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A Flexible Franchise Fee Scheme in a BOT Project

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The relationship between a government and a franchise firm in a build-operate-transfer (BOT) project is one that is wrought with incentive problems. It is well known that a contingent payment structure can help alleviate moral hazard problems. This paper provides a flexible franchise fee scheme from the perspective of a government which can charge a sufficient franchise fee and provide enough incentive for a private firm in a BOT project. This flexible franchise fee structure has option-like properties. A pricing model is derived in this paper to price this flexible franchise fee scheme. The closed-form pricing model that I have provided in this paper can help evaluate the effect of a flexible franchise fee on the performance of BOT projects. A numerical analysis shows that the proposed flexible franchise fee scheme is especially suitable for BOT projects with long investment horizons and revenue uncertainty.

Keywords

BOT; Franchise fee; Real options; Option pricing model

1. Introduction

Over the last decade, the governments of many countries have adopted plans to encourage private sectors to participate in infrastructure projects that are normally undertaken by the public sector. The infrastructures include the construction of highways and airports, power generation, water supply, and so on. The build-operate-transfer (BOT) structure is widely employed in the private financing of public infrastructures. Typically, a government gives a private company the right to finance, develop and operate an infrastructure project. The participating private company will engage in undertaking the construction, operation and maintenance, and finally, transfer the project property to the government after a certain period of time.

A franchise refers to an agreement by which the government awards, via competitive tendering, a monopoly to a private company to deliver a particular service in a defined area for a fixed period of time. Governments provide supports which mitigate financial related risks of a franchised private company. Fishbein and Babbar (1996) indicate that governments provide support to a private company in a BOT project to protect investors from the risk of inadequate cash flows. Charoenpornpattana, Minato and Nakahama (2003) consider that government support can be taken as a '*bundle of options*' given to private investors. They have explored options-like government supports in BOT projects based on the real options theory and proposed a design and formulation method for government support by using the real options approach.

On the contrary, a franchised private company pays a franchise fee to cover the costs of monitoring the service provision. The franchise fee can be a flat fee, fixed percentage commission, or a fixed fee plus a commission. Periodical payments are usually linked with sales or production. The relationship between a government and a franchised firm is one that is wrought with incentive problems. It is well known that a contingent payment structure can help alleviate moral hazard problems. We have observed from international experience, a wide range of contractual arrangements in BOT projects that contain a flexible franchise fee structure. For example, in California, the state government provides incentive programs for local government recycling and waste reduction in which the local governments are provided with more flexibility over time. The franchise agreement provides the right to adjust the franchise fee at any time, or at the time of any rate adjustments approved for the hauler. This is one of the examples in which the government has installed a flexible fee program on a private participation project.

This paper provides a dynamic payment scheme from the perspective of a government which can charge a sufficient franchise fee and provide enough incentive for a private firm in a BOT project.

On the one hand, a private company may be also willing to pay a flexible franchise fee. When the market is down, a smaller franchise fee allows the private firm to keep a large share of the project revenue. The selection of a successful bidder amongst prequalified bidders will be based on the least cost to the public and the highest cash flow to the government. The willingness of a private company to pay a flexible franchise fee can help the firm win the bid¹.

On the other hand, when the market is booming, the government should charge a higher portion of project revenue, since it is attributed by the whole economy. The government should charge more to absorb the monopoly benefit granted to the private company in a BOT project. An infrastructure project usually forms a natural monopoly. A franchise fee structure should be able to make sure that the private company will not take too much social welfare by taking the advantage of the monopolist. A flexible franchise fee structure enables the government to share profits with the private company. This is not like the franchise businesses granted by non-government entities. A government has the obligation to absorb excess economic rents in order to ensure social fairness.

In order to achieve a balance between efficiency and investment incentive, the government can install regulation constraints to induce the firm to price at marginal cost. I believe that the flexible franchise fee structure proposed in this paper is a way to induce efficiency and reduce monopoly rents.

In this paper, I will attempt to fill a gap by studying real options owned by the government in a BOT project. To achieve this goal, I will propose a flexible franchise fee structure in a BOT project. A pricing model is derived for this fee structure based on the option pricing theory. I will also run a numerical analysis to determine how important factors affect the value of the franchise fee options.

The structure of this paper is as follows. I develop a flexible franchise fee scheme for a BOT project in Section 2. I then derive a closed-form valuation model for the flexible franchise fee scheme in Section 3. In Section 4, I present some important properties of franchise fee options by using a numerical analysis. In Section 5, the conclusion is made.

2. A Flexible Franchise Fee Scheme in a BOT Project

The relationship between a government and a franchised firm is one that is wrought with incentive problems. A franchise fee charged based on a fixed

¹ The Taiwan High Speed Rail Corp won the Taiwan High Speed Railroad Project mainly because the company promised to provide cash feedback and asked for no government capital support.

percentage of the revenue generated by the project does not provide enough incentive for the franchised firm. It is well known that a contingent payment structure can help alleviate moral hazard problems.

For the real estate brokerage industry, it seems to be a stylized fact that broker commission rates are uniform. However, the fixed percentage and the flat fee models alone are not enough to provide a good incentive structure in an agency model (Anglin and Arnott, 1991). Later studies, like Sirmans and Turnbull (1997), suggest a changeable commission. Bruce and Santure (2000) suggest that an optional commission, in principle, depends on the characteristics of the relevant market. They argue that a non-linear contract is more efficient than simple sales commission.

Nwogugu (2009) has designed a dynamic royalty rate to alleviate the above problems. However, his model only incorporates two royalty-rates applied to the franchise sales and operating cash flow of the franchise, respectively. Neither does he try to derive a pricing model for his dynamic royalty rate structure.

I will attempt to provide a flexible franchise fee scheme for a BOT project. The key insight is that a government may not want to charge a high franchise fee in order to motivate private companies to exert more effort in a poor market. Also, a government has the obligation to collect more rent from a BOT project when the market is good, since it grants monopoly power to the private company.

I propose a flexible franchise fee structure that will include a flat fee, fixed percentage commission, and flat fee plus a bonus, depending on the revenue generated by the project at time t , $1 \leq t \leq T$:

$$f_t = \begin{cases} 0 & \text{if } R_t < K_0 \\ F_1 & \text{if } K_0 \leq R_t < K_1 \\ bR_t & \text{if } K_1 \leq R_t < K_2 \\ F_2 + s(R_t - K_2) & \text{if } R_t \geq K_2 \end{cases} \quad (1)$$

If the revenues R_t is in between the range K_0 and K_1 , the franchise fee is a flat fee F_1 , and if R_t is less than K_0 there will be no franchise fee. I consider a lower bound K_0 to ensure that the private companies pay fees only if they make revenue greater than K_0 . This property is similar to that of a knock-out option. When the revenues is in between the range K_1 and K_2 , private companies pay a certain percentage b of the revenue as the franchise fee, bR_t . When the revenue is above K_2 , the government is going to share the profit with the private companies; the franchise fee is now a fixed amount F_2 plus a share of the surplus $s(R_t - K_2)$, $0 \leq s \leq 1$.

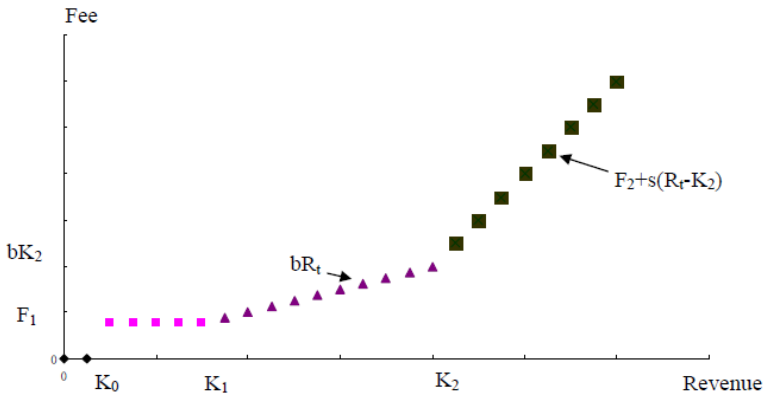
For the price function to be continuous, I need the following constraints²:

$$F_1 = bK_1$$

$$bK_2 = F_2$$

The definition of a flexible franchise fee as given in (1) is represented by Figure 1 below:

Figure 1 An Illustration of a Flexible Franchise Fee Structure



A BOT project has been typically used in sectors that require large capital expenditures and long periods of time to amortize investment costs. A franchise period of a BOT project may last over 35 or 50 years. In such a long period, operating circumstances change over time. There is a great deal of uncertainty with regards to future revenue flows. To handle revenue uncertainty in a BOT project, a flexible franchise fee scheme is able to provide enough incentive for the franchisee firm to provide good quality services when the market is bad, and let the government absorb the extra economic rent when the revenue from the BOT project is extremely high.

3. The Pricing Model

Based on the flexible franchise fee structure given in (1), I will derive a pricing model in this section. To the private companies in a BOT project, they need to incorporate such a dynamic franchise fee scheme into their project evaluation. Basically, they need to know the cost of such a payment scheme. In this paper, I derive a closed-form pricing function for this dynamic

² These constraints can be ignored since a discrete payoff function may not affect the pricing of an option.

franchise fee scheme. Using this pricing model, a government and a private firm can negotiate on the fee rate and come out with a mutually beneficial agreement.

In a risk-neutral world, I would assume that a project revenue R is evolved according to the geometric Brownian motion with a drift $(r-q)$ given below:

$$dR = (r - q)Rdt + \sigma Rdw^Q \tag{2}$$

where r is the risk-free rate, q is the dividend-yield of the project,³ σ is the volatility of the revenue, and dw^Q is the increment of a standard Wiener process. The initial conditions will be denoted by R_0 . The absence of an arbitrage assumption guarantees the existence of an equivalent martingale measure Q . Under the martingale measure Q , all expected rates of return equal the risk-free interest rate (see e.g. Schwartz, 1997).

By Itô's lemma, $d \ln R_t = (r - q - \frac{\sigma^2}{2})dt + \sigma dw^Q$

This implies that $R_t = R_0 \exp[(r - q - \frac{\sigma^2}{2})t + \sigma \Delta w_t^Q]$

Also by using the Girsanov theorem, $d \ln R_t = (r - q + \frac{\sigma^2}{2})dt + \sigma dw^R$, where $dw^Q = dw^R + \sigma dt$

$$\therefore R_t = R_0 \exp[(r - q + \frac{\sigma^2}{2})t + \sigma dw_t^R]$$

The time 0 value of the flexible franchise fee with maturity t , f_t^0 , is given by the discounted value of the risk-neutral expectation given below:

$$f_t^0 = e^{-rt} E^Q [F_1 I_{\{K_0 \leq R_t < K_1\}}] + e^{-rt} E^Q [bR_t I_{\{K_1 \leq R_t < K_2\}}] + e^{-rt} E^Q [(F_2 + s(R_t - K_2)) I_{\{R_t \geq K_2\}}] \tag{3}$$

The three components of (3) are computed below:

a. $e^{-rt} E^Q [F_1 I_{\{K_0 \leq R_t < K_1\}}] = e^{-rt} F_1 \Pr^Q (K_0 \leq R_t < K_1)$ (4)
 $= e^{-rt} F_1 [N(d_0) - N(d_2)] = A_t$

³ Less frequently traded real assets may earn a return below the equilibrium rate of return as expected in the financial markets from comparable traded financial securities of equivalent risk, with the rate of return shortfall necessitating a dividend-like adjustment (McDonald and Siegel, 1984).

$$d_0 = \frac{\ln\left(\frac{R_0}{K_0}\right) + \left(r - q - \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}, 1 \leq t \leq T \quad (5)$$

$$d_2 = \frac{\ln\left(\frac{R_0}{K_1}\right) + \left(r - q - \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \quad (6)$$

b. $e^{-rt} E^Q [bR_t I_{\{K_1 \leq R_t < K_2\}}] = e^{-qt} bR_0 [N(d_1) - N(d_2)] = B_t$ (7)

$$d_1 = \frac{\ln\left(\frac{R_0}{K_1}\right) + \left(r - q + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \quad (8)$$

$$d_3 = \frac{\ln\left(\frac{R_0}{K_2}\right) + \left(r - q + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \quad (9)$$

c. $e^{-rt} E^Q [(F_2 + s(R_t - K_2)) I_{\{R_t \geq K_2\}}]$
 $= e^{-rt} E^Q [(sR_t + (F - sK_2)) I_{\{R_t \geq K_2\}}]$ (10)

$= e^{-qt} sR_0 N(d_3) + e^{-rt} (F_2 - sK_2) N(d_4) = C_t$

$$d_3 = \frac{\ln\left(\frac{R_0}{K_2}\right) + \left(r - q + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \quad (11)$$

$$d_4 = \frac{\ln\left(\frac{R_0}{K_2}\right) + \left(r - q - \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \quad (12)$$

I then sum up the above three components of the franchise fee at each time period t to get the total value of the flexible franchise fees in a BOT project over the whole period T, as given below:

$$c = \sum_{t=1}^T f_t^0 = \sum_{t=1}^T (A_t + B_t + C_t) \quad (13)$$

4. Numerical Analysis

4.1 Fundamental Value and Sensitivity Analysis

I now consider some important properties of franchise fee options by using a numerical analysis. The base case of the parameters that I use in the example is: $r=0.03$, $\sigma=10\%$, $R_0=5$, $q=0.001$, $F_1=0.15$, $F_2=0.4$, $K_0=1$, $K_1=3$, $K_2=8$, $b=0.05$, and $s=0.2$. I have summarized the numerical results in Table 1. Similar to plain vanilla call options, the values of franchise fee options are increasing with the current price of the project revenue, risk-free interest rate and volatility of revenue, but decreasing with dividend yields. I also run a sensitivity analysis of the commission parameters b and s on option prices. The results of Table 2 show that the value of franchise fee options is increasing with the commission percentages.

Table 1 Prices of Franchise Fee Options

r=0.03				r=0.05			
σ	R_0	q		σ	R_0	q	
		0.001	0.002			0.001	0.002
10%	1	3.210	3.159	10%	1	3.270	3.166
	3	7.449	7.001		3	12.052	11.422
	5	19.299	18.199		5	27.360	26.169
	7	36.713	35.026		7	46.055	44.348
	9	56.725	54.530		9	66.111	63.921
30%	1	5.199	5.007	30%	1	5.892	5.683
	3	19.076	18.418		3	20.577	19.897
	5	34.596	33.448		5	36.767	35.598
	7	51.760	50.116		7	54.444	52.782
	9	69.946	67.805		9	72.988	70.835
50%	1	7.820	7.565	50%	1	8.224	7.963
	3	26.414	25.613		3	27.158	26.352
	5	45.936	44.584		5	46.828	45.479
	7	66.076	64.177		7	67.013	65.125
	9	86.581	84.137		9	87.490	85.066

Note: Assume that the franchise term is 50 years (T). The franchise fee is collected annually. Let $F_1=0.15$, $b=0.05$, $F_2=0.4$, $s=0.2$, $K_0=1$, $K_1=3$, $K_2=8$. The values of franchise fee options are increasing with the current price of the project revenue, risk-free interest rate and volatility of revenue, but decreasing with dividend yields.

$$dR = (r - q)Rdt + \sigma Rdw$$

$$f_t = \begin{cases} 0 & \text{if } R_t < K_0 \\ F_1 & \text{if } K_0 \leq R_t < K_1 \\ bR_t & \text{if } K_1 \leq R_t < K_2 \\ F_2 + s(R_t - K_2) & \text{if } R_t \geq K_2 \end{cases}, t = 1, 2, 3, \dots, T$$

Table 2 The Impact of Commission Percentage on the Prices of Franchise Fee Options

		s									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
b	0.01	12.522	24.272	36.023	47.773	59.523	71.274	83.024	94.774	106.525	118.275
	0.02	13.294	25.044	36.795	48.545	60.295	72.046	83.796	95.546	107.296	119.047
	0.03	14.066	25.816	37.566	49.317	61.067	72.817	84.568	96.318	108.068	119.819
	0.04	14.838	26.588	38.338	50.088	61.839	73.589	85.339	97.090	108.840	120.590
	0.05	15.609	27.360	39.110	50.860	62.611	74.361	86.111	97.862	109.612	121.362
	0.06	16.381	28.131	39.882	51.632	63.382	75.133	86.883	98.633	110.384	122.134
	0.07	17.153	28.903	40.654	52.404	64.154	75.905	87.655	99.405	111.156	122.906
	0.08	17.925	29.675	41.425	53.176	64.926	76.676	88.427	100.177	111.927	123.678
	0.09	18.697	30.447	42.197	53.948	65.698	77.448	89.198	100.949	112.699	124.449
	0.10	19.468	31.219	42.969	54.719	66.470	78.220	89.970	101.721	113.471	125.221

Note: Assume that the franchise term is 50 years (T). The franchise fee is collected annually. Let $r=0.03$, $\sigma =10\%$, $R_0=5$, $q=0.001$, $F_1=0.15$, $F_2=0.4$, $K_0=1$, $K_1=3$, $K_2=8$. The values of the franchise fee options are increasing with commission parameters b and s.

$$dR = (r - q)Rdt + \sigma Rdw$$

$$f_t = \begin{cases} 0 & \text{if } R_t < K_0 \\ F_1 & \text{if } K_0 \leq R_t < K_1 \\ bR_t & \text{if } K_1 \leq R_t < K_2 \\ F_2 + s(R_t - K_2) & \text{if } R_t \geq K_2 \end{cases}, t = 1, 2, 3, \dots, T$$

4.2 Model Comparison

The most commonly used franchise fee structure is the fixed percentage commission as described below:

$$f'_t = \begin{cases} 0 & \text{if } R_t < K_0 \\ bR_t & \text{if } K_1 \leq R_t \end{cases} \quad (14)$$

The time 0 value of the fixed percentage commission fee with maturity t , f_t^0 is given by the discounted value of the risk-neutral expectation given below:

$$f_t^0 = e^{-rt} E^Q [bR_t I_{\{K_1 \leq R_t\}}] = e^{-qt} bR_0 N(d_1) \quad (15)$$

$$d_1 = \frac{\ln(\frac{R_0}{K_1}) + (r - q + \frac{\sigma^2}{2})t}{\sigma\sqrt{t}}$$

The total value of the fixed percentage commission fees in a BOT project over the whole period T is given below:

$$c' = \sum_{t=1}^T f_t^0 \quad (16)$$

I run a comparison between a flexible franchise fee structure and a fixed percentage commission by varying the parameters R_0 , r , q and s . The results are shown in Table 3. I find that with lower risk-free rates (1%~2%) or higher rates of return shortfall q (0.012~0.02), the value of the franchise fee option will be lower than that of the fixed percentage commission. When the initial revenue R_0 is a little higher than $3(=K_1)$, the low boundary to charge a fixed percentage commission in the flexible franchise fee structure, the value of the fixed percentage commission is lower than that of the franchise fee option, especially when $R_0 > 5$. It is also important to note that when the revenue volatility is greater than 4%, the franchise fee option is higher in value than the fixed percentage commission. In addition, the franchise fee option tends to increase in value as volatility increases while the fixed percentage commission decreases in value. The above analysis provides a framework for a private company to decide whether or not to adopt a flexible franchise fee structure.

For a BOT with long investment horizons and high revenue volatility, a flexible franchise fee scheme can provide higher value for the government. The flexible franchise fee scheme is better than the traditionally used fixed percentage commission.

Table 3 A Comparison of Franchise Fee Options and Fixed Percentage Commission

R_0	c	c'	r	c	c'	q	c	c'	σ	c	c'
1	2.769	1.461	0.01	5.664	9.737	0.002	18.199	11.883	0.04	8.220	9.788
2	3.874	3.867	0.02	7.703	9.779	0.004	16.141	11.306	0.08	9.829	9.788
3	4.455	5.863	0.03	11.028	9.787	0.006	14.265	10.766	0.12	12.441	9.777
4	6.765	7.827	0.04	14.689	9.788	0.008	12.563	10.261	0.16	15.564	9.653
5	11.028	9.787	0.05	18.022	9.788	0.01	11.028	9.787	0.2	18.698	9.295
6	16.693	11.745	0.06	20.809	9.788	0.012	9.652	9.342	0.24	21.642	8.725
7	23.535	13.703	0.07	23.077	9.788	0.014	8.427	8.925	0.28	24.349	8.031
8	31.299	15.660	0.08	24.920	9.788	0.016	7.344	8.533	0.32	26.818	7.292
9	39.376	17.618	0.09	26.429	9.788	0.018	6.396	8.164	0.36	29.057	6.560
10	47.386	19.575	0.10	27.677	9.788	0.020	5.575	7.817	0.40	31.081	5.866

Note: Assume that the franchise term is 50 years (T). The franchise fee is collected annually. Let $F_1=0.15$, $b=0.05$, $F_2=0.4$, $s=0.2$, $K_0=1$, $K_1=3$, $K_2=8$.

$$dR = (r - q)Rdt + \sigma Rdw$$

$$f_t = \begin{cases} 0 & \text{if } R_t < K_0 \\ F_1 & \text{if } K_0 \leq R_t < K_1 \\ bR_t & \text{if } K_1 \leq R_t < K_2 \\ F_2 + s(R_t - K_2) & \text{if } R_t \geq K_2 \end{cases}, t = 1, 2, 3, \dots, T \quad c = \sum_{t=1}^T f_t^0$$

$$f'_t = \begin{cases} 0 & \text{if } R_t < K_0 \\ bR_t & \text{if } K_1 \leq R_t \end{cases} \quad c' = \sum_{t=1}^T f'_t$$

5. Conclusion

The past literature that examined real options in BOT projects has solely focused on the options held by private companies. Given the wide variety of arrangements observed in international BOT contracts, I have observed that a government may also install a flexible franchise fee structure into a BOT project. In this paper, I have examined a real option held by a government in a BOT project which exhibits a flexible franchise fee, in which its structure has option-like properties. The flexible franchise fee scheme can also calibrate a private company’s economic rent to ensure social fairness and maximize social welfare. Since BOT transfers the government’s right of control to private interests so that prices may rise and the private company may earn excess revenue by making use of its monopoly power, an effective way to absorb monopoly rent is to charge a higher franchise fee in a dynamic franchise fee scheme as I have provided in this paper. When the market is poor,

however, a government may have the incentive to lower the franchise fee in order to properly secure the execution of a BOT project.

In this paper, a closed-form pricing model has been derived for a flexible franchise fee based on the option pricing theory. I find that franchise fee options have similar properties as plain vanilla call options. My successful deriving of a closed-form pricing model of flexible fee options can help to evaluate the impact of these options on a BOT project. In addition, the flexible franchise fee structure proposed here is especially suitable for BOT projects with long investment horizons and revenue uncertainty, yet it can also be applied to many related fields, rather than BOT projects per se.

References

- Anglin, P. M. and Arnott, R., (1991), Residential Real Estate Brokerages as a Principal-Agent Problem, *Journal of Real Estate Finance and Economics*, **4**, 99-125.
- Bruce, D. and Santure, R., (2006), Optimal Real Estate Commissions, *Journal of Housing Economics*, **15**, 156-166.
- Charoenpornpattana, S., Minato, T., and Nakahama, S., (2003), Government Supports As Bundle of Real Options in Build-Operate-Transfer Highways Projects, 7th Annual International Conference on Real Options, Washington D.C., July.
- Fishbein, G. and Babbar, S., (1996), Private Financing of Toll Roads, *RMC Discussion Paper Series 117*, the World Bank, Washington D.C.
- McDonald, R. L. and Siegel, D. R., (1984), Option Pricing When the Underlying Asset Earns a Below-Equilibrium Rate of Return: A Note, *Journal of Finance*, **34**, 261-265.
- Nwogugu, M., (2009), On Franchise Royalty Rates, Franchise Fees and Incentive Effects, *International Journal of Mathematics, Game Theory, and Algebra*, **17**, Issue 5-6, 303-316
- Schwartz, E. S., (1998), Valuating Long-Term Commodity Assets, *Financial Management*, **27(1)**, 57-66.
- Sirmans, C.F. and Turnbull, G.K., (1997), Brokerage Pricing under Competition, *Journal of Urban Economics*, **41**, 102-117