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Lecture 5

Strategic interaction

Industrial Economics

Strategic interaction

- Interaction is modeled with ***game-theoretical*** devices
- ***Game*** is any situation in which the participants make ***payoff maximizing*** decisions
  - decisions are ***driven*** by well defined ***objectives***
- Interaction is ***strategic*** when a players' ***expected payoff depends*** on
  - The player's actions
  - The opponents' actions
- Thus, each player's course of action (***optimal response***) depends on the ***information available*** to ***that player***

Games

Information structure in games

- Games of ***complete information***
  - ***Everyone knows*** the structure of the game (opponents, rules, set of actions, payoffs)
  - Players may ***ignore*** some past actions by rivals
  - ***Example:*** poker
- Games of ***perfect information***
  - ***Everyone knows*** the full history of actions by rivals
  - Players may ***ignore*** the rules or the full set of possible payoffs
  - ***Example:*** competing firms' objectives

Static games of complete info

Assumptions:

- Players choose actions ***simultaneously***
- Players receive ***payoffs*** that depend on the ***combination*** of actions selected
- The payoff distribution with respect to combinations of actions ***(game bi-matrix)*** is ***common knowledge***
- Players care to ***maximize*** own payoffs
- ***Incentives*** and ***risk attitude*** is included in the bi-matrix payoffs

Static games

Dominated strategies

- A strategy is ***strictly dominated*** when it yields a strictly lower payoff than another strategy, independently of the actions of the other players
- Rational players ***do not play*** strictly dominated strategies
  - neither ***opponents expect*** them to choose such strategies
- Once a strategy is dominated by ***one other strategy*** it will never been played
- In some cases, elimination of one strategy may be ***conditional*** on a ***previous elimination*** of another strategy by some other player (***iteration***)

Static games

Equilibria in dominant strategies

- When each player has an action that dominates all other available actions, the outcome is a ***DE***
- When each player has an action that dominates all other available actions in an iterative manner, the outcome is ***IDE***

P1 \ P2	Left	Middle	Right
Up	~~1, 0~~	2, 2	0 1
~~Down~~	~~0, 2~~	~~0, 1~~	2 0

- Both DE and IDE are ***non-strategic*** concepts
  - optimal action ***does not depend*** on actions of other players

Drawbacks of non-strategic equilibria

- Need to assume that it is ***common knowledge*** that all players are ***rational***
- The process often produces a very ***imprecise prediction*** about the outcome of the game
- Elimination of ***weakly dominated strategies*** may eliminate potential strategic equilibria (NE)

Games without a DE

- Often games ***have no*** dominant equilibria
- Without a dominant action the optimal choice of every player will ***depend*** on what the ***others*** do
- A ***more general*** but also ***weaker*** equilibrium concept is the ***Nash Equilibrium***

  a combination of strategies from which no player has an incentive to deviate unilaterally

The Nash Equilibrium

- At the NE each player is doing the ***best*** they can ***given*** their expectations on their opponents' actions
- At the NE, any player who will ***deviate alone*** will end up ***worse off***
- The DE is a special case of the NE, so first check games for ***dominated strategies***
- The NE does not have to be the ***social optimum*** of the game

The "sidewalk" game

		P2	
		LHS	RHS
P1	LHS	1 , 1	0 , 0
	RHS	0 , 0	1 , 1

- There might be ***more than one*** NE
- Which one is the ***outcome*** of the game?
- Depends on
  - Where the game ***begins*** from, or
  - How ***initial perceptions*** are formed

What is the outcome in this game?

		Katya	
		Left	Right
Alex	Up	0, 0	1, 1
	Down	1B, 1B	0, 0

- *(D,L)* is a ***focal point***

Mixed strategies

- Some games ***do not have*** equilibria in pure strategies

		P2	
		C	D
P1	A	0 , 1	1 , 0
	B	1 , 0	0 , 2

- We can select the appropriate ***mixture*** of strategies that maximizes the expected payoff

  assigning a ***probability*** to each non dominated action
- P2 will mix $^1/_2$ C and $^1/_2$ D
  P1 will mix $^2/_3$ A and $^1/_3$ B; ***Why?***

Incompleteness

P1 \ P2	Left	Middle
Up	3 , ?	0 , ?
Center	0 , ?	3 , ?
Down	1 , ?	1 , ?

- How would you handle the above ***incomplete*** game?

The Prisoners' Dilemma

- The Prisoners' dilemma is the ***most useful game*** in IE

Bonnie \ Clyde	Confess	Deny
Confess	-5, -5	-1, -10
Deny	-10, -1	-2, -2

- The NE is *(C,C)* and it is ***socially suboptimal***
- Had there been ***commitment***, players would move to (D,D)
  - however, this game assumes ***no commitment***
- Players ***prefer*** to receive -5 rather than ***expose*** themselves to the danger of receiving -10

Repeated PD games

- In repeated games, ***two important things*** may happen:
  1. Players can develop ***reputations***
  2. Players have a chance for ***retaliation***
- Players may ***cooperatively try to impose*** an outcome that is better than the NE (but not NE)
  - there is ***still incentive for cheating*** in the static game
- Repetition may ***eliminate*** the incentive for cheating
- Thus, a ***NON-Nash outcome*** is possible to ***prevail***
  - because players may not want to ***sacrifice*** a cooperative string of payoffs for the one-off payoff from cheating

Dynamic games of complete info

- Consider a game between an entrant and an incumbent:

Inc. (I) \ Entrant (E)	Enter	Pass
Accommodate	1, 2	2, 0
Fight	-1, -3	2, 0

- The entrant has the advantage of ***moving first***
- But the incumbent can ***threaten***
  - if you '*enter*' I will '*fight*' – I may lose 1 but you will lose 3!
- However, this threat is ***empty (non-credible)***
  - once E enters, incumbent will want to ***accommodate***

Sub-game perfection

- ***Dynamic inconsistency:*** A strategy may be optimal ex ante but sub-optimal ex-post
  - the NE concept ***cannot distinguish*** empty threats
- We can use the ***backward induction*** method to solve it
  1. Represent the game in a ***tree form***
  2. Split it in smaller ***sub-games*** from each node
  3. Solve the last ***standalone*** game
  4. Replace it with its NE
  5. Continue the same logic to the ***next-to-last*** game
- ***SPNE:*** A profile of strategies that is a NE in every sub-game of this game that contains this profile

Energon vs. Orange

Energon \ Orange (1st)	Thin frame	Thick frame
Thin battery	3, 6	3, 0
Thick battery	1, 1	8, 3

- Orange Inc. produces ***cellphones***
- Energon produces ***batteries*** for cellphones
- ***Sequential game*** with Orange as the ***first-mover***
- Orange does best by producing ***thin cellphones***
  - Orange ***knows*** that Energon will ***then*** produce thin batteries
- Energon, however, prefers to make ***thick batteries***

Threat

Energon	Orange (1st): Thin frame	Orange (1st): Thick frame
Thin battery	3, 6	3, 0
Thick battery	1, 1	8, 3

- Can Energon ***induce*** Orange to produce ***thick frames***?
  - ***recall*** that Energon ***moves after*** Orange
- Suppose Energon ***threatens*** to produce thick batteries ***regardless*** what Orange does
  - not credible! – once Orange ***has produced thin*** frames, Energon ***will lose*** if carries out its threat
- Can Energon ***make the threat credible***?

A credible threat

Energon	Orange (1st): Thin frame	Orange (1st): Thick frame
Thin battery	0, 6	0, 0
Thick battery	1, 1	8, 3

- *Energon* ***burns down (!)*** the production line of thin batteries
- *Energon* now can ***credibly threaten*** that it will produce "thick batteries"
- Of course, *Energon* wants to make sure that *Orange* executives ***hear*** about the fire ;)

Irrationality

- If a player acquires the ***reputation of being "irrational"*** threats might be in fact credible
  - irrational individuals do ***not*** always make ***profit maximizing*** decisions
- In some occasions reputation of irrationality can lead to a ***significant advantage***
  - Opponents ***cannot estimate*** you with logic
  - Your ***threats*** will be taken more ***seriously***

ευχαριστώ!

(thank you!)

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