EE481: Industrial Economics

Dynamic Game with Complete Information

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Dynamic vs Static

- Static Game = One-shot game. Players move simultaneously.
- Dynamic Game = More realistic. Players move sequentially. They observe each other's action before deciding actions.

Dynamic Game: Extensive Form Game

- Normal form representation omits some important information of the game.
- Normal form game shows only Players, Strategies and Payoff and assumes that players choose strategies simultaneously
- Many games have dynamic structure where players take actions sequentially and have different information
- Extensive form game takes into account these dynamic characteristics

Entry Deterrence

- An incumbent monopolist faces the threat of entry from a new firm. The new firm first chooses whether to enter the industry or not. The incumbent observes this decision, and, upon entry, may decide whether to fight the entrant or acquiesce (call a truce). Fighting involves lowering prices below marginal cost in an attempt to deter entry, acquiescing involves setting prices at their one- shot Bertrand (differentiated-product) level.

Entry Deterrence

- *Players*: The entrant, E; and the incumbent, I. So N = {E,I}
- *Strategies*: E can choose to "Enter" or "Stay Out". I can choose to "Fight" or "Truce".
- *Payoffs:* Payoff (Profits) and timing are represented in the following game tree

Game Tree

Extensive form game

Extensive form representation of dynamic games consists of

- Players
- Timing of move
- Actions that players have to choose when it is their turn.
- History of the game: a sequence of actions by individual players (called a "node"). Players may or may not know whether the game reached some "node"
- Payoff or outcome of the game e.g. profits, utility

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Actions, Strategies and Outcomes

- Extensive form game representation can be transformed to Normal form game representation
- Since in Extensive form game, a player may take action more than one time, or in many nodes of the game.
- Strategy is a complete contingent plan of actions. A strategy of a player must tell him, what action to choose at every node he might be called upon to move. Including nodes that may not be reach!
- So Strategy in extensive form game is not just an action at a particular node but a "complete list" of actions instructing the player what to do when it is his turn.
- Examples... Entry deterrence and Maching Penny

Nash Equilibrium

- Once an extensive-form game has been represented in its strategic form, it is straightforward to find its Nash equilibria (pure and mixed).
- How many Nash equilibria does the entry deterrence game has?
- Nash equilibrium ignores dynamic aspect of the game. Does decision to "fight" from the incumbent credible?

Backward Induction

- When called upon to choose, what would the incumbent do?
- Then, what should the entrant choose?

Diagram...

Backward Induction

- Starting from (all of) the ends of the game, work out best responses. Move back a step, bringing the payoffs associated with the initial best responses along. Work out best responses. . .
- Centipede example...

Backward Induction and the Centipede

Information Sets

- "Generalise notion of extensive-form games to allow for *imperfect* information.
- Consider the Prisoners' Dilemma game introduced in the first lecture of Game Theory. Representing the game in extensive form requires the introduction of information sets
- Player 2 does not observe player 1's action and hence does not know whether the game has reached the first "node" or the second. The actions available to player 2 are the same at either node.

Information Sets

- When a player does not know which node he is currently at, we have imperfect information game.
- All the nodes that the player cannot distinguish belong to the same information set
- Prisoner's dilemma example...

Subgames

- Subgame starts with *singleton node* (stand alone node or a node that does not share an information set with other nodes) and include the rest of game tree that follow
- Subgame must not break any information set
- Example: Prisoners' dilemma game, entry deterrence

Subgame Perfect and Backward Induction

- Definition: A subgame perfect equilibrium induces a Nash equilibrium in every subgame.
- Example: Prisoner's dilemma, entry deterrence, centipede
- In perfect information games, subgame perfect and backward induction yield the same results
- In imperfect information games, we use the idea of backward induction (that is, solving the game backward) but we must do it in the subgame level.