Microeconomics

Acemoglu Laibson List

Chapter 13

Game Theory and Strategic Play

Modified by Joseph Tao-yi Wang

Chapter Outline

- 13.1. Simultaneous Move Games
- 13.2. Nash Equilibrium
- 13.3. Applications of Nash Equilibria
- 13.4. How Do People Actually Play Such Games?
- 13.5. Extensive-Form Games

Key Ideas

1. There are important situations when the behavior of others affects your payoffs.

2. Game theory is the economic framework that describes our optimal actions in such settings.

Key Ideas

3. A Nash equilibrium is a situation where none of the players can do better by choosing a different action or strategy.

4. Nash equilibria are applicable to a wide variety of problems, including zero-sum games, the tragedy of the commons, and the prisoners' dilemma.

Evidence-Based Economics Example

Is there value in putting yourself into someone else's shoes?

Game Theory and Strategic Play

- In 1970, Congress was considering banning cigarette advertising on TV.
- When they held hearings on the issue, not a single representative from the cigarette industry showed up to argue against the legislation. Why?

Game Theory and Strategic Play

▸ Game Theory
  ▸ The study of strategic interactions

Simultaneous Move Games

▸ Elements of a game
1. The players
2. The strategies
3. The payoffs

Simultaneous Move Games

▸ The Prisoners' Dilemma Game

  ▸ What happened:
  ▸ You and your partner in crime, Josie, got busted for robbery, caught in the act.
  ▸ The police separate you at the police station for questioning and offer each of you a deal...

Simultaneous Move Games

▸ If you both confess to having a gun, you each get 5 years.
▸ If you confess to having a gun during the crime, but Josie does not (you rat her out), you walk free and Josie gets 10 years.
▸ Josie gets the same deal—if she rats you out, she goes free and you get 10 years.
▸ If neither one of you confesses to the gun charge, you will each get 2 years for the robbery.

Simultaneous Move Games

▸ Elements of a game
1. The players—you and Josie
2. The strategies—confess or not confess
3. The payoffs—given by a payoff matrix

▸ Payoff matrix
  ▸ Represents payoffs for each player for each strategy

Simultaneous Move Games

	Column Player: Josie	
	Confess	Hold Out
Confess	• You get 5 years • Josie gets 5 years	• You are released • Josie gets 10 years
Hold Out	• You get 10 years • Josie is released	• You get 2 years • Josie gets 2 years

Row Player: You

Exhibit 13.1 Payoffs in the Prisoners' Dilemma

▸ Simultaneous move game
  ▸ Players pick their strategies at the same time

Simultaneous Move Games

	Column Player: Josie	
Row Player: You	**Confess**	**Hold Out**
Confess	• You get 5 years • Josie gets 5 years	• You are released • Josie gets 10 years
Hold Out	• You get 10 years • Josie is released	• You get 2 years • Josie gets 2 years

Exhibit 13.1 Payoffs in the Prisoners' Dilemma

▸ What should you do?

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Simultaneous Move Games

	Josie
You	**Confess**
Confess	• You get 5 years • Josie gets 5 years
Hold Out	• You get 10 years • Josie is released

Exhibit 13.2 Prisoners' Dilemma Game with Your Partner Confessing

▸ What if you think she will confess?

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Simultaneous Move Games

	Josie
You	**Hold Out**
Confess	• You are released • Josie gets 10 years
Hold Out	• You get 2 years • Josie gets 2 years

Exhibit 13.3 Prisoners' Dilemma Game with Your Partner Holding Out

▸ What if you think she will NOT confess?

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Simultaneous Move Games: Dominant Strategies & D.S. Equilibrium

▸ Dominant strategy
  ▸ One player's best response, regardless of what the other person does

▸ Dominant strategy equilibrium
  ▸ When each strategy used is a dominant strategy

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Simultaneous Move Games: Dominant Strategies & D.S. Equilibrium

	Column Player: Josie	
Row Player: You	**Confess**	**Hold Out**
Confess	• You get 5 years • Josie gets 5 years	• You are released • Josie gets 10 years
Hold Out	• You get 10 years • Josie is released	• You get 2 years • Josie gets 2 years

Exhibit 13.1 Payoffs in the Prisoners' Dilemma

▸ What if you two agree beforehand to both stay silent?

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Simultaneous Move Games
Games without Dominant Strategies

▸ Do all games have dominant strategies?

Surf shops and advertising

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Simultaneous Move Games
Games without Dominant Strategies

- Elements of a game
  1. The players—Hang Ten and La Jolla Surf
  2. The strategies—advertise or don't
  3. The payoffs—given by a payoff matrix

Simultaneous Move Games
Games without Dominant Strategies

	La Jolla	
	Advertise	**Don't Advertise**
Advertise	• Hang Ten earns $400 • La Jolla earns $400	• Hang Ten earns $700 • La Jolla earns $300
Don't Advertise	• Hang Ten earns $300 • La Jolla earns $700	• Hang Ten earns $800 • La Jolla earns $800

Hang Ten (row player label)

Exhibit 13.4 The Advertising Game

Simultaneous Move Games
Games without Dominant Strategies

	La Jolla Advertise
Advertise	• Hang Ten earns $400 • La Jolla earns $400
Don't Advertise	• Hang Ten earns $300 • La Jolla earns $700

Hang Ten

Exhibit 13.5 When La Jolla Surf Shop Advertises

- What should you do if you think La Jolla will advertise?

Simultaneous Move Games
Games without Dominant Strategies

	La Jolla Don't Advertise
Advertise	• Hang Ten earns $700 • La Jolla earns $300
Don't Advertise	• Hang Ten earns $800 • La Jolla earns $800

Hang Ten

Exhibit 13.6 When La Jolla Surf Shop Does Not Advertise

- What should you do if you think La Jolla will NOT advertise?

Simultaneous Move Games
Games without Dominant Strategies

- What should you do?

- Advertise or not advertise?

Nash Equilibrium

- Nash equilibrium
  - Each player chooses a strategy that is best, given the strategies of others; i.e., changing strategies does not make anyone better off

- Two requirements for Nash equilibrium:
  - All players understand the game and the payoffs of each strategy
  - All players recognize that the other players understand the game and payoffs

Nash Equilibrium:
Finding a Nash Equilibrium

La Jolla

		Advertise	Don't Advertise
Hang Ten	**Advertise**	• Hang Ten earns $400 • La Jolla earns $400	• Hang Ten earns $700 • La Jolla earns $300
	Don't Advertise	• Hang Ten earns $300 • La Jolla earns $700	• Hang Ten earns $800 • La Jolla earns $800

Exhibit 13.4 The Advertising Game

- ‣ If La Jolla advertises, you should advertise, too.
- ‣ Will you change your behavior?

Nash Equilibrium:
Finding a Nash Equilibrium

La Jolla

		Advertise	Don't Advertise
Hang Ten	**Advertise**	• Hang Ten earns $400 • La Jolla earns $400	• Hang Ten earns $700 • La Jolla earns $300
	Don't Advertise	• Hang Ten earns $300 • La Jolla earns $700	• Hang Ten earns $800 • La Jolla earns $800

Exhibit 13.4 The Advertising Game

- ‣ If La Jolla does not advertise, you should not advertise, either.
- ‣ Will you change your behavior?

Nash Equilibrium:
Finding a Nash Equilibrium

- ‣ There are two Nash equilibria for this game:

  - ‣ Both advertise
  - ‣ Both don't advertise

- ‣ What if the current position is not in one of these cells?

Nash Equilibrium:
Finding a Nash Equilibrium

La Jolla

		Advertise	Don't Advertise
Hang Ten	**Advertise**	• Hang Ten earns $400 • La Jolla earns $400	• Hang Ten earns $700 • La Jolla earns $300
	Don't Advertise	• Hang Ten earns $300 • La Jolla earns $700	• Hang Ten earns $800 • La Jolla earns $800

Exhibit 13.7 Two Nash Equilibria in the Advertising Game

- ‣ What if you are not advertising but La Jolla is?
- ‣ What if you are advertising but La Jolla is not?

Applications of Nash Equilibria:
Tragedy of the Commons Revisited

- ‣ Two interesting applications of Nash equilibria:

  1. Tragedy of the commons
  2. Soccer

Applications of Nash Equilibria:
Tragedy of the Commons Revisited

- ‣ Tragedy of the commons example:

  - ‣ Elements of this game
  1. The players: Polluter 1 and Polluter 2
  2. The strategies: Pollute or not
  3. The payoff: Payoff matrix

Applications of Nash Equilibria: Tragedy of the Commons Revisited

Exhibit 13.8 Payoff Matrix for Two Polluting Plants

▸ Both pollute is a DSE!

Game Theory and Strategic Play

▸ In 1970, Congress was considering banning cigarette advertising on TV.

▸ When they held hearings on the issue, not a single representative from the cigarette industry showed up to argue against the legislation. Why?

Applications of Nash Equilibria: The Zero-Sum Game

▸ Game theory is not just for business decisions—
▸ How you can be a better soccer player!

Applications of Nash Equilibria: The Zero-Sum Game

▸ Soccer example:

▸ Elements of this game
▸ The players: You and the goalie
▸ The strategies: Kick right or left
▸ The payoff: Payoff matrix

Applications of Nash Equilibria: The Zero-Sum Game

Exhibit 13.9 A Zero-Sum Game: Penalty Kicks

▸ Zero-sum game
▸ When one player wins, the other loses, so the payoffs sum to zero

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Applications of Nash Equilibria: The Zero-Sum Game

▸ Pure strategy
▸ Choosing one strategy
▸ Mixed strategy
▸ Randomly choosing different strategies

▸ Does game theory work in the real world?
▸ Two problems:
1. What are the payoffs?
2. Players may have different abilities

Extensive-Form Games

- Extensive-form games
  - There is an order to play instead of simultaneous play—i.e., one player goes first

- Game tree
  - Representation of an extensive form game

Extensive-Form Games
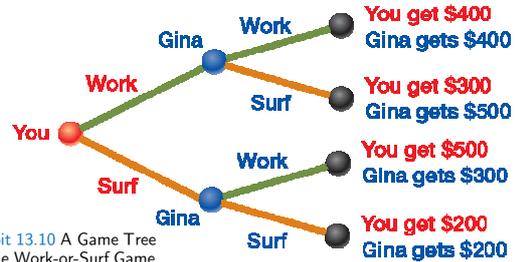
Exhibit 13.10 A Game Tree for the Work-or-Surf Game

- What should you do?

Extensive-Form Games: Backward Induction

- Backward induction

  - Considering the last decision and
  - deducing what the previous decisions have been

Extensive-Form Games: Backward Induction

Exhibit 13.11 Panel (a): Gina's Game Tree If You Decide To Work. Panel (b): Gina's Game Tree If You Decide To Surf.

- She will Surf if you Work, and
- She will Work if you Surf

Extensive-Form Games: Backward Induction

- Gina's two strategies:
  1. Surf if you work (you earn $300)
  2. Work if you surf (you earn $500)

- Since you now know what Gina will do as a result of each of your decisions, you can make the best decision... which is?

Extensive-Form Games: First-Mover Advantage, Commitment, & Vengeance

- First-mover advantage

  - When the first player in a sequential game benefits from being first

Extensive-Form Games:
Backward Induction
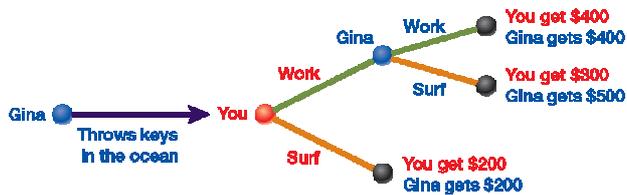
Exhibit 13.12 An Extensive-Form Game with a Credible Commitment

▸ She will Surf if you Work, and
▸ You will Work (to avoid lose-lose)!

Evidence-Based Economics Example

Is there value in putting yourself into someone else's shoes?

Game Theory and Strategic Play
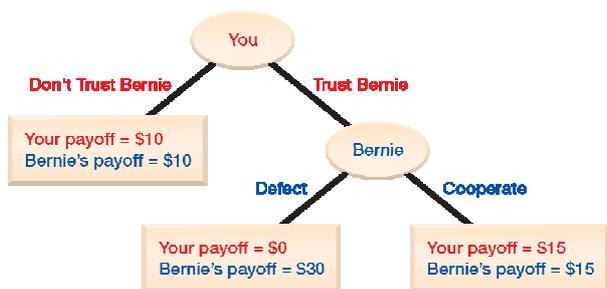
Exhibit 13.13 A Trust Game between You and Bernie

Game Theory and Strategic Play

▸ Is this the way we want things to be?

Homework

▸ ALL Chap.13, Problem 5, 8, 10, 11
  ▸ Bonus Question (See next slide)
▸ Challenge Questions (from Past Finals)
  ▸ 2007 - Essay Q6
  ▸ 2008 - Multi-Choice Q5
  ▸ 2009 - Multi-Choice Q9
  ▸ 2010 - Essay C & D
  ▸ 2013 - Essay IV
  ▸ 2014 - Essay B
  ▸ 2015 - Essay C & D

Bonus Question 1 (ALL 13-3)

▸ In the movie *Princess Bride*, the hero disguised as the pirate Westley is engaged in a game of wits with the villain Vizzini.

1. Westley puts poison in either his own glass of wine or in Vizzini's glass.
2. Vizzini will choose to drink from his own glass or from Westley's; Westley drinks from the glass Vizzini does not choose.

Bonus Question 1 (ALL 13-3)

- ‣ (You should think of this as a game where players move simultaneously since Vizzini does not see which glass Wetley has chosen).
- ‣ Assume drinking the poison and dying gives a payoff of -10; staying alive has a payoff of 10

1. Construct the payoff matrix for this game.
2. Does Vizzini have a dominant strategy? Does Westley have a dominant strategy?
3. Does this game have a Nash equilibrium where players use pure strategies?

Bonus Question 1 (ALL 13-3)

4. Now suppose that Westley has another strategy which is not to put poison in any of the glasses, and this will give him a utility of a regardless of Vizzini's choice.
   - ‣ For what values of a does Westley have a dominant strategy?

Bonus Question 1 (ALL 13-4)

- ‣ Suppose that auctions have never been conducted online and eBay is contemplating entering the market for online auctions.
- ‣ Another company, Yahoo! Auctions, also wants to enter this market.
  - ‣ If eBay enters the market but Yahoo! Auctions does not, then eBay earns enormous profits and Yahoo! Auctions earns 0.

Bonus Question 1 (ALL 13-4)

- ‣ Similarly, If Yahoo! Auctions enters the market but eBay does not, then Yahoo! Auctions earns enormous profits and eBay earns 0.
- ‣ If both enter the market, then each suffers losses. If neither enters, each earn 0.

1. Construct the payoff matrix for eBay and Yahoo! Auctions indicating the strategies they may choose.
2. Find the Nash equilibrium for this game.