ALTERNATIVE CONCESSION MODEL FOR BOT-CONTRACT PROJECTS

Implementation process of a BOT-contract

The implementation process of a BOT-contract involves many parties including the government, investor, financing institutions, construction contractor, and operating firms. The involvement of the project participants in a typical BOT-contract process is highlighted in Figure 1. The process of implementing a BOT-contract project can be divided into four major stages: project feasibility study and tendering, construction, operation, and post-transfer.

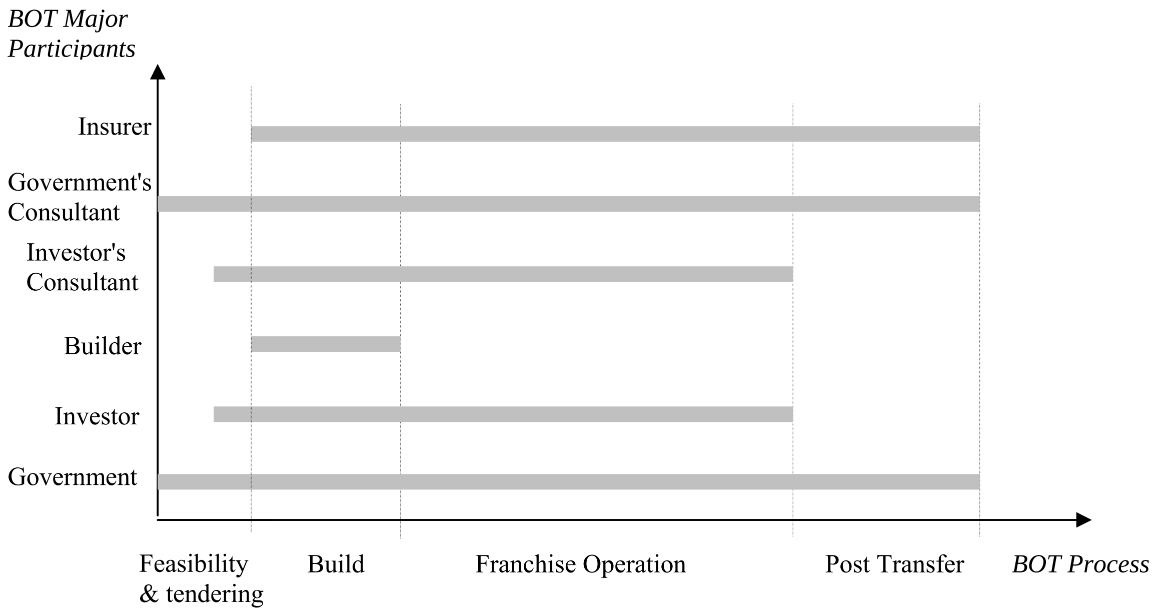

Figure 1 Involvement of major participants in BOT-contract process

Variables Affecting Concession Period in a BOT-Contract

The investor's considerations in a BOT-contract usually include the return on investment (ROI) and/or net present value (NPV). That is, the concession period should bring a certain level of ROI or NPV to the investor. However, the level of ROI and NPV is affected by the initial capital investment, income from operation, costs for operation, inflation, and interest rates. There is a standard procedure for calculating NPV, and investor's NPV can be established by:

$$NPV^{(1)} = \sum_{t=1}^{T_c} NPV_t = \sum_{t=1}^{T_c} \frac{(I_t - C_t)}{(1+r)^t} \tag{1}$$

Where:

$NPV^{(1)}$: the investor's net present value during the concession period

NPV_t: the net present value generated in year t

T_c : concession period of a BOT-contract

I_t : income in year t

C_t : costs in year t

r : discounted rate taking into account the effects of both interest and inflation rates, which is calculated as

$$r = \frac{1+I}{1+I_{nf}} - 1$$

where, I_{nf} denotes for inflation rate and I for interest rate.

Obviously, higher NPV provides better potential for the investor to make good profits from the project. To formulate the decision, the investor will establish a benchmark of expectation from

(2)

his capital investment. Usually this benchmark is given as an expected return rate, *ROI*, from his capital investment (I_c). Thus the following relation can be formed:

$$NPV^{(1)} \geq I_c \cdot R$$

Where:

$NPV^{(1)}$: investor's NPV

I_c : investor's capital investment

R : investor's expected return rate from capital investment

To illustrate the quantitative discussion, a hypothetical case is designed. Assume that a private investor is tendering for a BOT toll bridge, named as Dong-Fang Bridge. It is estimated that total investment of $120million is needed. The project started in 2000, and the economic life of the project will finish in 2030. The projected cash flow data are listed in Table 1. For the simplicity of the demonstration, all values in the table are calculated at present value.

Table 1 Cash flow data – Dong-Fang Bridge ($million in net present value)

Year	Income	Cost	Net value	Accumulated net value (NPV[a])	Year	Income	Cost	Net value	Accumulated net value (NPV[a])
2000		-14	-14	-14	2016	10	-5	5	13
2001		-12	-12	-26	2017	9	-5	4	17
2002		-10	-10	-36	2018	9	-5	4	21
2003	2	-9	-7	-43	2019	8	-5	3	24
2004	4	-8	-4	-47	2020	8	-7	1	25
2005	5	-8	-3	-50	2021	8	-7	1	26
2006	6	-7	-1	-51	2022	9	-7	2	28
2007	8	-6	2	-49	2023	9	-4	5	33
2008	9	-4	5	-44	2024	9	-4	5	38
2009	10	-3	7	-37	2025	8	-4	4	42
2010	10	-3	7	-30	2026	8	-5	3	45
2011	10	-4	6	-24	2027	6	-6	0	45
2012	11	-4	7	-17	2028	5	-8	-3	42
2013	12	-4	8	-9	2029	4	-10	-6	36
2014	13	-4	9	0	2030	3	-12	-9	27
2015	12	-4	8	8	2031	2	-15	-13	14
					2032	1	-16	-15	-1

If the investor for Dong-Fang Bridge is granted with the concession period until 2020, the NPV he can receive is $25million, namely, $NPV^{(1)}_{(Tc=20)}$ = $25million. If the investor aims for 15% return, i.e., R=15%, his expected investment return will be: I_cR=$120million ×15%=$18million. Thus the relation (2) exists to Dong-Fang project. In other words, the 20-years concession period can allow the investor to receive his expected return, and the investor should accept this term.

On the other hand, the government will consider what NPV can be obtained after the transfer of the project from the private investor. The NPV for the government after the concession period , denoted as $NPV^{(2)}$, can be established as:

$$NPV^{(2)} = \sum_{t=T_c+1}^{n} NPV_t = \sum_{t=T_c+1}^{n} \frac{(I_t - C_t)}{(1+r)^t} \qquad (3)$$

Where, n denotes for the whole servicing period of the project, measured by year; and other parameters have been defined in formula (1).

Referring to the Dong-Fang Bridge, if the government is to run the project from 2021 until year 2030, the total NPV that the government can receive during the post concession period will be:

$$NPV^{(2)} = \sum_{t=2021}^{2030} NPV_t = [1+2+5+5+4+3+0+(-3)+(-6)+(-9)] = \$2million$$

In fact, after the expiration of the concession period, the management organization will be changed. In order to maintain the capability for project to provide service, project maintenance costs will gradually increase as the project ages, thus the annual NPV can be negative. According to the projected cash flow, Dong-Fang project will produce negative annual NPV after 2027. The government would receive a total of -\$11million NPV if it has to operate the project to the end of 2031. Therefore, if the $NPV^{(2)}$ is negative or significantly small, the government will have to adjust to offer a shorter concession period to the investor so that the government can obtain a certain level of return. The benchmark for the government decision-making is that the NPV must be positive. Thus there is the relation:

$$NPV^{(2)} \geq 0 \tag{4}$$

However, a proper concession period in a BOT-contract should satisfy both the investor's interests defined in formula (2) and the government's interests defined in formula (4). The model for establishing the proper concession period will be discussed in the following section.

Model for Determining Concession Period

As addressed in the previous section, the proper concession period should satisfy both the investor's and the government's interests. To satisfy the investor's expectation that is defined in

$$NPV^{(1)} = \sum_{t=1}^{T_c} NPV_t = \sum_{t=1}^{T_c} \frac{(I_t - C_t)}{(1+r)^t} \geq I_c \cdot R$$

equations (1) and (2), and to satisfy the government's expectation that is defined in (3) and (4), the concession period *Tc* should concurrently meet the following constraints:

Considering Dong-Fang Bridge, when T_c is 20 years and *n* is 30 years, the constraints in equation

$$NPV^{(2)} = \sum_{t=T_c+1}^{n} NPV_t = \sum_{t=T_c+1}^{n} \frac{(I_t - C_t)}{(1+r)^t} \geq 0 \tag{5}$$

(5) will be met. It can be seen that the cash-flow format ($I_t - C_t$) and the investor's expected

return rate R have essential impacts on the value of T_c. Therefore it is essential to establish a proper cash-flow profile and a proper expected return rate before the concession period is to be agreed. As different development plans will incur different cash-flow profiles, each alternative development plan should be arranged with a specific concession period in order to satisfy both investor's and government's interests. In practical applications of BOT-contracts, as the operation of different types of projects will bring different cash-flow formats, different concession periods are applied. Table 2 provides examples of different concession periods for several typical BOT projects (Jun, 1998; Walker & Smith, 1995).

Table 2 Typical BOT projects with different concession periods

BOT Project	Country	Investment (US$)	Concession (Year)
Dartford Bridge	UK	310 million	20
The Channel Tunnel	UK & France	10.3 billion	55
Sydney Harbour Tunnel	Australia	550 million	30
Shajoe B Power Plant	China	550 million	10
East Harbour Tunnel	Hong Kong	565 million	30
South-North Highway	Malaysia	1.8 billion	30
Bangkok Highway	Thailand	880 million	30
No.3 Route	Hong Kong	940 million	30

To develop the model for determining concession period, it is assumed that the projected incomes and costs of a BOT-contract project can be graphically presented using curves illustrated in Figure 2. Figure 2(a) indicates the distributions of incomes and costs oof the project. Figure 2(b) is the distribution of net present value (NPV) which is obtained by subtracting the cost curve from the income curve. In Figure 2(b), parameter t_1 indicates the time when the project starts to generate profit. Figure 2(c) is an accumulated net present value curve.

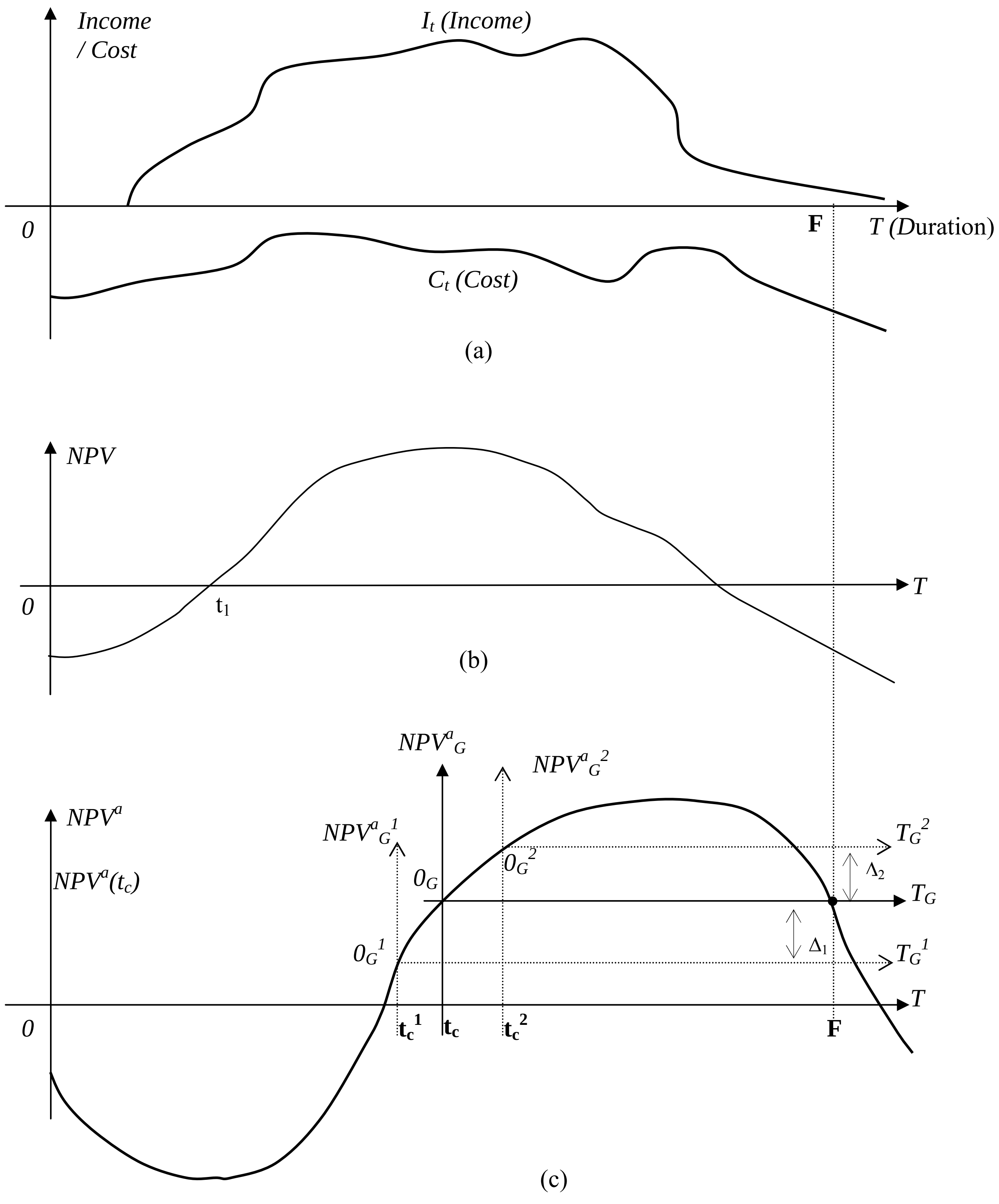

Figure 2 Modeling BOT Concession

In Figure 2(c), the parameter NPV^a is used to denote the accumulated NPV. $NPV^a(t_c)$, measured in the coordinate system NPV^a-T, is the accumulated NPV that the investor will obtain if the project concession period is t_c. To satisfy the investor's interest, which is defined in formula (2), the following relation should be true:

$$NPV^a(t_c) \geq I_c \cdot R \tag{6}$$

After the transfer, the government will start to operate the project from time t_c when the government has accumulated nil NPV but the investor has received $NPV^a(t_c)$, marked at point 0_G on the NPV^a curve. The NPV that the government can accumulate for the entire post-transfer period will be measured from point 0_G on the curve (see Figure 2(c)). As O_G is the start point for examining the government's NPV, the value of the government's NPV can be measured in the new coordinate system $NPV^a{}_G$-T_G taking 0_G as the origin point, as shown in Figure 2(c). Assume that the economic life of the project will be ended at point F, we can identify the position of t_c which allows the government's accumulated NPV at point F to be zero, measured in the new coordinate system $NPV^a{}_G$-T_G. In other words, the position of t_c can be identified to meet: $NPV^a{}_G(F) = 0$.

The point t_c in Figure 2(c) is called as the critical concession point and its value as the critical concession period, as any time for transferring the project before t_c will allow the government to receive positive NPV during the whole post-transfer period, and vice versa. For example, if the transfer happens at t_c^1 (see Figure 2(c)), the government's accumulated NPV can be measured in the coordinate system $NPV^a{}_G{}^1$-T_G^1 with 0_G^1 as the origin point. In this coordinate system, it can be seen that the value of $NPV^a{}_G{}^1$ at the time point F is positive, measured with Δ_1, namely, $NPV^a{}_G{}^1(\mathrm{F}) > 0$. On the contrary, the government will make negative accumulated NPV if the transfer of the concession happens after t_c. For example, if the transfer happens at $t_c{}^2$, the government's accumulated NPV will be negative at F when project ends, measured by Δ_2 in the coordinate system $NPV^a{}_G{}^2\text{-}T_G{}^2$ taking $0_G{}^2$ as the origin point. That is, $NPV^a{}_G{}^2(\mathrm{F}) < 0$.

Therefore, from Figure 2(c), in order to satisfy formula (4) which protects the government from absorbing any loss, the position of t_c in the coordinate system $NPV^a{}_G\text{-}T_G$ must satisfy the relation: $NPV^a{}_G(F) \geq 0$. And this relation can be rewritten within the coordinate system $NPV^a\text{-}T$ as follows:

$$NPV^a(t_c) \leq NPV^a(F) \qquad (7)$$

Formulas (6) and (7) work collectively as an alternative model for formulating a concession period that protects both investor's and government's interests. It shows that the position of F (the period of project servicing life) directly affects the arrangement of the concession period. The longer project servicing life can allow for a longer concession. Hudson et al's study (1997) shows that the servicing life for highway works is normally defined with 35-45 years, and 20-40 years for power plants. The previous records show that high way BOT projects are usually given with 25-30 years concession and 10-20 years for power plant projects (Jun, 1998).

By applying the concession model formed by (6) and (7), a range of alternatives of concession period t_c can be defined by the model:

$$I_c \cdot R \leq NPV^a(t_c) \leq NPV^a(F) \qquad (8)$$

As all alternatives satisfying the model (8) will be able to protect both investor's and government's basic expectation of interests, the application of the model provides more flexibility for negotiation between the private investor and the government concerned, thus improving the effectiveness of contracting arrangement. To illustrate the application of this model, the previous described Dong-Fang Bridge is referred again. Based on the information given in Table 1, we can obtain the following values:

$I_c \cdot R = \$120million\ x\ 15\% = \$18million$, and

$NPV^a\ (F{=}year\ 2030) = \$27million$

By applying these two values to model (8), the value of the concession period t_c can be defined as to satisfy: $\$18\ million \leq NPV^a(t_c) \leq \$27million$

From Table 1, it can be seen that as long as the transfer of the project happens between 2018 and 2022 the above criterion can be met. This provides a group of feasible alternatives which can protect the basic interests of both the private investor and the government concerned. The negotiation between the two sides should not beyond these alternatives. Although the final agreed concession period can be more favorable to the investor or government, it will certainly protect the basic interests for both sides.