of "the Belt and the Road" strategy, it is important to carry out infrastructure construction in these areas.However, whether it is economically developed areas need to upgrade infrastructure upgrades, or economically underdeveloped areas, need to introduce foreign capital and advanced technology for construction, which both requires a lot of money to solve these problems.

With the "the Belt and the Road" strategy to continue, China is actively promoting the new platform and new model to solve the financing gap. On October 24, 2014, China and other founding members jointly decided to set up the Asian Infrastructure Investment Bank. Subsequently, on December 29, 2014, Silk Road Fund was formally incorporated in Beijing. But these platforms can provide financing about 350 billion US dollars, and the Asian Development Bank is not entirely estimated that Asia's infrastructure investment demand of 8 trillion US dollars compared to far more than to meet the "area along the way" construction needs, cannot solve the foundation lack of facilities construction funds. Investment and financing innovation is not only to broaden the financing channels, but also need to continue to develop financing models, such as PPP model. This paper analyzes the mechanism of PPP mode financing from the perspective of game theory, solves the problem of funding gap in the construction of "the Belt and the Road", but also puts forward some suggestions on how

to introduce the PPP financing model better, so as to promote the construction of smooth progress.

### **The domestic and foreign development of the PPP financing model**

In the face of the large number of funding gaps needed in the construction of "the Belt and the Road", we should not only carry out the diversified financing, but also carry out PPP mode financing, fully tap the large amount of social capital in PPP mode, reduce the pressure of government funds, improve the efficiency of project operation, to achieve the government, investors, and the public in the "the Belt and the Road" in the multi-win. The introduction of PPP financing model to the "the Belt and the Road" construction, not only has its theoretical basis, but also has its practical needs.

### **The development of PPP mode in foreign**

Public-Private Partnership, also known as PPP model, that is, government and social capital cooperation, is a public infrastructure in a project mode of operation. In this mode, private enterprises and private capital are encouraged to cooperate with the government to participate in the construction of public infrastructure. PPP model originated in the early 20th century of the United Kingdom, later, the United States, Australia and other countries also launched the PPP model, since the PPP financing model in public infrastructure and social public goods services have been widely Application, and attracted the attention of scholars from all over the world. Bettignies and Ross (2004) argue that the public sector and the private sector can provide infrastructure and public goods services at a relatively low cost by signing contracts in PPP mode compared to other public service providers [ 1]. Hodge (2004) argues that risk can be diversified due to the long-term nature of investment in the PPP model and the lag of earnings [2]. Government departments and private cooperate to achieve benefit sharing and risk sharing, which not only improves the efficiency of public goods and services, but also meets the interests of the private sector to pursue. With the wide application of PPP in various fields, some scholars have begun to pay attention to the operational efficiency of this model. Bradford (2003) examines the efficiency of two public-private partnerships in Lake Ontario in the 1990s by empirical methods, and conclude that the PPP model is an innovative in economics and fully affirms this model .The Kim (2015) points out that the market can be the way to the social bond funds and other references to the PPP model to improve the efficiency of capital use.

### **The application and innovation of PPP model in China**

With the widespread use of the PPP model in the public around the world, China has also developed the PPP model after the reform and opening up in 1978. Before 2003, the PPP model was explored in China. This stage mainly absorbed foreign capital, had carried out a number of BOT projects, but did not succeed. From 2004 to 2013 it was the rapid development stage, involving the industry not a single plan development sector, but also including construction, transportation, environmental protection, state-owned and other industry authorities, at this stage, PPP model showed the Chinese characteristics to practicality as the goal. The key is to obtain social capital. After 2014, the PPP model began to standardize in China, and PPP-related policies and laws and regulations are closely introduced to guide social capital to participate in the construction of infrastructure and public utilities, improve the quality and efficiency of public services and protect the legitimate rights and interests of franchisees. The China Ministry of Finance PPP data shows

that until March 31, 2017, there are 12287 PPP projects, involving a total investment of 145,620,121 million RMB, covering 19 industries, PPP model flourishes in China.

### **The real needs of the PPP model in the "the Belt and the Road"**

"The Belt and the Road" strategy covers a wide range of regional, involving countries and regions, needs to diversify the types of investment projects, coupled with different levels of economic development in various countries and regions, countries. In the developing countries and regions, infrastructure construction is seriously behind. The Asian Development Bank is not entirely estimated that by 2020, Asia's infrastructure investment demand of 8 trillion US dollars, and the current size of the funds are available about 350 billion US dollars, accounting for only 4.375% of total demand, facing a huge gap in funding problem. And to solve a serious shortage funds of the "the Belt and the Road" infrastructure construction, we need to build a "multi-level, diversified, multi-subject" investment and financing system, not only depending the leading role of government capital, but also fully mobilizing the enthusiasm of private capital. The PPP model can not only play a greater role in bridging the financing gap, but also can greatly enhance the efficiency of global capital allocation. We need to introduce the PPP model to "the Belt and the Road" infrastructure investment construction.

### **The mechanism of PPP model financing based on game theory**

In the "the Belt and the Road" infrastructure investment construction, the introduction of PPP model not only has its theoretical basis, but also has practical needs. Next, we analyze the mechanism of PPP model in the "the Belt and the Road" based on the game theory.

### **Game theory analysis of "the Belt and the Road" Project Construction without PPP Mode**

Suppose there are two players of "The Belt and Road" governments, domestic and foreign private investors. For the government, the total government budget is  $B$ , whose goal is to maximize the utility of the various social products provided under budget constraints. If there is no PPP model, that is, private investors is not allowed to participate in "The Belt and Road" project construction, that is, government-owned. If the public goods provided by the government are  $M$ , in which the total demand for a social public product,  $N$ , will be met, the cost will be  $b_e$ . When the  $M$  kinds of social public products to achieve the maximization of social utility, the government for public product  $N$  investment cost for  $b_n$ , because the government budget is limited, at this time,  $b_n$  will be less than  $b_e$ , which means that the social public product  $N$  does not meet the social demand. At this time, the cost of government investment in public good  $N$  is  $b_n$ , and its social utility is  $U_n(b_n)$ ; the utility of other public goods inputs is  $U_n(B-b_n)$ . Thus, the total social utility of the government to provide  $M$  kinds of public goods is  $U_n(b_n) + U_n(B-b_n)$ .

### **Game Theory Analysis of "The Belt and Road" Project Construction with PPP Mode**

Due to the limited government revenue, the government cannot provide enough social public goods to meet the general needs of society. To improve the overall utility of social public goods, the government should introduce PPP mode. That is, the government and domestic and foreign private investors can participate in "The Belt and Road" project construction. After the introduction of domestic and foreign private investors, the total investment in social

public good  $N$  is  $b_e$ , the total social demand is met. At this time, the government's investment in public goods is  $b_n'$ , and the amount of investment invested by domestic and foreign private investors on public good  $N$  is  $b_e - b_n'$ . The social utility of public good  $N$  is  $U_n(b_e)$ .

From the government point of view, after the introduction of domestic and foreign private investors, the provision of public products of  $M$  generating social utility is  $U_n(b_n') + U_n(B - b_n')$ . From the domestic and foreign private investors, for total capital investment "The Belt and Road" project for the construction of  $K$ , the investment income as a function of  $Y(K)$ , assuming that domestic and foreign investors a total of  $T$  investment strategy, the goal is to maximize the total investment income. Domestic and foreign investors to obtain "The Belt and Road" project investment targets, usually need to pay a certain cost, including the cost of negotiation with the local government, to assess the project costs and the bidding cost, These costs, which we assume to be  $C$ , have the nature of sunk costs. If the government chooses to invest solely in the project after the negotiation, the investor's return is  $Y_n(K) - C$ ; If the domestic and foreign investors do not participate in the bidding process at the beginning, the corresponding income of investors is  $Y_n(K)$ ; If negotiations are completed, domestic and foreign investors participate in the investment of public product  $N$ , whose investment is  $K_n$  ( $K_n = b_e - b_n'$ ). Assume that domestic and foreign investors to participate in the "The Belt and Road" project will get the local government to provide tax incentives for  $V$ . Investors to participate in the "The Belt and Road" project risk, a risk factor for  $a$ , investment income function is its participation in public products for construction of  $N$   $(1-a) * Y_n(b_e - b_n') + Y_n[K - (b_e - b_n')] - C + V$ .

Thus, the game payment matrix of the government, domestic and foreign investors is as follows:

	Government sole proprietorship	Public-private partnership
Investors participation	$U_n(b_n) + U_n(B - b_n)$ $Y_n(K) - C$	$U_n(b_e) + U_n(B - b_n')$ $(1-a) * Y_n(b_e - b_n') + Y_n[K - (b_e - b_n')] - C + V$
Investors without participation	$U_n(b_n) + U_n(B - b_n)$ $Y_n(K)$	$U_n(b_e) + U_n(B - b_n')$ $Y_n(K)$

The Nash equilibrium solution of the payoff matrix is affected by various factors. We will discuss the situation in detail:

(1) If  $U_n(b_n) + U_n(B - b_n) > U_n(b_e) + U_n(B - b_n')$ , that is to say, the total utility produced by the public goods that were provided by the government is greater than the total utility produced by the public goods provided by the public-private partnership. The reason for this may be that the government's investment in the public good  $N$  process found that the choice of PPP model financing, the cost of investment  $b_n'$  than before the cost of investment  $b_n$  to be large, that is,  $b_n' > b_n$ . Moreover, the increase of the total social utility of the public product  $N$  brought by the introduction of investors cannot make up for the decline of the total social utility caused by the reduction of government investment in other public goods sectors.

This shows that even if the government intends to select the PPP mode of financing, but in the negotiations or the bidding process, the ownership structure or arrangement of capital

structure cannot enable the government to obtain a larger income, the government will also choose to model the provision of public goods; government owned mode is the dominant strategy. It seems that domestic and international private investors will be able to reach an agreement only when they are arranged for the ownership structure and capital structure of both parties.

(2) If  $U_n(b_n) + U_n(B-b_n) < U_n(b_e) + U_n(B-b_n')$ , That is to say, the total utility produced by the social public goods provided by the government is less than the total utility provided by the social and public products provided by the public-private joint venture, and the government chooses the PPP mode to finance. The reasons for this situation may have two kinds: ①  $b_n' < b_n$ , that the introduction of investors increases the input to public good N and thus increases the social utility of public good N. And because the government has reduced its investment in public good N and increases its investment in other public goods, the social utility of other public goods has increased accordingly. ②  $b_n' > b_n$ , even if the outcome of the negotiations is the corresponding increase of government public goods investment N, but because of the reasonable equity and capital structure of the public products N investment to increase the social utility is greater because of the government and other departments to reduce the loss of the investment of social utility, which makes the total utility of social public products under the mode of PPP is greater than the total social public utility the government owned product pattern produces. At this time, the government chooses PPP financing mode.

In the above second cases, the existence of solutions of equilibrium of government and domestic and foreign investors, depending on the size of the investment income of investors to participate in the "The Belt and Road" project construction and not to participate in the construction.  $(1-a) * Y_n(b_e - b_n') + Y_n[K - (b_e - b_n')] - C + V$  is compared with the size of  $Y_n(K)$ . If  $(1-a) * Y_n(b_e - b_n') + Y_n[K - (b_e - b_n')] - C < Y_n(K)$ , the Nash equilibrium solution is (nonparticipation, public-private partnerships), and the corresponding payments are  $[Y_n(K), U_n(b_e) + U_n(B-b_n')]$ , and this solution is invalid solution; If  $(1-a) * Y_n(b_e - b_n') + Y_n[K - (b_e - b_n')] - C > Y_n(K)$ , the investment income of investors participating in the project construction is greater than the investment income that does not participate in the investment construction, so the solution of the Nash equilibrium is (participation, public-private partnerships), and the corresponding payments are  $[(1-a) * Y_n(b_e - b_n') + Y_n[K - (b_e - b_n')] - C + V, U_n(b_e) + U_n(B - b_n')]$ .

## CONCLUSIONS AND COUNTERMEASURES

From the above analysis, Conclusions can be drawn: in order to introduce PPP financing mode to the "The Belt and Road" project construction, we need to increase the revenue function of domestic and foreign investors to invest "The Belt and Road" project construction as well as the domestic and foreign investors to arrange reasonable equity and capital structure. Domestic and foreign investors to participate in the "The Belt and Road" project revenue depends on the investor's productivity, investors negotiation and transaction costs, government tax incentives and investment risk of the country's political and cultural. According to the analysis of game theory, there exists a Nash equilibrium solution for the participation of domestic and foreign investors in the PPP project, and in this case, the total utility of social public goods reaches the Pareto optimality. Secondly, the payoff function  $Y_n(k)$  investors to participate in the "The Belt and Road" project and revenue function of  $Y_n(k)$  not involved in the "The Belt and Road" project the differences will also affect whether investors participated in the PPP project.

Based on the above conclusions, in order to better the introduction of PPP financing mode in the "The Belt and Road "project construction, we put forward the following suggestions:

First, the Chinese government and the "The Belt and Road" along the government should establish good cooperation mechanism in the political, cultural and other aspects, reduce the risk of investors in "The Belt and Road "project, and reduce the investor and the government negotiating cost, increase revenue function of investors to participate in the "The Belt and Road "PPP project construction, so as to improve enthusiasm of investors and the government to build "The Belt and Road "project.

Secondly, the government and "The Belt and Road" along the government raise the tax preferential policies to investors who participate in the "The Belt and Road" PPP project appropriately. Especially for some of the higher efficiency but the ability to resist the risk of weak investors to increase the rate of tax incentives to attract these investors into the "The Belt and Road" PPP project construction. In the actual operation process of PPP financing mode, it may involve equity and capital structure distribution and other issues. We should strengthen the publicity and familiar with the host country and the "The Belt and Road" along the country's laws and regulations related to this. For China, it is necessary to gradually improve the laws and regulations related to the PPP financing model and the corresponding regulatory mechanism.

Finally, Enterprises involved in "The Belt and Road" PPP project to do the localization work. The PPP field is often related to the beneficial to the people's livelihood, The public goods price, service quality and industrial layout of the related industries involved in the PPP contract are important to national interests of the host country, It is easy for the host Government to abandon the commercial agreement when the political appeal of the host country and the commercial interests of the overseas investor are in conflict. Chinese enterprises should consider actively working with local government enterprises, through the localization of interests and risks tied with the local government, which will help to achieve the long-term investment interests of Chinese enterprises in the protection. Enterprises involved in "The Belt and Road" PPP project to do the relevant professional ability construction. Enterprises should introduce domestic PPP consulting excellent consulting companies and law firms, hired Chinese consultants and lawyers to the sea. Through the domestic advisory body and the local advisory body cooperation, achieve the domestic system on the host country system impact and amendment, and fully protect the legitimate interests of Chinese enterprises.

## REFERENCES

- [1] Bettignies JED, Ross TW. (2004). The Economics of Public-Private partnerships [J] . Canadian public policy / Analyse de Politiques, 30 (2) : 135-154.
- [2] Hodge GA. (2004) .The Risk Business of Public-Private partnerships [J]. Australian Journal of Public Administration, 63 (4) :37-49
- [3] Kim J (2015). Performance-based Development Funding Using Market Mechanisms: A? Public-Private? Partnership Social Financing Model for Medical Equipment Technology in Developing Countries [J] Progress in Development Studies,15(3) : 257-269
- [4] Bradford N (2003) Public-Private partnerships ? Shifting paradigms of Economic Governance in Ontario [J]. Canadian Journal of Political Science / Revue Canadienne De Science Popitique 36 (5) : 1005-1033
- [5] Liu Wei. PPP. Model theory and its practical illustration. [J]. reform, 2015 (1)

- [6], LvQihong, Wang Xiaodong. On the application and Enlightenment of PPP model in infrastructure construction in Philippines province [J]. Southeast Asian Studies, 2011 (4)
- [7] bamboo forest. The new urbanization: exploring the business model of PPP, CITIC J. Economic Herald, 2014 (8)
- [8] XueWenguang, Zhang Yingming. PPP and financing mechanism innovation mode to promote the construction of financial The Belt and Road. 2015 sight, (7).