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Foreign Investment and Development of Water Business in China

Based on Option-Game Approach

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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.

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

Unit: ten thousand tuns/day

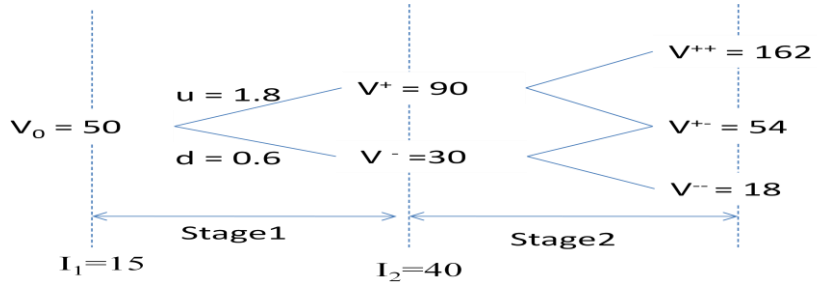
	Company	Water Supply (Accumulated)	WWT capacity (Accumulated)	Total Treatment (Accumulated)
1	Veolia	1216.5	345.2	1561.7
2	Beijing Capital Group	558.1	493	1051.1
3	Suez	518	33.75	551.75
4	General Water of China Ltd	306	160.8	466.8
5	Shenzhen Water Group Ltd	378.1	82	460.1
6	Capital Environment Projection	50	303.5	376
7	China Water Affairs Group Ltd	229.5	23	322.5
8	Sangde Group	59	171.5	230.5
9	China Water Industry Group Ltd	215	11.5	226.5
10	ZKC Environment Group Ltd		212	212
11	Shanghai Yangchen Investment	196.7		196.7
12	HHO	188	4	192
13	Tongfang Water	0	174	174
14	Goleden State Group Ltd	95.5	70.1	165.6
15	China Everbright Internantional Ltd	0	151	151

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: $P = \frac{(1+r)V_0 - V^-}{V^+ - V^-} = 0.4 \qquad 1 - p = 0.6$



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× 40 = 20 million).

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

		Firm B	
		Wait	**invest**
Firm A	**Wait**	V^+ (40, 12.5) V^- **(5, 0)**	V^+ (0, 50) V^- (0, -10)
	Invest	V^+ (50, 0) V^- (-10, 0)	V^+ **(40,10)** 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:

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

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:

$\text{Option}_{\text{A}}^{+} = \frac{0.4\left(\frac{2}{3}\times 162-20\right)+0.6(1\times 54-40)}{1.08} \approx 40$ $\text{Option}_{\text{B}}^{+} = \frac{0.4\left(\frac{1}{3}\times 162-20\right)+0.6\times 0}{1.08} \approx 12.5$

The value of option at V^{-}=30 are:

$\text{Option}_{\text{A}}^{-} = \frac{0.4(1\times 54-40)+0.6\times 0}{1.08} \approx 5$ $\text{Option}_{\text{B}}^{-} = \frac{0.4\times 0+0.6\times 0}{1.08} = 0$

<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}:

$\text{NPV}_{\text{A}}^{+} = \frac{2}{3}\times\left(\frac{3}{4}\times 90\right) - 20 = 25$ $\text{NPV}_{\text{B}}^{+} = \frac{1}{3}\times\left(\frac{3}{4}\times 90\right) - 20 = 2.5$

$\text{NPV}_{\text{A}}^{-} = \frac{2}{3}\times\left(\frac{3}{4}\times 30\right) - 20 = -5$ $\text{NPV}_{\text{B}}^{-} = \frac{1}{3}\times\left(\frac{3}{4}\times 30\right) - 20 = -12.5$

At a strategic profile {Wait, Wait};

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

<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^{+} (0,50) V^{-} (0, -10)
	Invest	V^{+} (50, 0) V^{-} (-10, 0)	V^{+} **(25, 25)** V^{-} (-5, -5)

FIG 1.2

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

$\text{Option}_{\text{A}}^{+} = \frac{0.4\times\left(\frac{1}{2}\times 162-20\right)+0.6\times\left(\frac{1}{2}\times 54-20\right)}{1.08} \approx 26.5$ $\text{Option}_{\text{A}}^{-} = \frac{0.4\times\left(\frac{1}{2}\times 54-20\right)+0.6\times(0)}{1.08} \approx 2.5$

At a strategic profile {Invest, Invest};

$\text{NPV}_{\text{A}}^{+} = \text{NPV}_{\mathbf{B}}^{+} = \frac{1}{2}\times 90 - 20 = 25$ $\text{NPV}_{\text{A}}^{-} = \text{NPV}_{\mathbf{B}}^{-} = \frac{1}{2}\times 30 - 20 = -5$

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

		Firm B: Wait	Firm B: 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};

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

At a strategic profile {Invest, Invest};

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

Calculate NPV:

$$\text{NPV}_{\text{A}}(\text{W},\text{W}) = \frac{0.4\times 37+0.6\times 5}{1.08} \approx 33 \qquad \text{NPV}_{\text{A}}(\text{W},\text{I}) = \frac{0.4\times 0+0.6\times 0}{1.08} = 0$$

$$\text{NPV}_{\text{B}}(\text{W},\text{W}) = \frac{0.4\times 37+0.6\times 5}{1.08} \approx 16.5 \qquad \text{NPV}_{\text{B}}(\text{W},\text{I}) = \frac{0.4\times 50+0.6\times(-10)}{1.08} 13$$

$$\text{NPV}_{\text{A}}(\text{I},\text{W}) = \frac{0.4\times 50+0.6\times(-10)}{1.08} \approx 13 \qquad \text{NPV}_{\text{A}}(\text{I},\text{I}) = \frac{0.4\times 40+0.6\times 0}{1.08} \approx 15$$

$$\text{NPV}_{\text{B}}(\text{I},\text{W}) = \frac{0.4\times 0+0.6\times 0}{1.08} = 0 \qquad \text{NPV}_{\text{B}}(\text{I},\text{I}) = \frac{0.4\times 10+0.6\times(-10)}{1.08} \approx -2$$

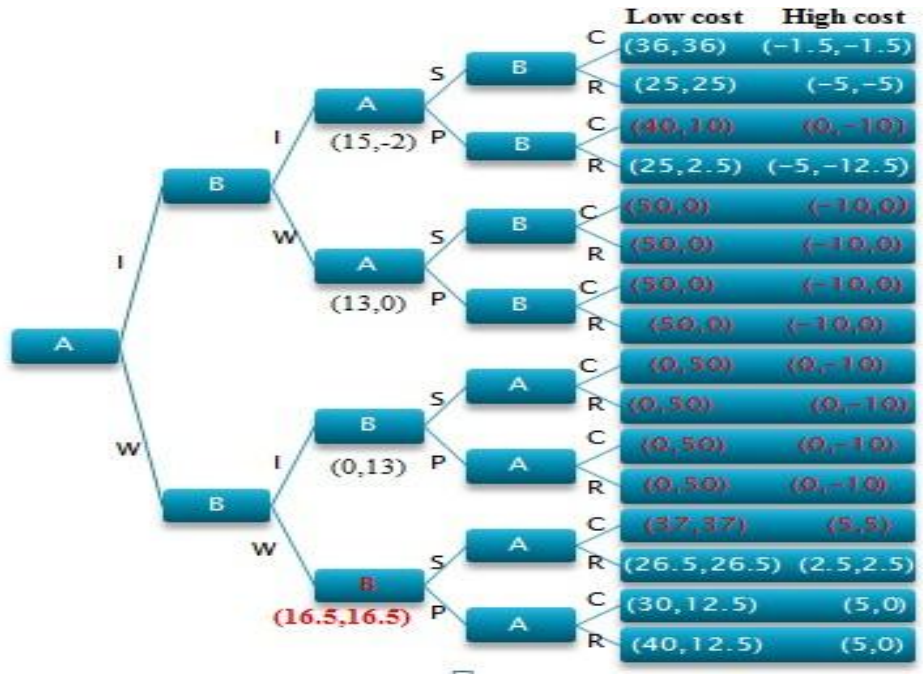


FIG 1.4

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.

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