Chapter 118
Research on Negotiating the Transfer Price for T0T Project Financing Mode Based on Game Theory

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Abstract This paper extends the transfer-operate-transfer (TOT) concession model (Liu et al. 2002) to a new method for identifying a concession period by using bargaining-game theory. Transfer price is one of the most important decision variables in arranging a TOT-type contract, and there are few methodologies available for helping to determine the value of this variable. The previous model presents an alternative method by which determined are the win-win price level to furnish theoretic basis on which to form and decide the transfer price and TOT projects. Nevertheless, a typical weakness in using the previous model is that the model cannot recommend a specific time span for concessionary. This paper introduces a new method called TOT bargaining concession model to enable the identification of a specific concession period. The two parties concerned in engaging a TOT contract in the model are the investor and the government and their bargaining behavior is the key factor in the model.

118.1 Research Background

As we all know, TOT (transfer- operate- transfer) is a new kind of financing mode through the sale of existing assets for Incremental funding [1]. This approach is the use of private capital to operate infrastructure projects. This is an effective mode of exploiting private capital to operate infrastructure. The main objective of TOT financing model is to revitalize the stock assets and to improve the efficiency of operation of the project.

Infrastructure industry is characterized by the huge investment, long construction period, and comparative low rate of return. So in the mainland of China, the construction and operation of the infrastructure are conducted by the government,

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which leading to a state of low efficiency and monopolization [2]. So the private reform of the infrastructure in China is imperative. Now the most popular private participation in the infrastructure is the BOT. A build-operate-transfer contractual arrangement provides a mechanism for governments to use private finance and management skill. But in the mainland of China, we must consider the regime of state ownership and a lot of existing state-owned infrastructure. So the TOT model has more merits in the private participation.

118.1.1 Mitigating the Investing Risk

The foreigner invest the infrastructure must face a host of examine and approve, which increase the investment risk. But the TOT model makes the foreign enterprise and civil enterprise have more opportunity to participate the infrastructure industry. Adopting the TOT model, the investors avoid design and construction of the infrastructure, in which stage there are a lot of uncertain factors. But in the TOT model, the investors are just responsible for the running of the existing infrastructure [3].

118.1.2 Motivating the Operator

The revenue of the investors is associated with the operating efficiency of the infrastructure, which can take full advantage of the infrastructure and contributes the social welfare. Due to the less professional running of the government, the private participation can alleviate the fiscal burden or increase the tax income for the government.

118.1.3 Keeping the Property of State

After the concession period, the assets of the project free return to the government to keep the property of state, which is very significant to regulate and control the infrastructure [4]. So TOT is a comprise method that not only can induce the private capital to the infrastructure but also subtly avoid the ideology constraint.

The determination of the transfer price is the key factor of the model, as the price of the transfer directly affects both the investor's and the concerned government's interests. In general, a lower transfer price is more beneficial to the private investor. But if the price is too low, it will cause the loss of state assets. The debate is centered on the transfer price. What types of transfer prices are reasonable?

On the other hand, if the transfer price is too high, the investor will either reject the contract or be forced to increase the service fees during the operation of the project in order to recoup the investment and make a certain level of profit. Consequently, the risk burden of a higher transfer price will be shifted to the public who use the facilities. In a recent development, Liu et al. (2002) introduced the interest allocation model for helping identify a concession period interval, by adopting a method whereby the basic interests of the both sides can be protected. This article attempts to identify the transfer price under the aim to achieve a win-win for the TOT project, even though the different targets under the transfer pricing decision. The negotiation for this period is, in fact, a bargaining process. This paper examines this bargaining process by using bargaining-game theory to assist in identifying a specific transfer price.

118.2 Research Method

118.2.1 Existing Model

This research is the extension to an existing model, the TOT interest allocation model, introduced by Liu et al. (2002), which is based on the rationale that the transfer price in procuring a TOT-type project shall protect the basic interests of both the government concerned and the private investor.

Suppose the construction period of a infrastructure is T, the investment of the government is P_0 (for simple, P_0 is all invested at the first year), the average net revenue is L'_k (k = 1, 2, ... , m) before transferring the project. After running m years, the project is transferred to the private investor. The concession period is n, the transfer price is P, supposed to be paid at the beginning of the concession period. After the end of the concession period, the government gets the infrastructure back, the residual value is M_0. For the government take high risk during the construction of the project, its rate of return is i_1, similar with the industry benchmark rate of return.

So when the government transfers the project, the NPV (net present value) of the government is

$$NPV_1 = \sum_{t=T+1}^{T+m} \frac{L'_1}{(1+i_1)^t} + \frac{P}{(1+i_1)^{T+m}} + \frac{M_0}{(1+i_1)^{T+m+n}} - P_0 \qquad (118.1)$$

Suppose that the government always operate the project by itself, the average net revenue is L_j (j = 1, 2, ... , n), so the NPV of the government is:

$$NPV_2 = \sum_{t=T+1}^{T+m} \frac{L'_1}{(1+i_1)^t} + \sum_{t=T+m+1}^{T+m+n} \frac{L_1}{(1+i_1)^t} + \frac{M_0}{(1+i_1)^{T+m+n}} - P_0 \qquad (118.2)$$

The concession period of the private investor is n, during which the average net revenue is R_j (j=1, 2, . . . , n). Even though the private investor do not have to take the risk of the construction, but his capital cost is higher than the government. The private rate of return i_2 is higher than i_1. The NPV of the private investor is:

$$NPV_3 = \frac{1}{(1+i_2)^{T+m}}\left(\sum_{t=1}^{n}\frac{R_1}{(1+i_2)^t} - P\right) \tag{118.3}$$

Then we can analyze the transfer price through the quotation. When the $NPV_1 = NPV_2$, we got the price P'_1. At the moment, the invest revenue of the efficiency raise is all distribute to the private investor. The government does not get any benefit, so it will have no enthusiasm to transfer the assets. When the $NPV_1 = NPV_3$, we got the price P'_2. The benefit from the TOT model is distribute to both side on average, by which the private investor lose his enthusiasm. To make both side satisfied, the appropriate transfer price should between P_1 and P_2, namely $P = \alpha P'_1 + (1-\alpha)P'_2$, $0 < \alpha < 1$ α is the interest weight that α is more bigger, the private sector gets more interest.

I think the last analysis distribute the interest from the view of both parties. In the following bargaining model, the interest will be distribute interest through the situation of the negotiation without considering the sunk cost.

118.2.2 Basic Principles of Bargaining Theory

Research in bargaining and game theory has already experienced a long history. Among the early contributors to the study in this field were Nash [5], Raiffa [6], and Harsanyi [7]. Bargaining theory deals with the situations where people interact rationally with each other, assuming that an individual's action depends essentially on what other individuals may do. The theory is commonly used to describe the situation similar to where a chess player thinks about all issues that may arise logically in the game [8]. Muthoo [9] opined that a bargaining situation is a situation in which two players have a common interest to cooperate but have conflicting interests over exactly how to cooperate. Muthoo [9] further opined that bargaining is any process through which the players try to reach an agreement. This process is typically time consuming and involves the players making offers and counteroffers to each other. There are a large number of analytical models examining bargaining process (for example, Nash 1950a, 1951; [6, 7, 9–13]). These models are based the following major assumptions: Rational Behavior, Information Sharing, Bargaining Payoff, Bargaining Cost and Time Value [14].

118.3 Negotiating for a Specific Concession Period in Committing a TOT-Type Contract

The benefit the government gets is :

$$NPV_1 - NPV_2 = \frac{1}{(1+i_1)^{T+m}}\left(P - \sum_{t=1}^{n}\frac{L_1}{(1+i_1)^t}\right) \tag{118.4}$$

The benefit the private investor gets is $NPV_{3.}$
The economic benefit arising from the transfer is B:

$$B = NPV_1 + (NPV_1 - NPV_2) = \frac{1}{(1+i_1)^{T+m}}\sum_{t=1}^{n}\frac{R_1 - L_1}{(1+i_1)^t} \tag{118.5}$$

Of course, the transfer can be accepted by both sides when the

$$P1 = \sum_{t=1}^{n}\frac{L_1}{(1+i_1)^t} < P < \sum_{t=1}^{n}\frac{R_1 + L_1}{(1+i_i)^t} = P2,$$

$$P = \beta P_1 + (1-\beta)P_2, 0 < \beta < 1$$

The parameter β in the TOT interest allocation model is the bargaining focus. The β presents a numerical interval, suggesting that any value P within the interval is an effective concession solution that can protect the basic interests of the both sides. The two players (the government concerned and the private investor) will need to negotiate for a specific value within the interval through a bargaining process. According to the principles of bargaining theory discussed previously, each side will wish to gain maximum benefit. The two players will bargain until they reach to a point where both sides will receive some benefits that are more than or at least equal to their basic expectations. This bargaining process can be illustrated in Fig. 118.1.

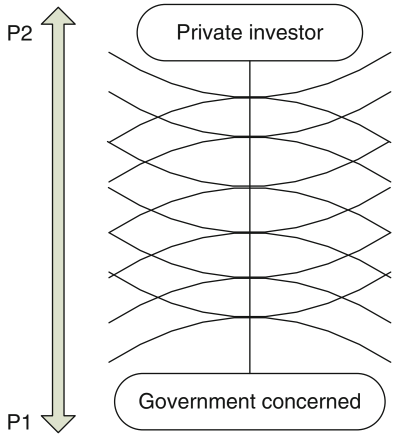

Fig. 118.1 The profile of the utility gains by the government concerned and the private investor

118.4 Bargaining Process of Identifying the Transfer Price

In a typical bargaining exercise, it is demonstrated that there is a little advantage to the player who offers first [14]. The following discussions consider two scenarios where the first round offer is given respectively by the government concerned and the investor.

The government makes an offer first. Let Q_g denote the maximum payoff and q_g for the minimum payoff that the government can receive if the government's offer is accepted in the first round of bargaining. And let Q_p and q_p denote respectively the maximum and minimum payoffs that the investor can receive from his counteroffer if he rejects the government's offer. While making the offer, the government will consider the possibility that the investor may reject the offer and initiate a bargaining. In order to reduce the chance of a further bargaining, thus saving the cost of time value, the government should make a reasonable offer by analyzing simultaneously the investor's position. If the offer is not attractive to the investor, according to the rule of rational behavior, the investor will reject the offer and propose a counteroffer. However, to propose the counteroffer, the investor will bear the bargaining cost f_p and the cost of time value (by applying the discount rate γ_p); thus, he can get a minimum payoff $\gamma_p q_p - f_p$ and a maximum payoff $\gamma_p Q_p - f_p$ [15]. Therefore, the government's best strategy is to make a first-round offer that can allow the investor to gain a similar range of payoffs to what the investor would gain from his possible counteroffer.

As discussed previously, the total benefit from operating a TOT infrastructure during a project's economic life is measured by B, and this benefit will be shared between the government and the investor. Accordingly, using the government's best strategy will allow it to get a minimum payoff $B - (\gamma_p Q_p - f_p)$ and a maximum payoff $B - (\gamma_p q_p - f_p)$. Nevertheless, as assumed, the government expects a maximum Q_g and a minimum q_g payoff from its first-round offer strategy. Therefore, the above discussions lead to the formulation of the following inequalities:

$$Q_g \leq B - \left(\gamma_P q_p - f_p\right) \tag{118.6}$$

$$q_g \geq B - \left(\gamma_P Q_p - f_p\right) \tag{118.7}$$

To look at this scenario further, assume that the investor does make a counteroffer. By using a similar analogy to that applied above, the investor should propose a reasonable counteroffer by analyzing carefully the government's position. In this case, the government may make a further counteroffer, and if it does, the government will bear twice the bargaining cost (namely $2f_g$) for producing the first offer and the further counteroffer. The government will also bear the cost of time value (by applying the discount rate γ_g). Therefore, the government can get a minimum payoff $(\gamma_g q_g - 2f_g)$ and a maximum payoff $(\gamma_g Q_g - 2f_g)$ if it makes a further counteroffer. Having realized this possibly further counteroffer by the government, the investor's best strategy is to make an offer that allows the government to gain a similar range of payoffs to what the government can gain if bargaining continues to the next round. As a result, the investor can get a minimum payoff $B - (\gamma_p Q_g - 2f_g)$ and a maximum payoff $B - (\gamma_p q_g - 2f_g)$. Considering that the investor expects a maximum Q_p and a minimum q_p payoff, the following inequalities can be formulated:

$$Q_p \le B - \left(\gamma_g q_g - f_g\right) \tag{118.8}$$

$$q_p \ge B - \left(\gamma_g Q_g - f_g\right) \tag{118.9}$$

By applying Eqs. (118.6) and (118.7) to Eqs. (118.8) and (118.9) respectively, the following results can be obtained:

$$Q_g \le \left[(1-\gamma_p)B - 2\gamma_P f_g + f_p\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.10}$$

$$q_g \le \left[(1-\gamma_p)B - 2\gamma_P f_g + f_p\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.11}$$

As Q_g denote the maximum payoff and q_g for the minimum payoff for the government t, the inequalities (118.7) and (118.8) lead to the following:

$$Q_g = q_g = \left[(1-\gamma_P)B - 2\gamma_P f_g + f_p\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.12}$$

Therefore, the consequence of the bargaining is that the government will receive an extra payoff Qg or qg, and a upper boundary of transfer price will be P_u .

So the government can get the benefit:

$$\left[(1-\gamma_P)B - 2\gamma_P f_g + f_p\right] \Big/ \left(1 - \gamma_P \gamma_g\right)$$

Namely,

$$\frac{1}{(1+i_1)^{T+m}}\left(P_u - \sum_{t=1}^{n} \frac{L_1}{(1+i_1)^t}\right) = \left[(1-\gamma_P)B - 2\gamma_P f_g + f_g\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.13}$$

By examining the situation that the investor makes an offer first, the same procedure may be easily adapted to obtain inequalities for private investor:

$$Q'_p \le \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] \Big/ \left(1 - \gamma_P \gamma_g\right) \tag{118.14}$$

$$q'_p \leq \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] / \left(1-\gamma_P\gamma_g\right) \tag{118.15}$$

As Q_g denote the maximum payoff and q_g for the minimum payoff for the government t, the inequalities (118.14) and (118.15) lead to the following:

$$Q_g = q_g = \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] / \left(1-\gamma_P\gamma_g\right) \tag{118.16}$$

Therefore, the consequence of the bargaining is that the government will receive an extra payoff *Qp* or *qp*, and a lower boundary of transfer price will be P_L.

So the private investor can get the benefit:

$$\left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] / \left(1-\gamma_P\gamma_g\right)$$

namely,

$$\frac{1}{(1+i_2)^{T+m}}\left(\sum_{t=1}^{n}\frac{R_1}{(1+i_2)^t} - P_L\right) = \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g\right] / \left(1-\gamma_P\gamma_g\right) \tag{118.17}$$

Referring to Eqs. (118.13) and (118.17), the new transfer price interval is derived as (P_L, P_u) , When the bargaining process continues, further new intervals can be formed by repeating the above analytical process. The interval will gradually converge on a specific point, for example, after *n* times of bargaining, and there should be an equation at this point. $P_L = P_u$

Nevertheless, in the application, it is difficult to find a perfect converging point. By using δ, any point within the converging interval (P_L,P_u) that is derived from *i* times of bargaining is considered an agreeable concession period if the following criterion can be met:

$$(P_u - P_L)/B = \delta \tag{118.18}$$

118.5 Application of BOT Bargaining Concession Model

A power plant was built in 1990 and was put into operation in 1994. The project total investment was 3.2 billion yuan. In 1999, the power station was conducted the TOT model. The TOT contract stipulates: the concession period of 20 years, promise tariff of 35 cents/kWh, the production benchmark of 6.6 billion kWh/year, residual values of 1.28 billion yuan (40% of total project 3.2 billion investments).

For the traditional power industry, the industry's benchmark rate of return is 12 %, so take i_1 as 12 %; the tariff of the project site is generally 0.30 yuan/kWh and the cost of power generation in general is 0.24 yuan/kWh; the tax rate of power generation is for 15 %. Supposed the transferee request the return on investment was 15 % ($i_2 = 15$ %); due to the high efficiency of the privatization of enterprises, the cost of power generation reduced to 0.134 yuan/kWh. Tax rate of power generation is still 15 %.

Net cash flow before and after the transfer based on the above data, is calculated:

$$\begin{aligned} R_i &= (0.35\ \text{yuan/kWh} - 0.134\ \text{yuan/kWh}) \times 6.6\ \text{billion kWh} \times (1 - 0.15) \\ &= 1.221\ \text{billion yuan}\ (i = 1, 2, \ldots, 20) \end{aligned}$$

$$\begin{aligned} L'_k = L_j &= (0.3\ \text{yuan/kWh} - 0.24\ \text{yuan/kWh}) \times 6.6\ \text{billion kWh} \times (1 - 0.15) \\ &= 0.337\ \text{billion yuan}\ (k = 1, 2, \ldots, m; j = 1, 2, \ldots, n) \end{aligned}$$

Referring to Eq. (118.1), $NPV_1 = -14.74$

Referring to Eq. (118.3), $NPV_3 = 21.57 - \frac{P}{(1+0.15)^9}$

When the objective function is $NPV_1 = NPV_2$, solve the equation to gain $P'_1 = 2.515$ billion yuan. When the objective function is $NPV_1 = NPV_3$, solve the equation to gain $P'_2 = 7.037$ billion yuan.

In the bargaining model,

$$B = \frac{1}{(1+i_1)^{T+m}} \sum_{t=1}^{n} \frac{R_1 - L_1}{(1+i_i)^t} = 2.381$$

the following assumptions are used: $f_g = f_p = 2$ million yuan ; $\gamma_g = \gamma_p = 0.98$; and $\delta = 10$ %.

$$\frac{1}{(1+i_1)^{T+m}} \left(P_u - \sum_{t=1}^{n} \frac{L_1}{(1+i_1)^t} \right) = \left[(1-\gamma_P)B - 2\gamma_P f_g + f_p \right] \Big/ \left(1 - \gamma_P \gamma_g \right) = 1.154,$$

$P_u = 5.717$ billion yuan

$$\frac{1}{(1+i_2)^{T+m}} \left(\sum_{t=1}^{n} \frac{R_1}{(1+i_2)^t} - P_L \right) = \left[\left(1-\gamma_g\right)B - 2\gamma_g f_p + f_g \right] \Big/ \left(1 - \gamma_P \gamma_g \right) = 1.154,$$

$P_L = 5.919$ billion yuan

$$(P_u - P_L)/B = (5.919 - 5.717)/2.318 = 8.7\% < 10\%$$

The above calculation suggests that the transfer price range is (5.717, 5.919) yuan.

118.6 Conclusions

In the TOT project, the government wants a higher transfer price so that he can recoup his initial investment. But the private investor procures a lower transfer price to decrease his investment. In the transfer price determining process, we can firstly identify the price range that the government concerned and the private investor both get interest. What is the ultimate transfer price in the range is related to the different bargaining parameter of both sides. Then we could exploit the bargaining model the paper discussed to find a more precise price. We can conclude that the bargaining model of TOT transfer price supply a model that can estimate the transfer price precisely.

References

1. Liu TJ, Li XJ (2003) TOT financing model of urban infrastructure. J Mod Manag Sci 4:84–85
2. Liu XM, Wan WW (2000) Research on the regime innovation and model of infrastructure industry. J Railw Econ Res 1:19–21
3. Li M (2010) Research on the methods of franchise pricing of urban sewage treatment project. J Xidian Univ 5:64–67
4. Guo JX, Gao XP, Bai WX (2002) Nature and conversion of the right to operate in TOT project. J Sci Technol Prog Policy 20(10):163–164
5. Nash JF (1950) Equilibrium points in n -person games. Proc Natl Acad Sci USA 361:48–49
6. Raiffa H (1953) Arbitration schemes for generalized two-person games. In: Kuhn H, Tucker AW (eds) Contributions to the theory of games. Princeton University Press, Princeton, pp 3–8
7. Harsanyi J (1956) Approaches to the bargaining problem before and after the theory of the games: A critical discussion of Zeuthen's, Hick's, and Nash's theories. Econometrica 242:144–157
8. Montet C, Serra D (2003) Game theory and economics. Palgrave Macmillan, New York, pp 1–15
9. Muthoo A (1999) Bargaining theory with applications. Cambridge University Press, Cambridge, UK, 10–25, 41–50, 74–89
10. Selten R (1999) Game theory and economic behaviour. Edward Elgar, Cheltenham, 175–194, 276–330
11. Rubinstein A (1982) Perfect equilibrium in a bargaining model. Econometrica 501:97–110
12. Kreps D (1991) Game theory and economic modeling. Clarendon Press, Oxford, pp 16–28
13. Aumann R, Brandenburger A (1995) Epistemic conditions for Nash equilibrium. Econometrica 635:1161–1180
14. Rubinstein A (1982) Perfect equilibrium in a bargaining model. J Econ 50(1):97–110
15. Shen LY, Bao HJ, Lu WS (2007) Using bargaining-game theory for negotiating concession period for BOT-type contract. J Constr Eng Manag 133(5):385–392