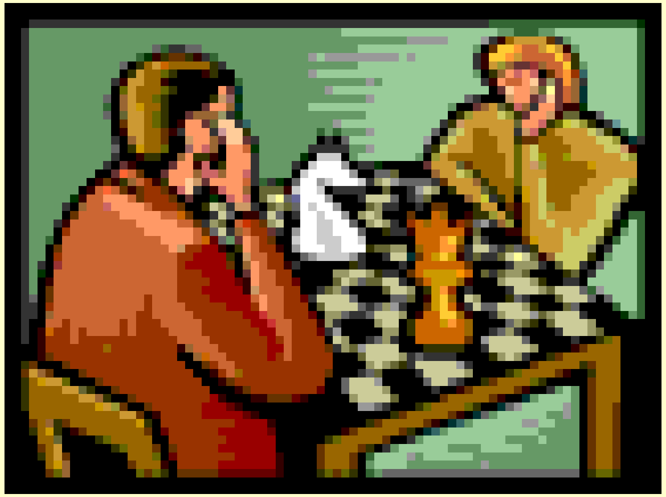
제 10 장

전략적 행위

Strategic Behaviors: Game Theory



게임의 요소

Normal Form Game

- A Normal Form Game consists of:
  - Players (경기자).
  - Rules (게임의 법칙): Timing of moves, Available strategies or feasible actions of each player, etc.
  - Outcomes (결과): They depend on the moves or actions that each player chooses.
  - Payoffs (보수): It represents the players' preferences over the outcomes.

A Normal Form Game

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

Normal Form Game: Scenario Analysis

- Suppose 1 thinks 2 will choose “A”.

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

Normal Form Game: Scenario Analysis

- Then 1 should choose "a".
  - Player 1's best response to "A" is "a".

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

Normal Form Game: Scenario Analysis

- Suppose 1 thinks 2 will choose "B".

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

Normal Form Game: Scenario Analysis

- Then 1 should choose “a”.
  - Player 1’s best response to “B” is “a”.

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

Normal Form Game
Scenario Analysis

- Similarly, if 1 thinks 2 will choose C…
  - Player 1's best response to "C" is "a".

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

Dominant Strategy (우월 전략)

- Regardless of whether Player 2 chooses A, B, or C, Player 1 is better off choosing “a”!
- “a” is Player 1’s Dominant Strategy!

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

Putting Yourself in your Rival's Shoes

- What should player 2 do?
  - 2 has no dominant strategy!
  - But 2 should reason that 1 will play "a".
  - Therefore 2 should choose "C".

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

The Outcome

Player 2

Player 1

Strategy	A	B	C
a	12,11	11,12	14,13
b	11,10	10,11	12,12
c	10,15	10,13	13,14

- This outcome is called a Nash equilibrium:
  - “a” is player 1’s best response to “C”.
  - “C” is player 2’s best response to “a”.

A Market-Share Game

- Two managers want to maximize market share.
- Strategies are pricing decisions.
- Simultaneous moves (동시게임).
- One-shot game (1회 게임).

The Market-Share Game in Normal Form

Manager 2

Manager 1

Strategy	P=$10	P=$5	P = $1
P=$10	.5, .5	.2, .8	.1, .9
P=$5	.8, .2	.5, .5	.2, .8
P=$1	.9, .1	.8, .2	.5, .5

Market-Share Game Equilibrium (가격설정전략과 시장점유율)

Manager 2

Manager 1

Strategy	P=$10	P=$5	P = $1
P=$10	.5, .5	.2, .8	.1, .9
P=$5	.8, .2	.5, .5	.2, .8
P=$1	.9, .1	.8, .2	.5, .5

Nash Equilibrium

Key Insight

- Game theory can be used to analyze situations where "payoffs" are non monetary!
- We will, without loss of generality, focus on environments where businesses want to maximize profits.
  - Hence, payoffs are measured in monetary units.

Examples of Coordination Games

- Industry standards
  - size of floppy disks.
  - size of CDs.
- National standards
  - electric current.
  - traffic laws.

A Coordination Game in Normal Form

Player 2

Player 1

Strategy	A	B	C
1	0,0	0,0	$10,$10
2	$10,$10	0,0	0,0
3	0,0	$10,$10	0,0

A Coordination Problem: Three Nash Equilibria!

Player 2

Player 1

Strategy	A	B	C
1	0,0	0,0	$10,$10
2	$10,$10	0,0	0,0
3	0,0	$10, $10	0,0

Key Insights

- Not all games are games of conflict.
- Communication can help solve coordination problems.
- Sequential moves can help solve coordination problems.

An Advertising Game

- Two firms (Kellogg's & General Mills) managers want to maximize profits.
- Strategies consist of advertising campaigns.
- Simultaneous moves.
  - One-shot interaction.
  - Repeated interaction.

A One-Shot Advertising Game

General Mills

Kellogg's

Strategy	None	Moderate	High
None	12,12	1, 20	-1, 15
Moderate	20, 1	6, 6	0, 9
High	15, -1	9, 0	2, 2

Equilibrium to the One-Shot Advertising Game

General Mills

Kellogg's

Strategy	None	Moderate	High
None	12,12	1, 20	-1, 15
Moderate	20, 1	6, 6	0, 9
High	15, -1	9, 0	2, 2

Nash Equilibrium

Can collusion work if the game is repeated 2 times?

General Mills

Kellogg's

Strategy	None	Moderate	High
None	12,12	1, 20	-1, 15
Moderate	20, 1	6, 6	0, 9
High	15, -1	9, 0	2, 2

No (by backwards induction).

- In period 2, the game is a one-shot game, so equilibrium entails High Advertising in the last period.
- This means period 1 is "really" the last period, since everyone knows what will happen in period 2.
- Equilibrium entails High Advertising by each firm in both periods.
- The same holds true if we repeat the game any known, finite number of times.

Can collusion work if firms play the game each year, forever?

- Consider the following "trigger strategy" by each firm:
  - "Don't advertise, provided the rival has not advertised in the past. If the rival ever advertises, "punish" it by engaging in a high level of advertising forever after."
- In effect, each firm agrees to "cooperate" so long as the rival hasn't "cheated" in the past. "Cheating" triggers punishment in all future periods.

Suppose General Mills adopts this trigger strategy. Kellogg's profits?

$$\Pi_{Cooperate} = 12 + 12/(1+i) + 12/(1+i)^2 + 12/(1+i)^3 + \dots$$

$$= 12 + \boxed{12/i}$$

Value of a perpetuity of \$12 paid at the end of every year

$$\Pi_{Cheat} = 20 + 2/(1+i) + 2/(1+i)^2 + 2/(1+i)^3 + \dots$$

$$= 20 + 2/i$$

General Mills

Kellogg's

Strategy	None	Moderate	High
None	12,12	1, 20	-1, 15
Moderate	20, 1	6, 6	0, 9
High	15, -1	9, 0	2, 2

Kellogg's Gain to Cheating:

- $\Pi_{Cheat} - \Pi_{Cooperate} = 20 + 2/i - (12 + 12/i) = 8 - 10/i$
  - Suppose $i = .05$
- $\Pi_{Cheat} - \Pi_{Cooperate} = 8 - 10/.05 = 8 - 200 = -192$
- It doesn't pay to deviate.
  - Collusion is a Nash equilibrium in the infinitely repeated game!

General Mills

Kellogg's

Strategy	None	Moderate	High
None	12,12	1, 20	-1, 15
Moderate	20, 1	6, 6	0, 9
High	15, -1	9, 0	2, 2

Benefits & Costs of Cheating

- $\Pi_{Cheat} - \Pi_{Cooperate} = 8 - 10/i$
  - 8 = Immediate Benefit (20 - 12 today)
  - 10/i = PV of Future Cost (12 - 2 forever after)
- If Immediate Benefit - PV of Future Cost > 0
  - Pays to "cheat".
- If Immediate Benefit - PV of Future Cost $\leq$ 0
  - Doesn't pay to "cheat".

General Mills

Kellogg's

Strategy	None	Moderate	High
None	12,12	1, 20	-1, 15
Moderate	20, 1	6, 6	0, 9
High	15, -1	9, 0	2, 2

Key Insight

- Collusion can be sustained as a Nash equilibrium when there is no certain “end” to a game.
- Doing so requires:
  - Ability to monitor actions of rivals.
  - Ability (and reputation for) punishing defectors.
  - Low interest rate.
  - High probability of future interaction.

Real World Examples of Collusion

- Garbage Collection Industry
- OPEC
- NASDAQ
- Airlines

Normal Form Bertrand Game

Firm 2

Firm 1

Strategy	Low Price	High Price
Low Price	0,0	20,-1
High Price	-1, 20	15, 15

One-Shot Bertrand (Nash) Equilibrium

Firm 2

Firm 1

Strategy	Low Price	High Price
Low Price	0,0	20,-1
High Price	-1, 20	15, 15

Potential Repeated Game Equilibrium Outcome

Firm 2

Firm 1

Strategy	Low Price	High Price
Low Price	0,0	20,-1
High Price	-1, 20	15, 15

Simultaneous-Move Bargaining

- Management and a union are negotiating a wage increase.
- Strategies are wage offers & wage demands.
- Successful negotiations lead to $600 million in surplus, which must be split among the parties.
- Failure to reach an agreement results in a loss to the firm of $100 million and a union loss of $3 million.
- Simultaneous moves, and time permits only one-shot at making a deal.