Real Option in BOT projects

Využití reálných opcí při BOT projektech

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Abstract

The aim of this paper is government support in highway BOT project. In this type of project government normally provides support which mitigating financial-related risks such as market risk. According of Charoenpornpattana, Minato and Nakahama (2003) examples of these kinds of supports are direct financial subsidy, demand guarantee, revenue sharing, extension of concession period and shadow tolls. In this paper we focus on minimum demand guarantee government support. On the end of this paper we make a short case study on the case of Slovak highway project.

Key words

Real option, Built-Operate-Transfer project, Minimum revenue guarantee

**JEL Classification:** C61, G13, G32, G11,

1   Introduction

Built – Operate – Transfer project (BOT projects) are coming from the idea of private financing of public project (mostly infrastructure projects, airports, power plants, waterworks, public lighting …). These projects normally involves dealing with many parties, huge amount of budget, long time period and many uncontrollable factors. All these features make these projects very risky. Because of these uncontrollable factors are BOT projects very risky for private sector. We can say, that main risks are for example development risk, market risk, cost increase risk, operation risk, political risk, performance risk, environmental risk, credit risk, …. Realization of Built Operate Transfer project does not imply, that private sector undertaking project must assume all the project risk. In this projects very much of reasonable supports or risk sharing are from government side.

We can say, that BOT project is a form of project financing, where in a private entity (for example Project Company) receives a concession from the private or public sector to finance, design, construct, and operate a facility stated in the concession contract. This enables the project proponent to recover its investment, operating and maintenance expenses in the project. Due to the long-term nature of the arrangement, the fees are usually raised during the concession period. The rate of increase is often tied to a combination of internal and external variables, allowing the proponent to reach a satisfactory internal rate of return for its investment. BOT project scheme is now widely used in many countries such as Thailand, Turkey, Israel, Croatia, Vietnam, Japan, Australia, New Zeland, some states of U.S., …

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Figure 1: Participants and contractual relationships in BOT project
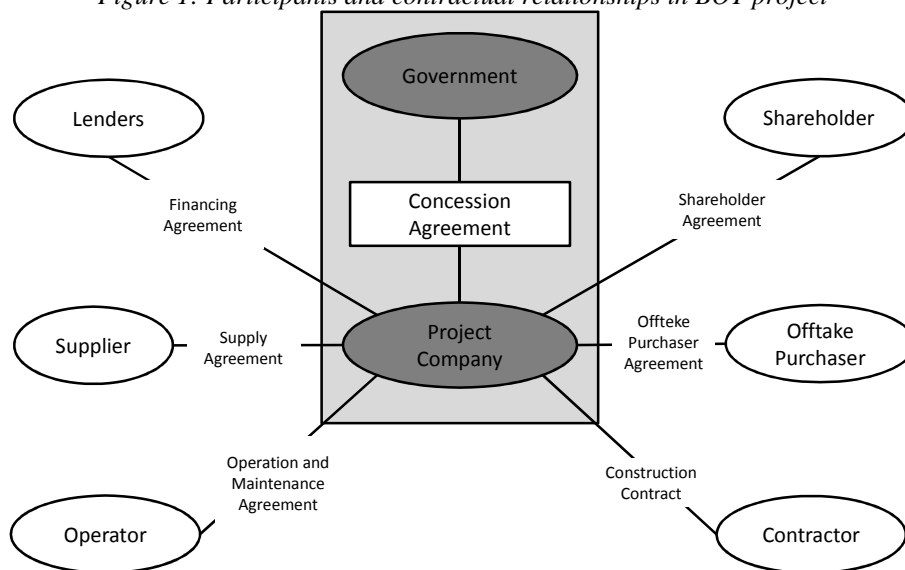
Chyba! Nenalezen zdroj odkazů. shows typical participants and relationships in BOT project. However, BOT scheme does not imply the Project Company must assume all the risks. Many literatures, such as Fishbein and Babbar (1996), Dailami and Leipziger (1997), and Ye and Tiong (2000), indicated that supports from government play important roles in project success. However, designs of supports are still subjective, intuitive and irrational. (Charoenpornpattana, Minato and Nakahama, 2003).

2   Government Support

Fishbein and Babbar (1996) indicated that there are two reasons for government to provide support to Project Company in highway BOT project. Firstly, it is expected to reduce capital requirement and to improve income stream during the project. Secondly, it is to protect investors from risk of inadequate cash flows. There are mainly eight categories of government financial support given to Project Company:

1. **Equity guarantees**. This kind of guarantee gives Project Company a right to sell the project to the government with a guaranteed minimum return on equity.
2. **Debt guarantees**. Under this guarantee, government provides a full guarantee or a cash-flow deficiency guarantee for repayment of debt.
3. **Exchange rate guarantees**. Fluctuation of currency can create significant impact on project which involved foreign capital. By the guarantee, government compensates the Project Company for increases in local cost of debt service due to exchange rate movements.
4. **Grants and subordinated loans**. Government can help in enhancing project economics by providing non-repaying grants or subordinated loan. Subordinated loan will be repaid to government after the senior loan. At such time, project would normally be in the relieved financial stage.
5. **Shadow tolls**. In this system, government, instead of users, pay a specific annual payment per vehicle recorded on the road to Project Company. The shadow tolls can be made into several rates depending on demand volume, such as declining schedule rate.
6. **Minimum traffic guarantee**. Government will compensate to Project Company in cash if traffic falls below a specified minimum level. This is the common type of

support in BOT project. In some case, besides the minimum guarantee, the contract may specify ceiling traffic level too. If traffic volume goes beyond the ceiling level, government has benefit sharing from the excess volume too.

7. **Concession extensions**. Government may give right to Project Company to extend the concession term if revenue falls below a specified level. This type of support give less financial exposure to government, but also give less efficiency in easing financial status of Project.

8. **Revenue enhancements**. Government normally enhances project revenue by limiting competition, facilitating demands, or allowing development of ancillary facilities.

These eight types of government support have different features.

3   Minimum Traffic Guarantee

With Minimum Traffic Guarantee type of support, Project Company can claim for compensation from government if Traffic volume of any year does not meet the agreed minimum threshold. In our case this threshold will be revenue from highway tolls. We assume that during our time period will not change payments for each vehicle. In this case, the Project Company holds yearly "Put Option" through the project life. As the traffic decreases, revenues from "Highway Payments" decrease, below a certain point, value of the option increases. In this type of support, there is only single Option and we show the option variables in Table 1.

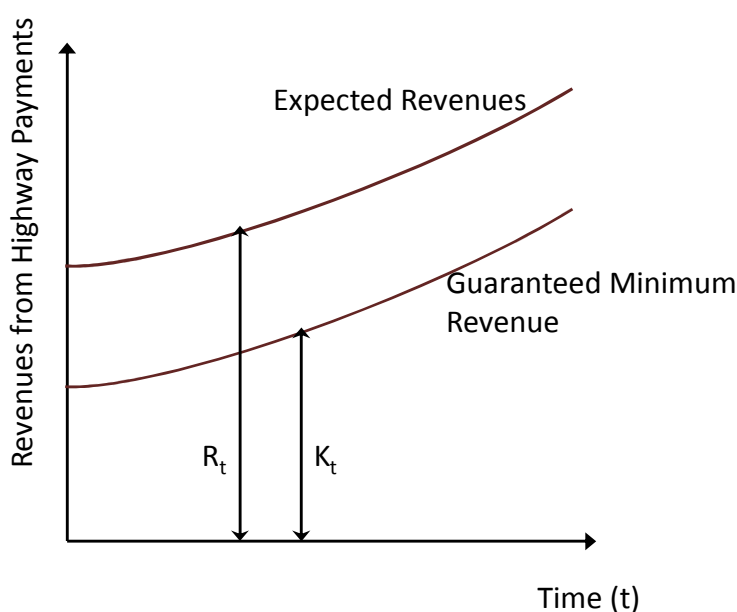*Figure 2: Expected Traffic and guaranteed minimum traffic revenue*

Table 1: Variables in the case of Minimum Traffic Guarantee support

Variables	Minimum Traffic guarantee support
Type of Option	Put
Underlying asset	Underlying Cash-Flow
Exercise price	Cash-Flow at minimum traffic guarantee
Maturity time	1 Year
Volatility	Volatility of Cash-Flow
Risk-free interest rate	Risk-free interest rate

Source: Charoenpornpattana, Minato and Nakahama (2003)

Cash-Flow without government guarantees (CF_t):

$$CF_t = (R_t - C_t)(1 - T)$$

Where:

R_t – Expected revenues from Highway Payments in year t

E_t – Costs in year t (in our case they are for maintenance of highway)

T – Tax rate

Cash-Flow at minimum revenue guarantees (CF_{Kt}):

$$CF_{Kt} = (KR_t - C_t)(1 - T)$$

Where K represent minimum revenue from highway payments (percentage rate from expected revenues)

On the base of statistic theory we can calculate the **volatility of Cash-Flow** on the base of volatility of traffic volume (σ_{trafic}):

$$\sigma_{CF} = \left(\frac{R_t}{R_t - C_t}\right)\sigma_{trafic}$$

Value of option is determined by:

$$RO_t = f\left(CF_t, CF_{Kt}, r, \sigma_{trafic}, M\right)$$

Where r represents risk-free interest rate and M is the maturity of option, which is in our example one year.

Then the **total option value** is

$$Total\ option\ value = \sum_{t=1}^{n} RO_t$$

4   Example of Minimum Traffic Guarantee support

We consider that minimum revenues are counted from Highway payments as a rate from expected revenues. We have to find the minimum revenues, which will be guaranteed by government. For finding this rate, we have to count two Cash-Flows from the project, one without the option and one Cash-Flow with minimum revenues that means, Cash-Flow with option. On next step we use binomial model for calculating the value of real option and for rate from expected revenue on which the government will take the option.

Table 2: Features of a case study of BOT highway project

Investment	2 290 mil. €
Forecast of revenues from highway payments	106 mil. € Volatility of traffic 30% Yearly growth of revenues from highway payments (from growing of highway traffic): 3% (year 1 – 10), 4% (year 11 – 30)
Concession period	30 years excluding construction period
Yearly Operating expenses	9,95 mil. € Increasing 0,5% yearly
Tax rate	19%
Risk free interest rate	5% (continuous)
Weight Average Cost of Capital (WACC)	15% (continuous)

Government support with minimum revenue from highway payments guarantee is quite easy. We have to find acceptable level of revenue from payments. As a basement we use expected level of revenue. Guaranteed level of revenue (K_t) is then calculated as a fraction (K) from expected revenues.

$$(K_t) = KR_t$$

From it follows, that the required value of option (government support) is 285,55 mil. € - $285,55\,mil.\,€ = \sum_{t=1}^{n} RO_t$. With using the value of real option and simple binomial model we can calculate the rate from expected revenues (*K*), which will the government guarantee. In our case it is 87,06 %. This holds in case of yearly growth of traffic volume according table 2 and not growing toll rate (Highway payments).

5 Conclusion

For large investment projects, there are many risks, which investors should consider. We have seen how the government can help to take risks to a private investor. Government help in the projects, which are not primarily for investors interesting, but they have great social wage. We choose from a variety of potential risks only one – Minimum traffic guarantee. If we use the method of real option to provide government assistance, the procedure is as follows: First divide the Cash-Flow of the project on two parts – Cash-Flow without option and Cash-Flow with option. Government support for the project is an option, which may or may not be utilized. Then we calculate the guaranteed level of revenue and from the total value of option we calculate the expected revenues, which will be the government support.[2]

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Summary

Investičné projekty financované metódou BOT (Built-Operat-Transfer) majú, mnoho rizík. Z tohto dôvodu vláda môže zostrojiť takzvaný balík opcií na zníženie rizika projektov.

Verejné projekty počas uvažovaného obdobia nemusia priniesť kladnú čistú súčasnú hodnotu, na základe čoho by ich súkromný sektor nerealizoval. Práve preto, sa vláda prostredníctvom opcií zaväzuje, že poskytne súkromným investorom pomoc, ak niektorý z vopred stanovených ukazovateľov nedosiahne požadovanú hodnotu. V predkladanom príspevku uvádzame príklad takejto vládnej opcie na príklade výstavby diaľnic. V tomto prípade môžeme hovoriť o vládnej pomoci ktorá znižuje finančné a trhové riziká, ktoré majú priamy vplyv na projekt (v tomto prípade si treba uvedomiť, že vláda neznáša celé riziká, poskytuje iba pomoc pri ich znižovaní a eliminácii súkromnej sfére). My sa v tomto prípade sústreďujeme na vládnu pomoc v prípade, že objem dopravy na diaľnici nedosiahne požadovanú úroveň. Úroveň dopravy je meraná príjmom z diaľničných poplatkov počas sledovaného obdobia, ktorá sa nemení. Počas uvedeného obdobia sa v našom prípade mení iba objem dopravy, ktorý sa zvyšuje. Medzi iné príklady pomoci vlády pri výstavbe a prevádzke diaľnic môžeme zaradiť priame vládne dotácie, záruku dopytu, predĺženie času koncesií, výšku poplatkov za používanie diaľnic.