Part III: Market Structure

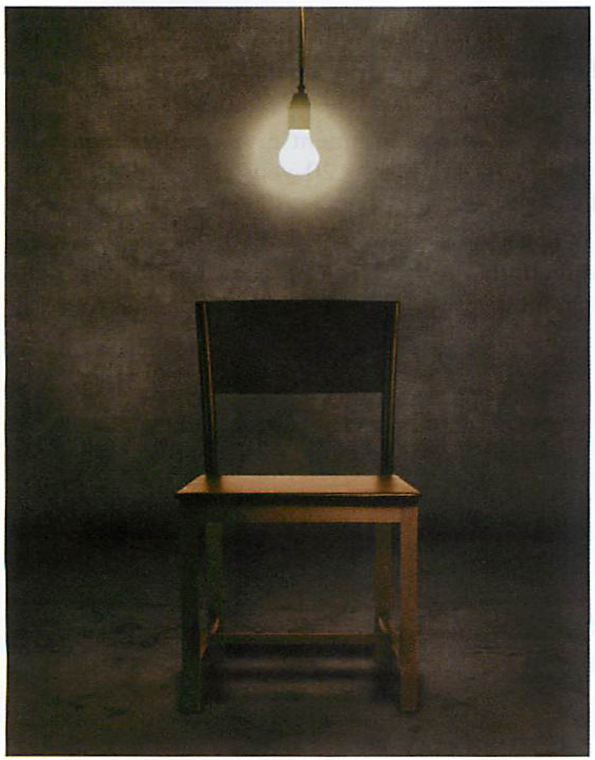
12. Monopoly
13. Game Theory and Strategic Play
14. Oligopoly and Monopolistic Competition

Chapter 13
Game Theory and Strategic Play

2015.12.18.

Outline

Evidence-Based Economics



Q: Is there value in putting yourself into someone else'sshoes?

- There are important situations when the behavior of others affects your payoffs.
- Game theory is the economic framework that describes our optimal actions in such settings.

- A Nash equilibrium is a situation where none of the players can do better by choosing a different action or strategy.
- Nash equilibria are applicable to a wide variety of problems, including zero-sum games, the tragedy of the commons, and the prisoners' dilemma.

13.1 Simultaneous Move Games

- **Game theory** is the study of situations in which the payoffs of one agent depend not only on his actions, but also on the actions of others.
- It is important to recognize the three key elements of any game:
  1. The players
  2. The strategies
  3. The payoffs

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.
  - If you both confess to also having a gun, you each get 5 years.
  - If you confess to having a gun, but Josie does not, you walk and Josie gets 10 years. Josie gets the same deal.
  - If neither one of you confesses to the gun charge, you will each get 2 years for the robbery.

Elements of the game:

- *Players*: You and Josie
- *Strategies*: Confess or hold out
- *Payoffs*: See Exhibit 13.1

		Column Player: Josie: Confess	Column Player: Josie: Hold Out
Row Player: You	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

- This game is called a **simultaneous move game** because players select their actions at the same time.

Best Responses and the Prisoners' Dilemma

- A first step in figuring out how to play any game is to put yourself in the shoes of the other player.

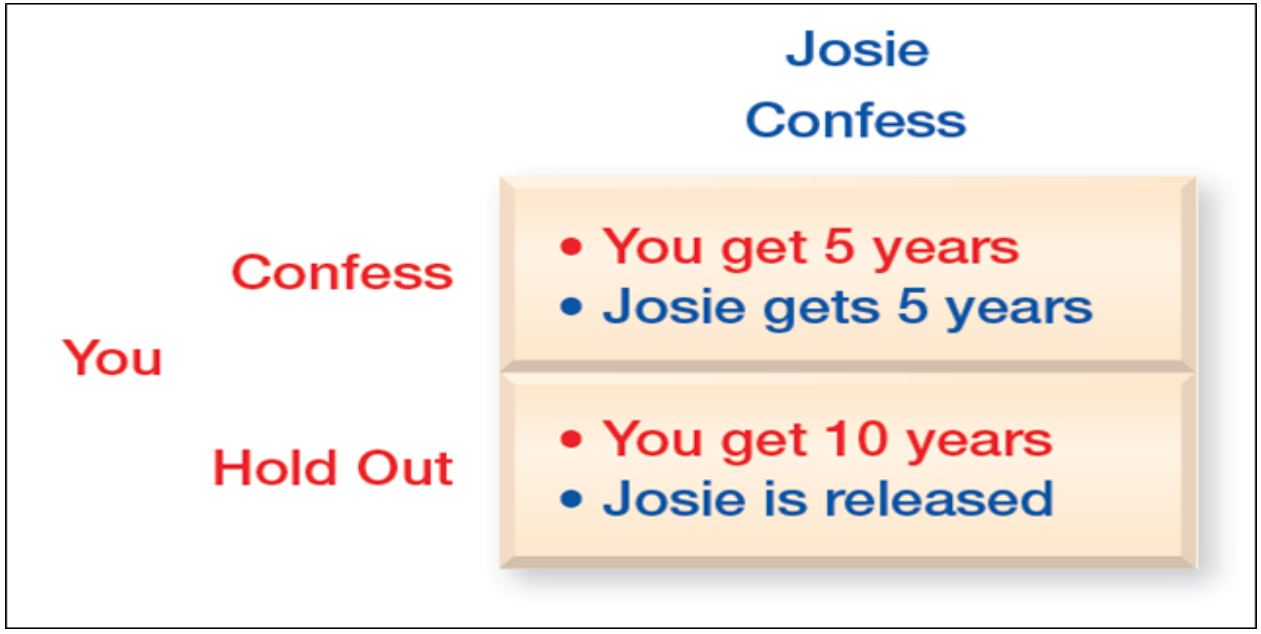


Exhibit 13.2 Prisoners' Dilemma Game with Your Partner Confessing

- Your *best response* when you expect Josie to confess is to confess yourself (because 5 years is better than 10 years).
- A **best response** is simply one player's optimal strategy *taking the other player's strategy as given*.

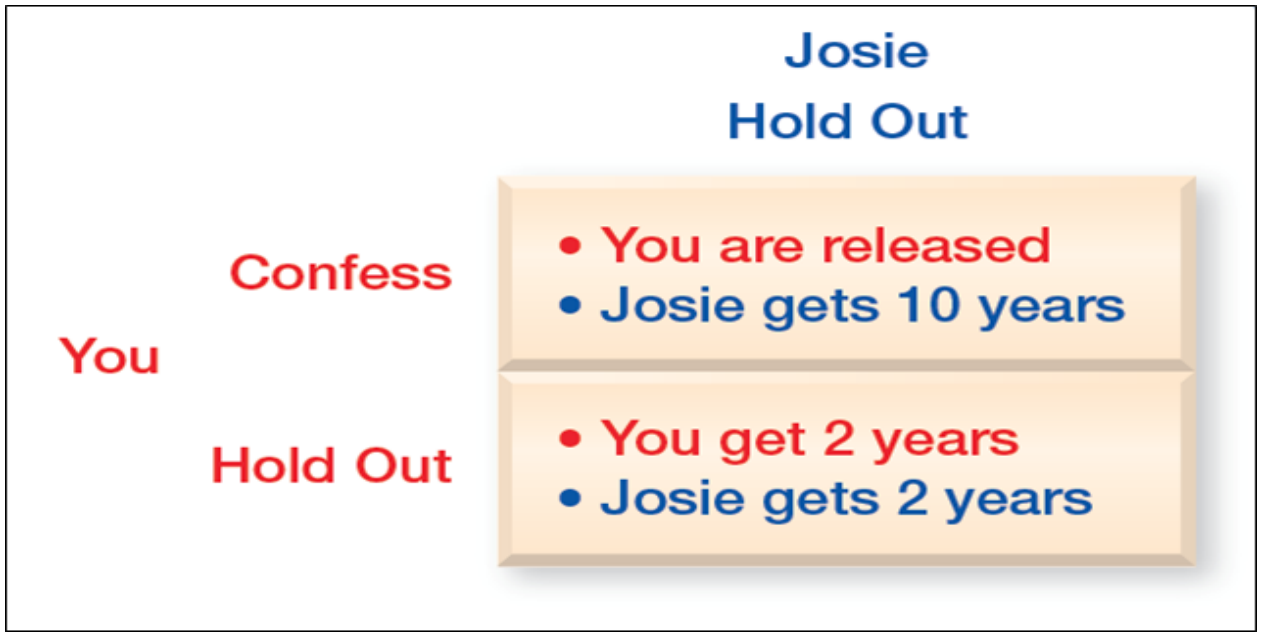


Exhibit 13.3 Prisoners' Dilemma Game with Your Partner Holding Out

- Your when you expect Josie to hold out is still to confess.
- No matter what you think Josie will do, you should *always* confess.

Dominant Strategies and Dominant Strategy Equilibrium

- When a player has the same best response to every possible strategy of the other player(s), then we say that the player has a **dominant strategy**.
- After doing the same exercise for Josie, you can reason that Josie also has a dominant strategy of confessing, too.
- A strategy combination for the players is a **dominant strategy equilibrium** if the relevant strategy for each player is a dominant strategy.
- In the prisoners' dilemma game, there is a dominant strategy equilibrium: both confess (dominant strategy).
- The equilibrium leads to an outcome that is *not* best for both players.

Games without Dominant Strategies

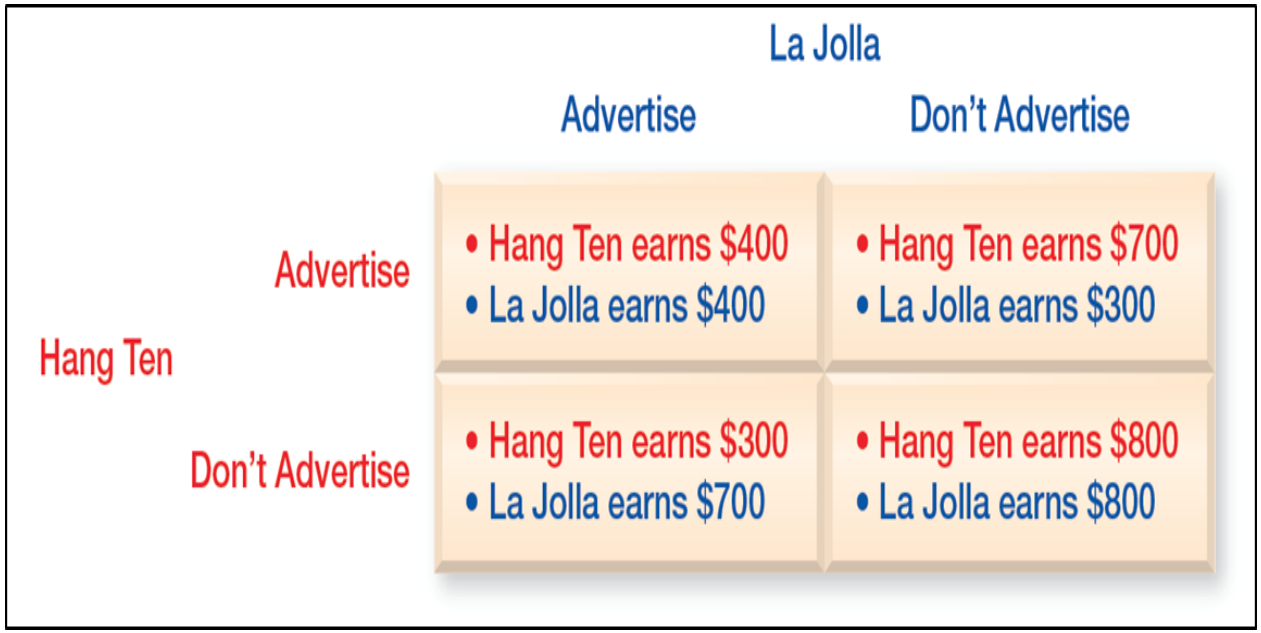


Exhibit 13.4 The Advertising Game

Three key elements of the advertisement game:

- *Players*: Hang Ten in Da Den and the La Jolla Surf Shop
- *Strategies*: To advertise or not to advertise
- *Payoffs*: See Exhibit 13.4

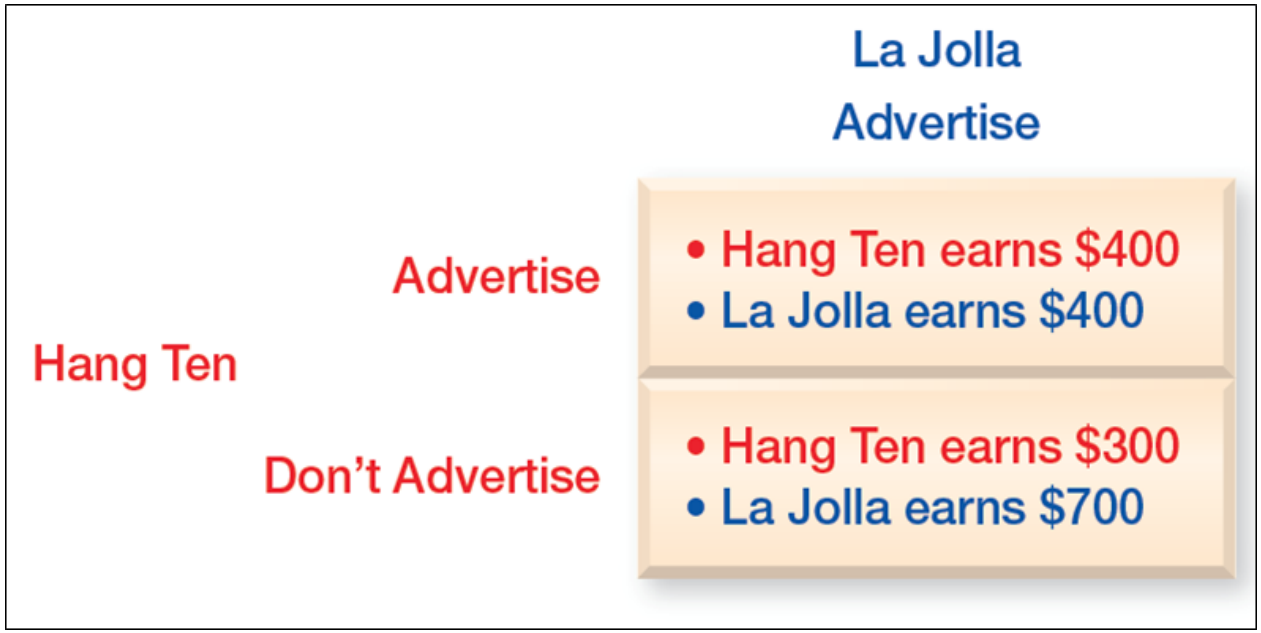


Exhibit 13.5 When La Jolla Surf Shop Advertises

- When La Jolla Surf Shop chooses to advertise, your *best response* is to advertise.

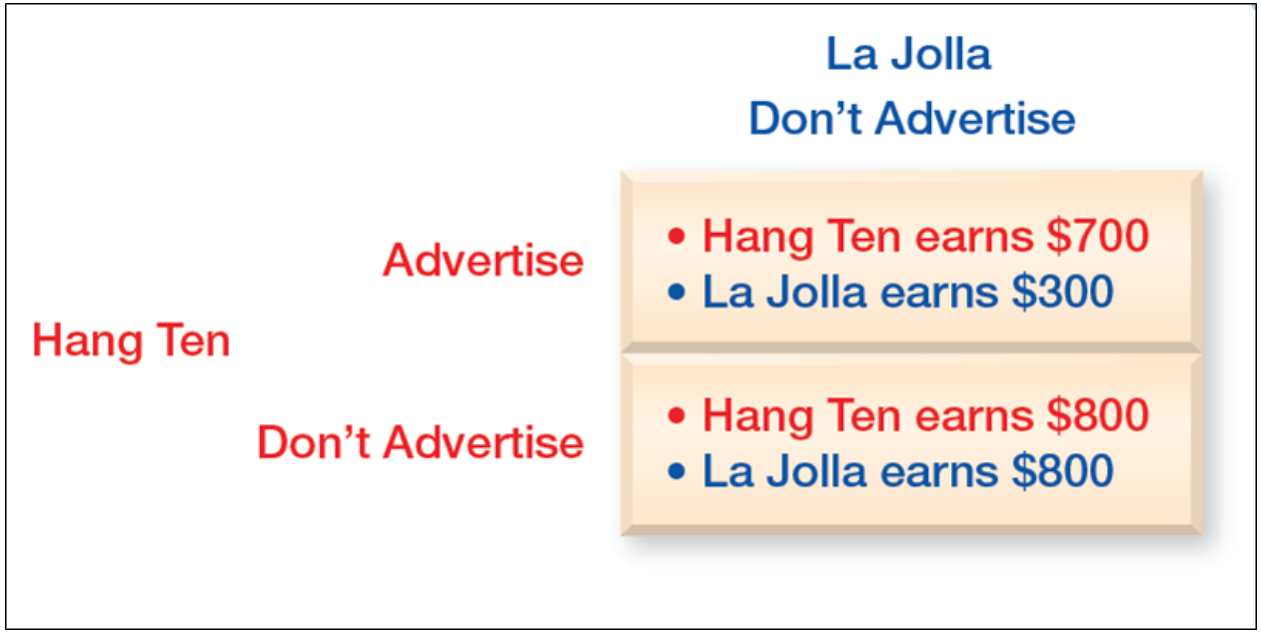


Exhibit 13.6 When La Jolla Surf Shop Does Not Advertise

- When La Jolla Surf Shop chooses not to advertise, your *best response* is not to advertise.
- You do not have a dominant strategy.
- By similar reasoning, La Jolla Surf Shop does not have a dominant strategy.
- You don't always have a simple best response that works against all strategies of others.

13.2 Nash Equilibrium

- A combination of strategies is a **Nash equilibrium** if each player chooses a strategy that is best response to the strategies of others. That is, no player in a game can change strategy and improve his payoff.
- Accordingly, the dominant strategy equilibrium that we found in the prisoners' dilemma game is a Nash equilibrium.
- 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.

Finding a Nash Equilibrium

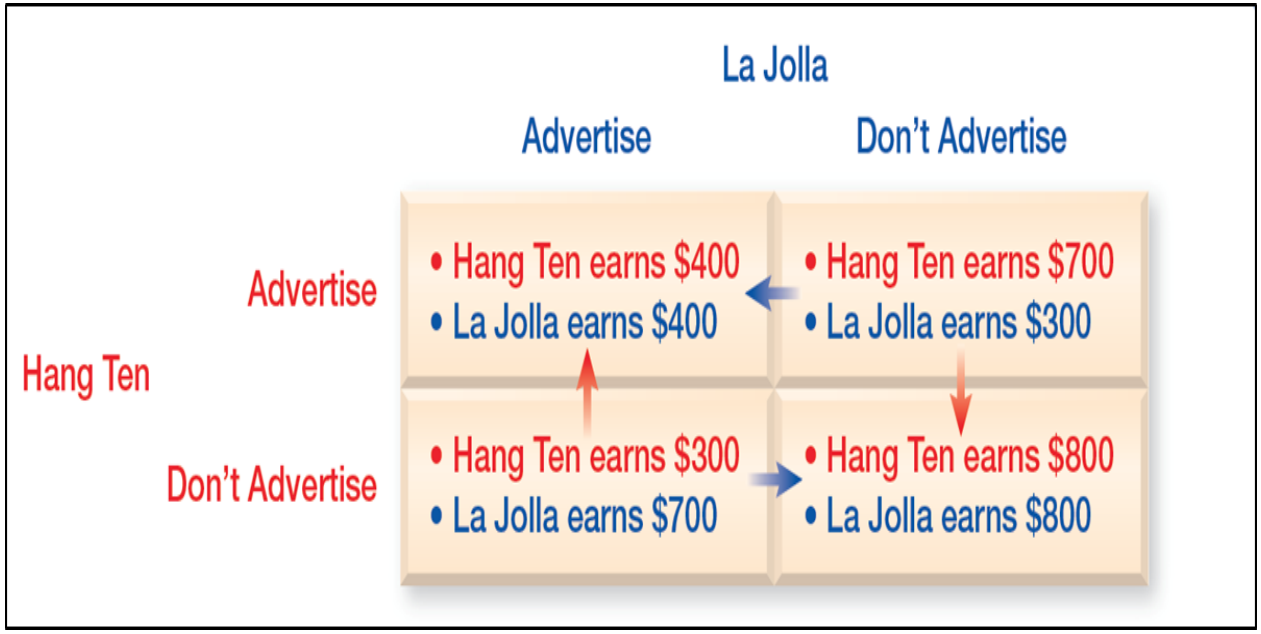


Exhibit 13.7 Two Nash Equilibrium in the Advertising Game

Two Nash equilibria:

- (advertise, advertise)
- (don't advertise, don't avertise)

CHOICE & CONSEQUENCE

To Work or To Surf?

Two Nash equilibria:

- (Work, Surf)
- (Surf, Work)

13.3 Applications of Nash Equilibrium

Tragedy of the Commons Revisited

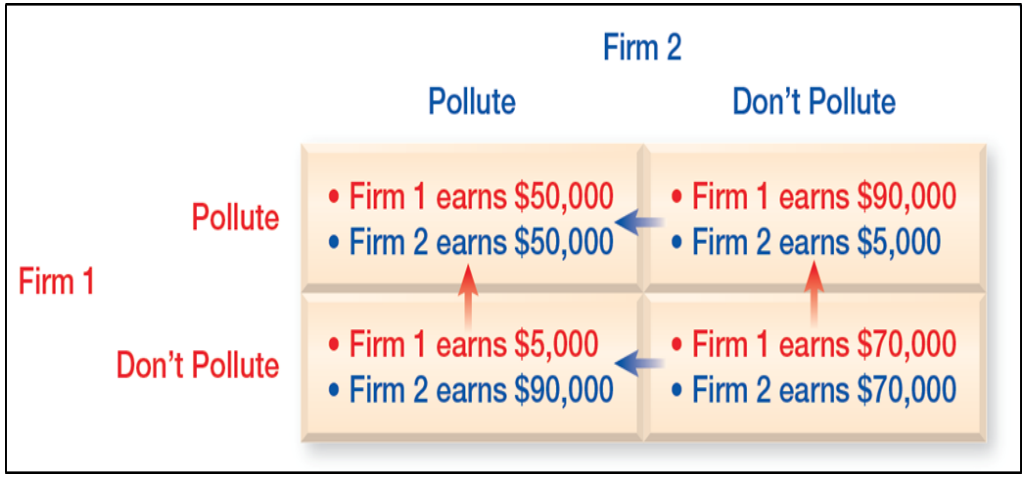


Exhibit 13.8 Payoff Matrix for Two Firms

Three key elements of the game:

- *Players*: Firm 1 and Firm 2
- *Strategies*: To pollute or not to pollute
- *Payoffs*: See Exhibit 13.8

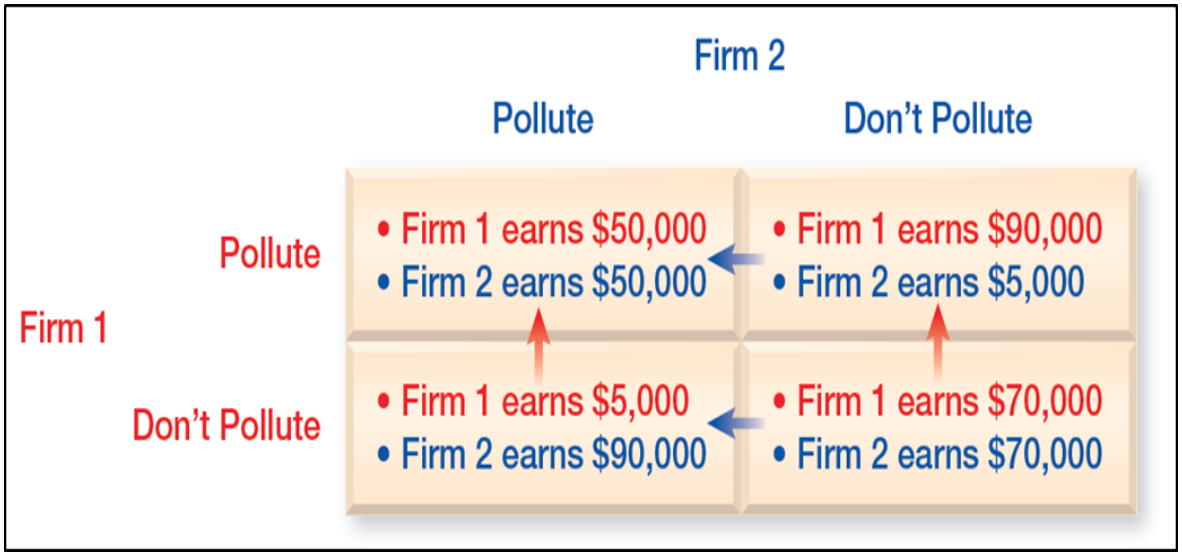


Exhibit 13.8 Payoff Matrix for Two Firms

- In the dominant strategy equilibrium, both firms choose to pollute, and both they and society are worse off, creating a tragedy of the commons result.

Zero-Sum Games

- When one player's loss is another's gain, the sum of the payoffs is zero. This is called a **zero-sum game.**

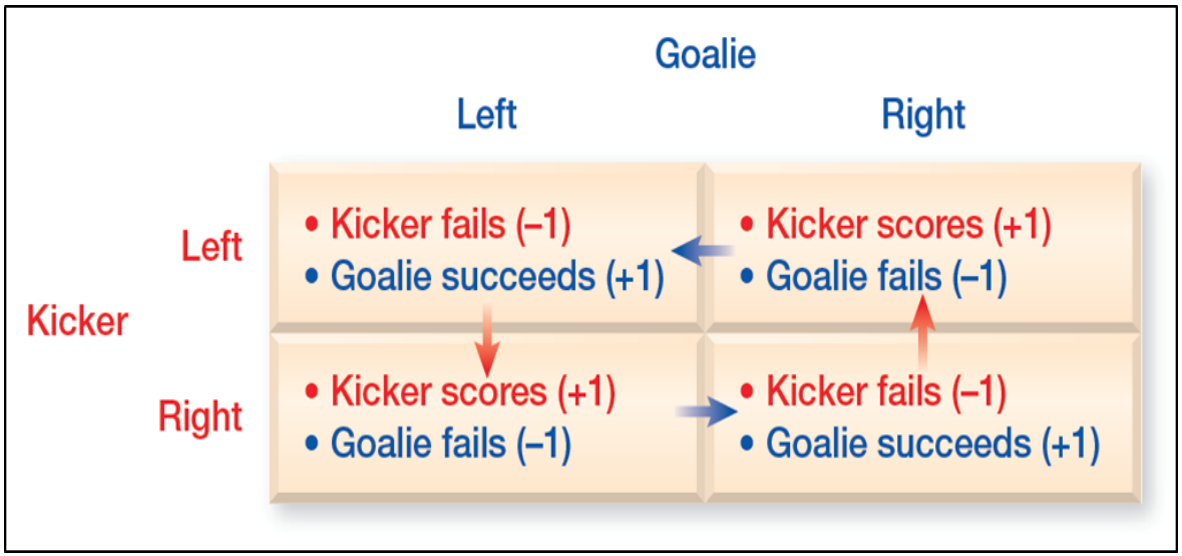


Exhibit 13.9 A Zero-Sum Game: Penalty Kicks

- No Nash equilibrium exists.
- We can not make any predictions about the behavior in the penalty kick game.

- Choosing randomly has a clear advantage in this game relative to a **pure strategy**, which means always choosing a single action for a situation.
- If always *kick right*, in time goalies will notice and best respond by always diving right.
- If you are the kicker, you should therefore be as unpredictable as possible.
- You should randomize by playing a **mixed strategy**, which involves choosing between different action randomly.

13.4 How Do People Actually Play Such Games?

Two problems in the real world:

- The exact payoffs of individuals playing the game is unknown.
- Players may have different abilities.

Game Theory in Penalty Kicks

- The best move for both sides in penalty kicks is to employ a mixed strategy— randomly choose left or right for each kick.
- Three economists analyze all the penalty kicks taken during a 3-year period in the French and Italian elite soccer leagues to test game theory.
- They classified kickers' and goalies' choices into one of three strategies: Left, Right and Center.
- The economists found in the actual data that penalty kickers and goalies randomize across three strategies.
- Players had a lot at stake in the games and therefore had a lot of incentive to optimize their behavior very well.
- Similar pattern of randomization was found in serve choice in professional tennis matches.

13.5 Extensive-Form Games

- A situation where one player goes first and the other chooses an action after seeing how the first player chose is represented by an **extensive-form game**.
- Extensive-form games introduce the sense of timing that is missing in simultaneous move games.
- An extensive-form game specifies the order of play and payoffs that will result from different strategies and uses a **game tree** to represent them.

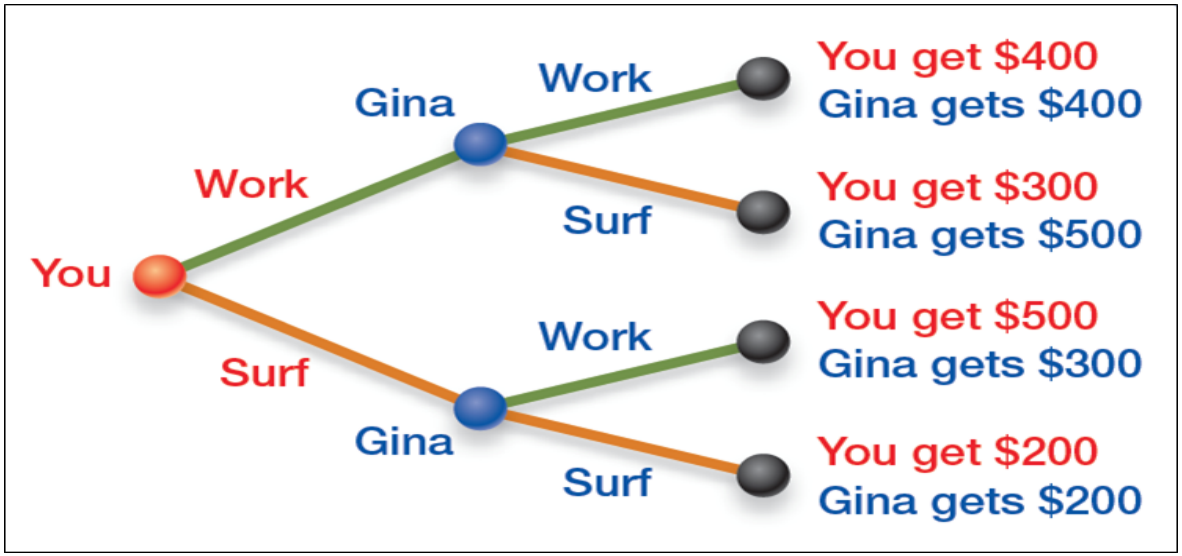


Exhibit 13.10 A Game Tree for the Work-or-Surf Game

- There are three sets of "nodes" in this game tree.
- The first two nodes (red and blue) represent the two decision makers.
- The payoffs are in the end of the game true.
- What should you do?

Backward Induction

- The easiest way of approaching any extensive-form game is to use **backward induction**, which is the procedure of solving an extensive-form game by first considering the last mover's decision.
- Given the last mover's decision, we then consider the second-to-last mover, and so on.

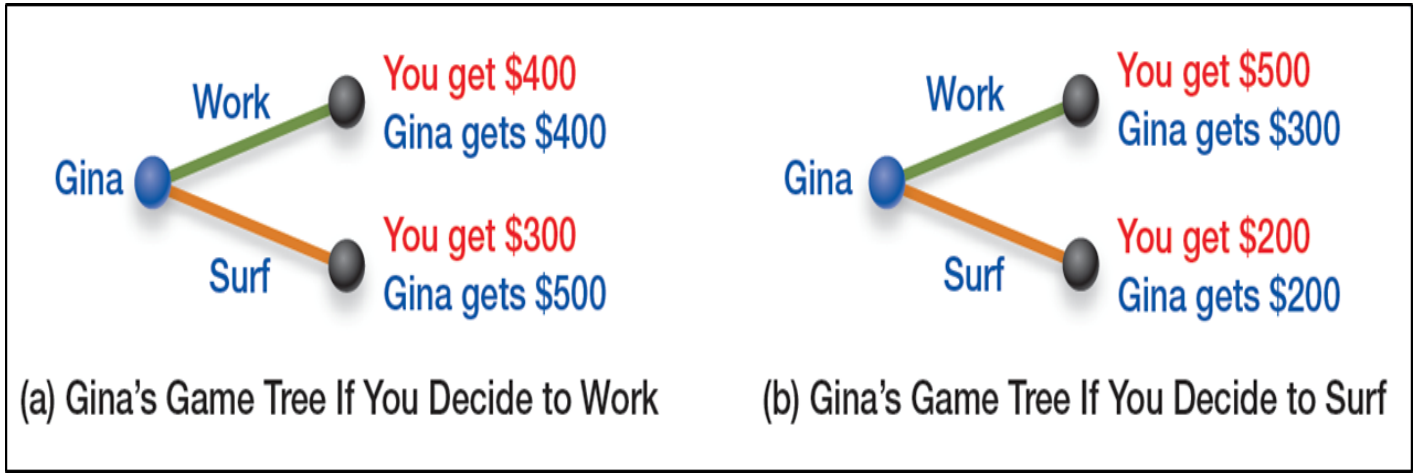


Exhibit 13.11 Gina's Game Tree If You Decide to Work and If You Decide to Surf

- Gina's optimal strategies are:
  - Choose to surf if you decide to work, you get $300
  - Choose to work if you decide to surf, you get $500
- Knowing Gina's optimal strategies, you decide to surf and get $500.
- In equilibrium, Gina chooses to work and gets $300.

First-Mover Advantage, Commitment, and Vengeance

- The sequential game features a **first-mover advantage** if the first mover earns more benefits than the second mover.
- Is there any way that Gina can take away the first-mover advantage?
- There is if she can make a credible commitment.
- A **commitment** is an action that one can not turn back on later, even if it is costly.
- One commitment device would be for her to throw her shop keys away so that the only way that she can get into the shop is for you to go to work.
- Establishing a reputation as somebody who would seek revenge against misdeeds even though this is costly for you has the same effect of a credible commitment.

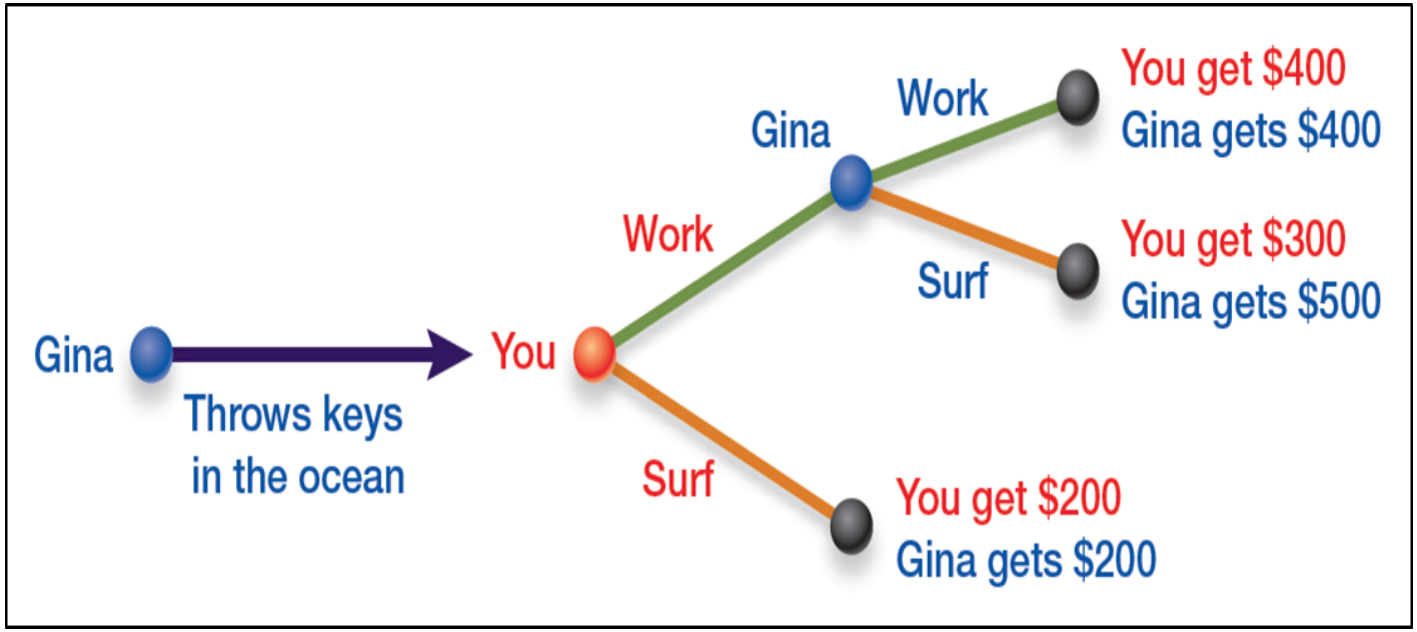
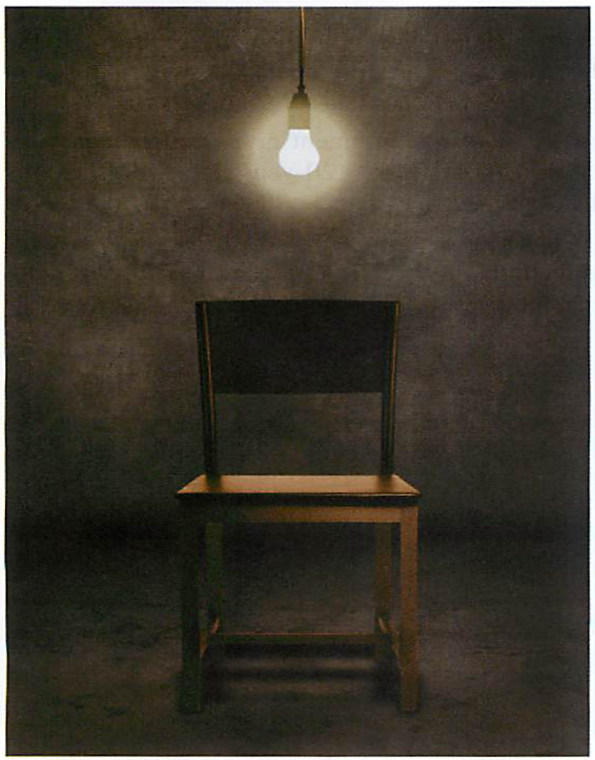


Exhibit 13.12 An Extensive-Form Game with a Credible Commitment

- Given that Gina has credibly committed to not working without you, the way that you maximize your payoff is to go to work.
- Gina then choose to surf, getting a payoff of $500.

Evidence-Based Economics



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

"When I am getting ready to reason with a man, I spend one-third of my time thinking about myself and what I am going to say, and two-thirds about him and what he is going to say."
— Abraham Lincoln

- President Lincoln understood that it was necessary to put himself into the other man's shoes before discussion started.

A Trust Game

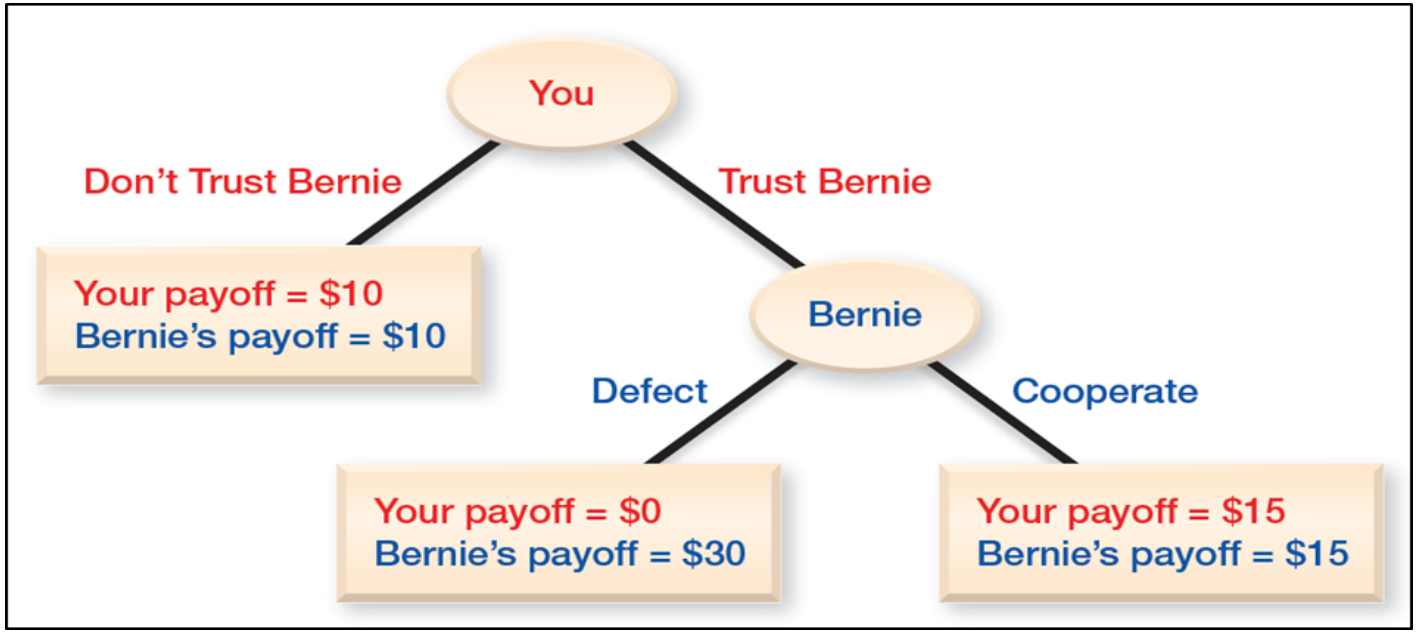


Exhibit 13.13 A Trust Game Between You and Bernie

- When given the chance, Bernie will defect because $\$30 > \$15$.
- Knowing that Bernie will defect, you choose don't trust Bernie because $\$10 > \$0$.
- This is not socially efficient. The trust game is a sequential prisoners' dilemma game.

- What factors could cause the equilibrium in Exhibit 13.13 to be different?
- One important factor is reputational concerns: if the game is played several times, the player might attempt to develop a reputation.
- The long-run strategy might shed light on the kinds of interactions we observe constantly in the real word— e.g. why business people trust one another, or friends and families share trust.

- John List did an experiment at several sports card trading shows.
- John List recruited buyers to approach sellers and purchase baseball cards.
- The sellers were either local dealers who had a reputation to uphold, or nonlocal dealers who lived in another city.
- After each transaction, the buyers turned the goods over to List to have the true grade ascertained by a licensed expert.
- Another experiment in which John List had buyers purchase sporting event ticket stubs at two different points in time.
- There was no professional grading service to evaluate the quality of the stubs in the first instance while a grading service had emerged directly before the second time period.

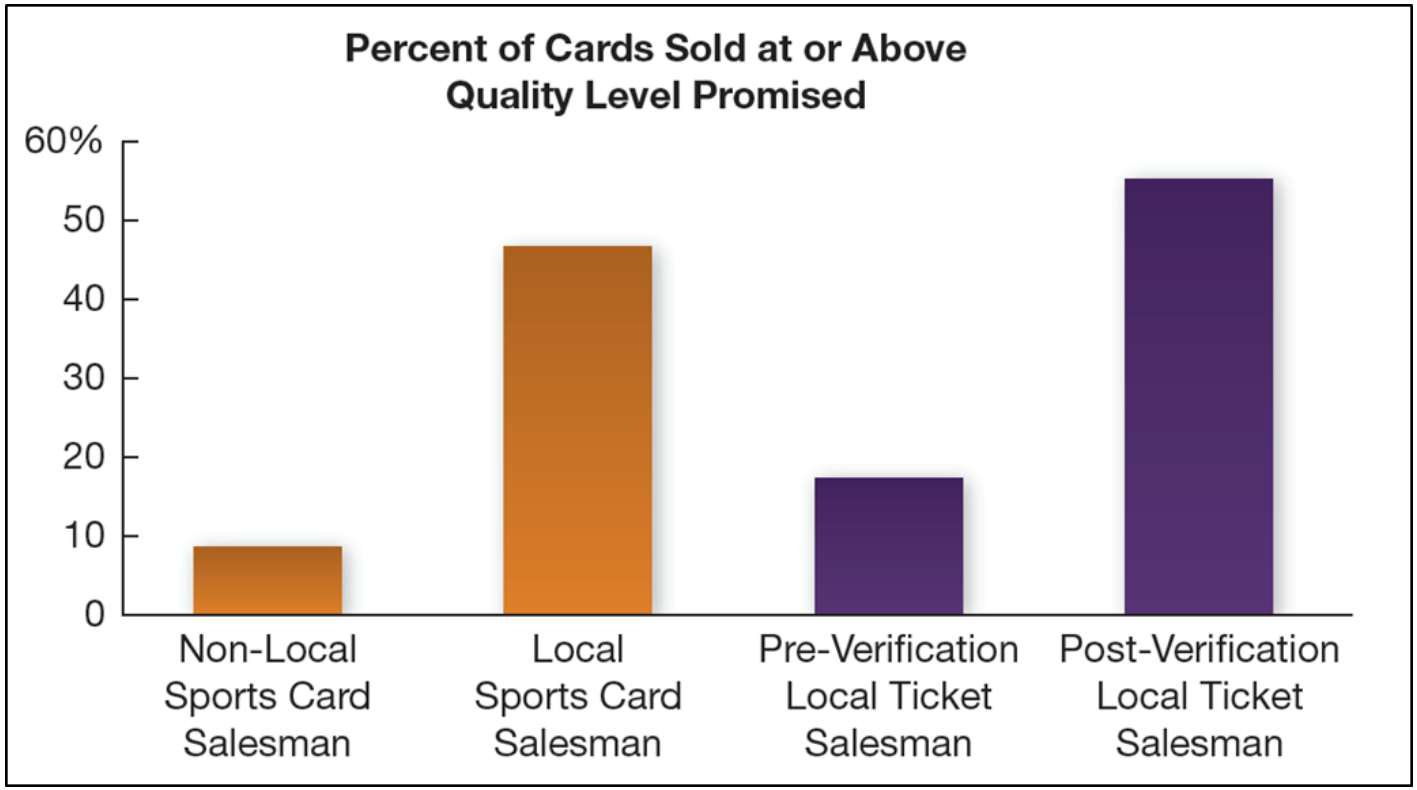


Exhibit 13.14 Percent of Sales at or above Promised Quality Level by Dealer Type

- The results are consistent with the importance of reputation.
- Reputational concerns made local sellers much more likely to deliver cards at the quality level they promised.