JAIST Repository

https://dspace.jaist.ac.jp/

Title	Foreign Investment and Development of Water Business in China Based on Option-Game Approach		
Author(s)	Feng, YanYan; Fujiwara, Takao		
Citation	年次学術大会講演要旨集,25:1101-1105		
Issue Date	2010-10-09		
Туре	Conference Paper		
Text version	publisher		
URL	http://hdl.handle.net/10119/9480		
Rights	本著作物は研究・技術計画学会の許可のもとに掲載す るものです。This material is posted here with permission of the Japan Society for Science Policy and Research Management.		
Description	一般講演要旨		



Japan Advanced Institute of Science and Technology

2J05

Foreign Investment and Development of Water Business in China

Based on Option-Game Approach

oFeng YanYan Fujiwara Takao (Toyohashi Tcchnology University)

1. Introduction

The current situation of China's water market:

Since 1990s the Chinese government began to deregulate the water sector and loosen control to the sector and open up to the market, many foreign investors have bumped into China's water market. The rising of water price and the company profit would become the trend in China's water market. With opening up of business opportunities to foreign investors, the competition among the foreign enterprises, the stated owned enterprises, and the private companies will become more and more serious in the near future.

2. The state of Water Business in China

2.1 The Structure of China' Water Business in China

The water companies participating in China's water market are classified into four types,

Foreign specialized operators, Chinese Investment Developers (SOEs), Privatized Local Water Companies, Water TNCs. The SOEs capture share in an aggressive manner and are considered real competitors for foreign competitors.

		Unit: to	en thousand tuns	/day
ļ	Company	Water Supply	WWT capacity	Total Treatment
		(Accumulated) (Accumulated)	(Accumulated)
1	Veolia	1216.	5 345.2	1561.7
2	Beijing Capital Group	558	493	1051.1
3	Suez	51	8 33.75	551.75
4	General Water of China Lto	30	6 160.8	466.8
5	Shenzhen Water Group Lto	378.	1 82	460.1
6	Capital Environment Proje	tion 5	0 303.5	376
7	China Water Affairs Group	_td 229	5 23	322.5
8	Sangde Group	5	9 171.5	230.5
9	China Water Industry Grou	p Ltd 21	5 11.5	226.5
10	ZKC Environment Group Lt	ł	212	2 212
11	Shanghai Yangchen Investr	nent 196.	7	196.7
12	нно	18	8 4	192
13	Tongfang Water		0 174	174
14	Goleden State Group Ltd	95.	5 70.1	165.6
15	China Everbright Internant	onal Ltd	0 151	151

Table 1. Statistics of Water Supply and Treatment (Accumulated) Capacity

2.2Analysis on the competition in Chinese water market

At present, China implements excitability policy through special permission bid system to introduce competition by using BOT (build-operate-transfer), TOT (transfer-operate-transfer) patterns and so on. The governments are explicit about the rights and obligations with the companies that obtained the franchise rights through contract agreement or other methods.

3.Models

Consider a situation that there are two firms (say Firm A and Firm B) invest a BOT water project in China. We assume a two-stage option-game between the 2 players: first-stage infrastructure investment $I_1=15$ (million dollars), second stage operating and maintenance investment $I_2=40$, up or down with binomial parameter u=1.8 and d=0.6, risk-adjusted discount rate k=0.20, risk free interest rate $r_f=0.08$, and original

project value $v_0=50$. If so, risk neutral probability will be given as: $P = \frac{(1+r)V_0 - V^-}{V^+ - V^-} = 0.4$ 1 - p = 0.6



4.Analysis of the model

Consider a two-stage game with endogenous competitive reactions in the second (production) stage among two otherwise similar competitors. The initial investment for the first period $I_1=15$, the production investment for the second period $I_2=40$. When A and B make decision to invest, if they share the investment, it is half of the total cost assumed in this case.

 $(I_A^2 = 1/2 \times 40 = 20 \text{ million}).$

<1>when competitor's reaction is contrarian, the payoffs of proprietary strategic investment:

Firm B

		Wait	invest
	Wait	V ⁺ (40, 12.5)	$V^+(0, 50)$
Firm A		$V^{-}(5,0)$	V (0, -10)
	Invest	$V^{+}(50, 0)$	V ⁺ (40,10)
		V ⁻ (-10, 0)	V ⁻ (0, -10)
		FIG 1	.0

At V^+ , when B invests, A waits: $NPV_A = 0$

When B waits, A invests: $NPV_A = 90 - 40 = 50$

When both leaders A (can occupy larger market share $S_A=2/3$) and follower B invest by sharing investment $I_{2:}$

$$NPV_A = \frac{2}{3} \times 90 - 20 = 40$$
 $NPV_B = \frac{1}{3} \times 90 - 20 = 10$

If both of firms choose to wait, the competitive dynamics of the next-period subgames are as follows: Firm A will get a big share ($S_A = 2/3$) at high demand ($V^{++}=162$), and preempts the full value at $V^{+-}=54$. Both of them will delay investment at $V^{-}=18$. Hence, the value of option at $V^{+}=90$:

$$\begin{array}{l} \text{Option}_{A}^{+} = \frac{0.4 \left(\frac{2}{3} \times 162 - 20\right) + 0.6(1 \times 54 - 40)}{1.08} \approx 40 \\ \text{Option}_{B}^{+} = \frac{0.4 \left(\frac{1}{3} \times 162 - 20\right) + 0.6 \times 0}{1.08} \approx 12.5 \\ \text{The value of option at V}^{-} = 30 \text{ are:} \\ \text{Option}_{A}^{-} = \frac{0.4(1 \times 54 - 40) + 0.6 \times 0}{1.08} \approx 5 \\ \text{Option}_{B}^{-} = \frac{0.4 \times 0 + 0.6 \times 0}{1.08} = 0 \end{array}$$

<2>when competitor's reaction is reciprocating, the payoffs of proprietary strategic investment: (Suppose that Firm A will get 2/3 of stage-2 total value through proprietary strategic investment, but it will invite a reaction by a reciprocating competitor, so the total market value will reduced by 1/4.)

		Firm B	
		Wait	invest
Firm A	Wait	V ⁺ (30, 12.5) V ⁻ (5 , 0)	$V^+(0, 50)$ $V^-(0, -10)$
	Invest	V ⁺ (50, 0) V ⁻ (-10, 0)	V ⁺ (25, 2.5) V ⁻ (-5, -12.5)

FIG 1.1

At a strategic profile {Invest, Invest}:

$$NPV_{A}^{+} = \frac{2}{3} \times \left(\frac{3}{4} \times 90\right) - 20 = 25 \qquad NPV_{B}^{+} = \frac{1}{3} \times \left(\frac{3}{4} \times 90\right) - 20 = 2.5$$
$$NPV_{A}^{-} = \frac{2}{3} \times \left(\frac{3}{4} \times 30\right) - 20 = -5 \qquad NPV_{B}^{-} = \frac{1}{3} \times \left(\frac{3}{4} \times 30\right) - 20 = -12.5$$

At a strategic profile {Wait, Wait};

$$Option_{A}^{+} = \frac{0.4 \times \left(\frac{1}{2} \times 162 - 20\right) + 0.6 \times (1 \times 54 - 40)}{1.08} \approx 30 \qquad Option_{B}^{+} = \frac{0.4 \times \left(\frac{1}{4} \times 162 - 20\right) + 0.6 \times (0)}{1.08} \approx 7.5$$

<3> when competitor's reaction is contrarian, the payoffs of share strategic investment:

Firm B

			Wait	invest
Firm	A	Wait	$V^{+}(26.5,26.5)$ $V^{-}(2.5,2,5)$ $V^{+}(50,0)$	$V^+(0,50)$ $V^-(0,-10)$ $V^+(25,25)$
		Invest	V (-10, 0)	V (-5, -5)

FIG 1.2

The spillover effects are changed by contrarian reaction. Then at a strategic profile {Wait, Wait};

 $Option_{A}^{+} = \frac{0.4 \times (\frac{1}{2} \times 162 - 20) + 0.6 \times (\frac{1}{2} \times 54 - 20)}{1.08} \approx 26.5 \qquad Option_{A}^{-} = \frac{0.4 \times (\frac{1}{2} \times 54 - 20) + 0.6 \times (0)}{1.08} \approx 2.5$

At a strategic profile {Invest, Invest};

$$NPV_{A}^{+} = NPV_{B}^{+} = \frac{1}{2} \times 90 - 20 = 25$$
 $NPV_{A}^{-} = NPV_{B}^{-} = \frac{1}{2} \times 30 - 20 = -5$

<4> when competitor's reaction is reciprocating, the payoffs of share strategic investment:

Firm B

		Wait	invest
Firm A	Wait	V ⁺ (37,37) V ⁻ (5,5)	V ⁺ (0,50) V ⁻ (0, -10)
	Invest	V^+ (50, 0) V^- (-10, 0)	V ⁺ (36,36) V ⁻ (-1.5,-1.5)

FIG 1.3

Each market value increases into 5/4 times by share strategy and reciprocating reaction. Then at a strategic profile {Wait, Wait};

 $Option_{A}^{+} = \frac{0.4 \times \left(\frac{1}{2} \times \frac{5}{4} \times 162 - 20\right) + 0.6 \times \left(\frac{1}{2} \times \frac{5}{4} \times 54 - 20\right)}{1.08} \approx 37 \quad Option_{A}^{-} = \frac{0.4 \times \left(\frac{1}{2} \times \frac{5}{4} \times 54 - 20\right) + 0.6 \times (0)}{1.08} \approx 5$

At a strategic profile {Invest, Invest};

$$NPV_{A}^{+} = NPV_{B}^{+} = \frac{1}{2} \times \left(\frac{5}{4} \times 90\right) - 20 = 36 \qquad NPV_{A}^{-} = NPV_{B}^{-} = \frac{1}{2} \times \left(\frac{5}{4} \times 30\right) - 20 = -1.5$$

Calculate NPV:

$$NPV_{A}(W, W) = \frac{0.4 \times 37 + 0.6 \times 5}{1.08} \approx 33 \qquad NPV_{A}(W, I) = \frac{0.4 \times 0 + 0.6 \times 0}{1.08} = 0$$
$$NPV_{B}(W, W) = \frac{0.4 \times 37 + 0.6 \times 5}{1.08} \approx 16.5 \qquad NPV_{B}(W, I) = \frac{0.4 \times 50 + 0.6 \times (-10)}{1.08} 13$$
$$NPV_{A}(I, W) = \frac{0.4 \times 50 + 0.6 \times (-10)}{1.08} \approx 13 \qquad NPV_{A}(I, I) = \frac{0.4 \times 40 + 0.6 \times 0}{1.08} \approx 15$$
$$NPV_{B}(I, W) = \frac{0.4 \times 0 + 0.6 \times 0}{1.08} = 0 \qquad NPV_{B}(I, I) = \frac{0.4 \times 10 + 0.6 \times (-10)}{1.08} \approx -2$$



Notes: I: Investment W: wait S: share O: proprietary C: contrarian R: reciprocating

If both firms invest simultaneously, and firm B's reaction is contrarian, proprietary is good strategy for firm A. If firm A invest, firm B wait, no matter what firm B choose, its payoff is zero. Identically, firm B invests, firm A wait, the result is opposites. When both firms wait and get the value of option, so share is the best strategy for firm B if firm A's reaction is contrarian. From the figure 3.6, we can find the strategic profile

{Wait, Wait}'s payoff (16.5,16.5) is Nash equilibrium. The payoff of firm 1 is 16.5-15=1.5>0, which means that she will make profit even if she shares the technology with firm 2. The Nash Equilibrium may indicate the possibility that foreign hi-tech pioneer and Chinese domestic companies make partnership to share technology and market information.

		Firm B	
		Wait	invest
Firm A	Wait	Partnership	Gray zone
	Invest	Gray zone	competition

5. Conclusion

A joint venture in a BOT project enabling the firms to cooperate in infrastructure building period during the first stage could be a way to avoid the prisoners' dilemma. It can achieve the same research benefits with low costs by each firm and reduce the risk. In order to obtain these benefits, the firms may have to give up the possibility to gain a first-mover advantage on the other members of the alliance.

REFERENCES

- 1. Smit, H.T.J and L. Trigeorgis. (2004). Strategic Investment: Real Options and Games. Princeton, NJ. : Princeton University Press.
- 2. www.h2o-China, Statistics of Water Supply and Treatment (Accumulated) Capacity.