

# EE481: Industrial Economics

## Game Theory (Dynamic Game)

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# Game Theory

- In many circumstances, there are more than 1 player.
- The decision of 1 player can affect the payoffs to other players.
- Game theory analyzes how each player makes strategic decisions

Strategic decisions = **decisions that take into account other players' actions and responses.**

Static Game = One-shot game. No player can observe the others' decisions.

# Dynamic vs. Static

- Static Game = One-shot game. No player can observe the others' decisions.
- Dynamic Game = More realistic, players meet and compete more than 1 time
  - Repeated Game
    - Finitely repeated
    - Infinitely repeated
  - Sequential Game

# Noncooperative vs. Cooperative Games

- Cooperative game = Participants can negotiate binding contracts that allow them to make joint-strategies.

Example:

- Noncooperative game = Negotiation and enforcement of binding contracts between players is not possible.

Example:

# Nash Equilibrium

Nash Equilibrium = A solution concept for a game proposed by Prof. John Nash.

- Dominant Strategies: I'm doing the best I can *no matter what another person do*. You're doing the best you can *no matter what I do*.
- Nash Equilibrium: I'm doing the best I can *given what you are doing*. You're doing the best you can *given what I am doing*.
  - At the Nash Equilibrium, no player has an incentive to unilaterally change their decision.

# Finitely Repeated Games

- Actions are taken and payoffs are received over and over again.
- Increase a possibility to enforce an agreement (firms compete in more than 1 period).

Example: Price-fixing Game

		Firm 2	
		Cooperate	Defect
Firm 1	Cooperate		
	Defect		
		<b>Payoff (Firm 1, Firm 2)</b>	

- Suppose this game is played repeatedly for 20 periods.
- What now would be each player's strategy?

# Finitely Repeated Games

- Finite number of repetitions
  - Game theory predicts that cooperation will never happen.
- Suppose firm1 and firm2 successfully cooperate until period 19, what would happen in period 20 (last period)?
  - Nash Equilibrium solution suggests that both defect.
- If both would defect in the last period, what benefit there would be to cooperate in the next-to-last period?
  - None. So in period 19, both would defect again.
- Use the same rational back to the first period.
  - Both defect from the beginning.
  - Cooperate would never be chosen!

# Infinitely Repeated Games ( $T = \infty$ )

- In the real world, we see that firms sometimes cooperate, sometimes defect.
  - Needs to find a better model to explain the situation.
- Infinitely repeated game
  - There is no end period
- Infinitely repeated game allows us to predict that firms would cooperate.

# Infinitely Repeated Games (Strategies)

## Grim Strategy

- 1 Start by choosing “cooperate”.
- 2 Continue to choose “cooperate” unless some player has chosen “defect”, in which case choose “defect” forever.

## Tit-for-Tat

- 1 Start by choosing “cooperate”.
- 2 Thereafter, in period  $n$  choose the action that the other player choose in period  $(n - 1)$ .

# Infinitely Repeated Games (In Practice)

## Grim Strategy and Tit-for-Tat in Practice

- Could work in practice, although firms don't compete infinitely (there is an end at some point)
- This is because
  - 1 There is uncertainty about when the game would end
  - 2 Firms may not be 100% rational. So, would not be able to work out that if they compete for a finite number of periods, it is rational to just cheat from the first period.
- But if there are too many firms, Grim Strategy and Tit-for-Tat would be difficult to enforce.



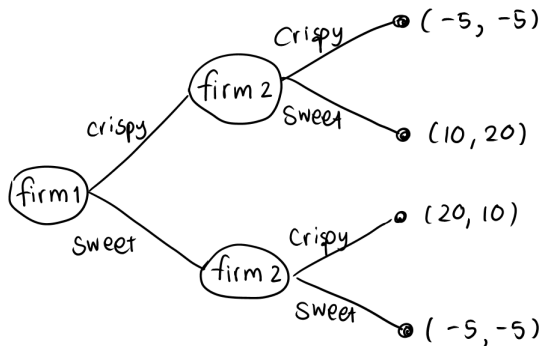
# Sequential Games

- Sequential games = game in which players move in turn, responding to each other's actions and reactions.

The **extensive form** representation of a sequential game identifies:

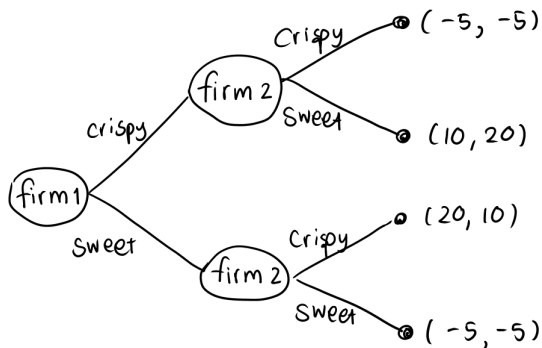
- 1 Identity of each player
- 2 Timing of move
- 3 Choices and actions available to each player
- 4 Information (history of the game)
- 5 Payoffs (all possible outcomes)

# A Simple Sequential Game



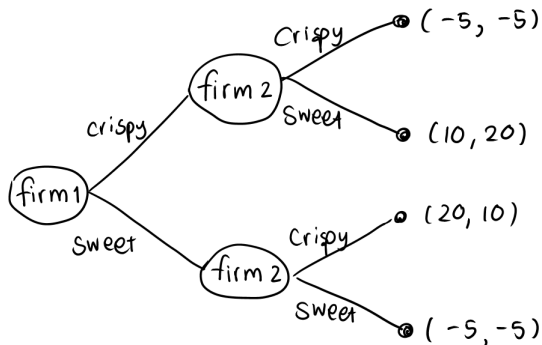
## Non-Credible Threats (Empty Threats)

- A non-credible threat is a threat that would never happen if the firm is rational.



## Backward Induction and SPNE

- We can use “backward induction” to find the equilibrium of the game.
- The equilibrium found would be called a Subgame Perfect Nash Equilibrium (SPNE). For SPNE, the solution to every subgame is a Nash Equilibrium.



# Entry Deterrence Example

# Reference and Further Reading I



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