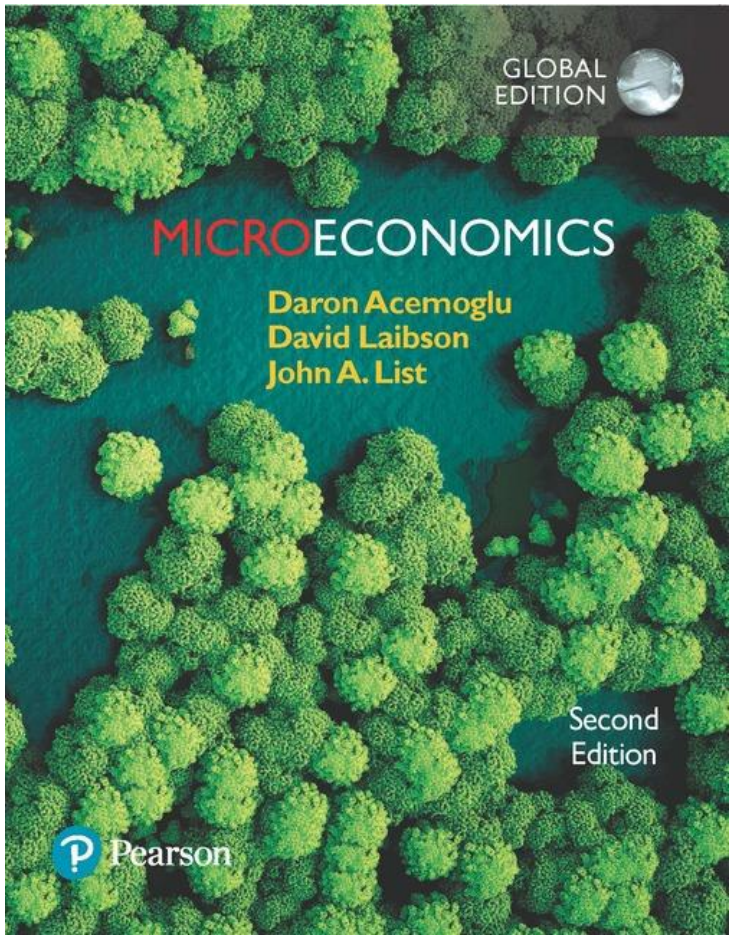
Microeconomics

Second Edition, Global Edition



Chapter 13
Game Theory and Strategic Play

Game Theory

The study of strategic interactions

Lecture Today

Nash Equilibrium

Pure strategy v.s. Mixed strategy

Simultaneous Move Games v.s. Sequential Game

(Extensive-form games)

How Do People Actually Play Such Games?

Evidence-Based Economics Example:

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

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?

Some Applications of Game Theory

- The study of oligopolies (industries containing only a few firms)
- The study of cartels; *e.g.* OPEC
- The study of externalities; *e.g.* using a common resource such as a fishery.
- The study of military strategies.
- Bargaining.

Elements of a Game

1. The players
2. The strategies
3. The payoffs

The Prisoners' Dilemma Game

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…

警察提供誘因希望有人招

-- 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 walk free 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 this 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

This is a simultaneous move game:

Players pick their strategies at the same time

13.1 Payoffs in the Prisoners' Dilemma

		Column Player: Josie	
		Confess	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

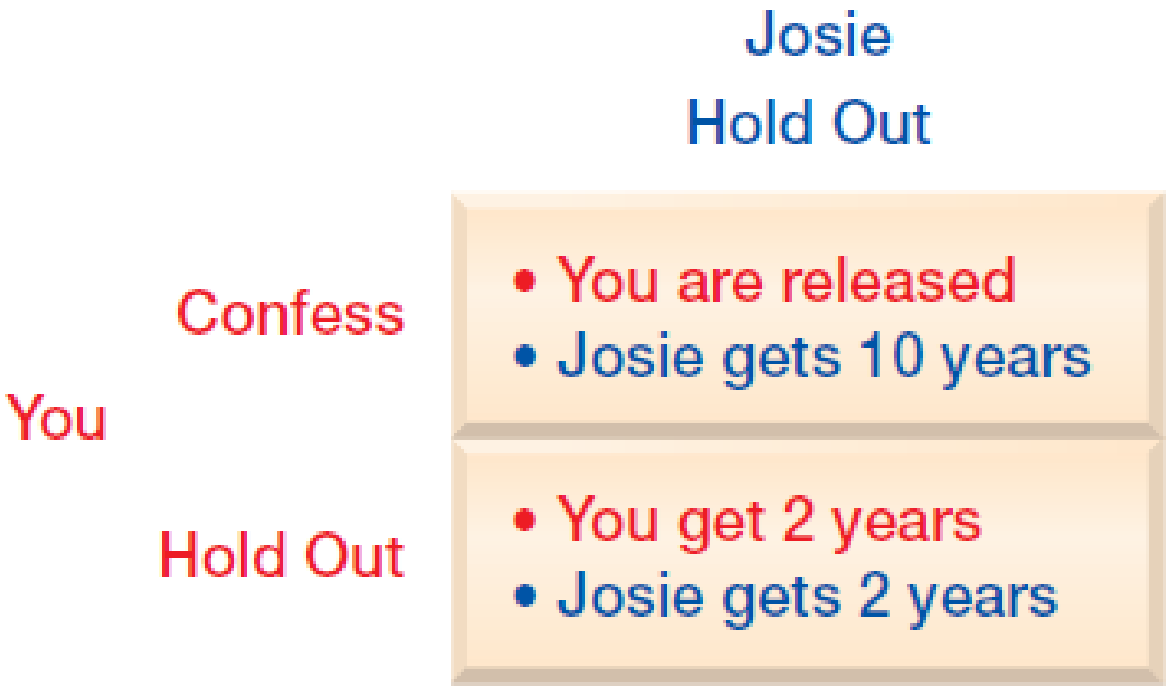
Prisoners' Dilemma Game with Your Partner Confessing

What if you think she will confess?

What is your best response in this case?

13.3 Prisoners' Dilemma Game with Your Partner Holding Out

What if you think she will NOT confess?



Dominant strategy 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).

如果事前約好了被抓到也都不要招
你會遵守事前的約定嗎?

不會! 背叛的誘因難以忽視!

Dominant Strategy

For both you and Josie

In the equilibrium, the outcome is not best for both players.

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.

In the prisoners' dilemma game, the Nash equilibrium is

(confess, confess)

Two requirements for Nash equilibrium:

1. All players understand the game and the payoffs of each strategy
2. All players recognize that the other players understand the game and payoffs

Do all games have dominant strategies?

No.

Surf shops and advertising

Elements of this 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

The Advertising Game

廣告很貴，如果對方不打廣告，我也不打廣告可以賺比較多

但如果對方打廣告了 我不打廣告會賺比較少

		La Jolla: Advertise	La Jolla: 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

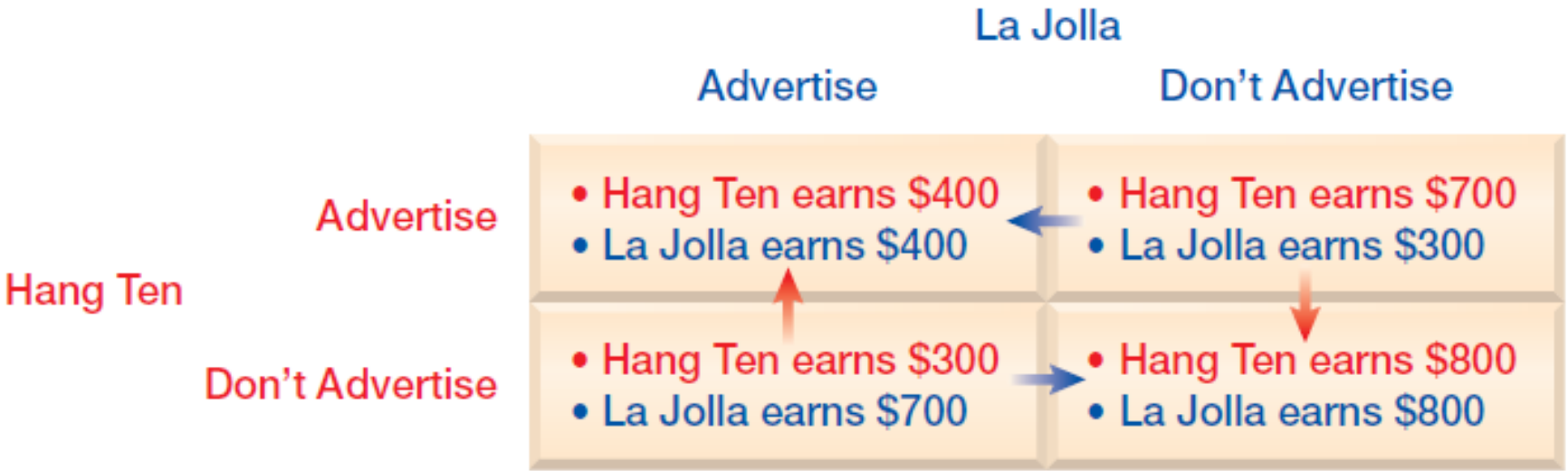
There are two Nash equilibria for this game:

1. Both advertise
2. Both don’t advertise

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

Two Nash Equilibria in the Advertising Game

What if you are not advertising but La Jolla is?



Applications of Nash equilibria:

- Tragedy of the commons

兩家廠商共用河水，水不乾淨的營運成本很高，但汙水防治的成本也很高。一家廠商排放的汙水會對兩家廠商都造成影響。

兩個漁家捕魚，兩家都捕小魚會有不良的後果，但對手不捕小魚的話，捕小魚可以賺錢。

- Soccer (Zero sum game)

Tragedy of the commons example:

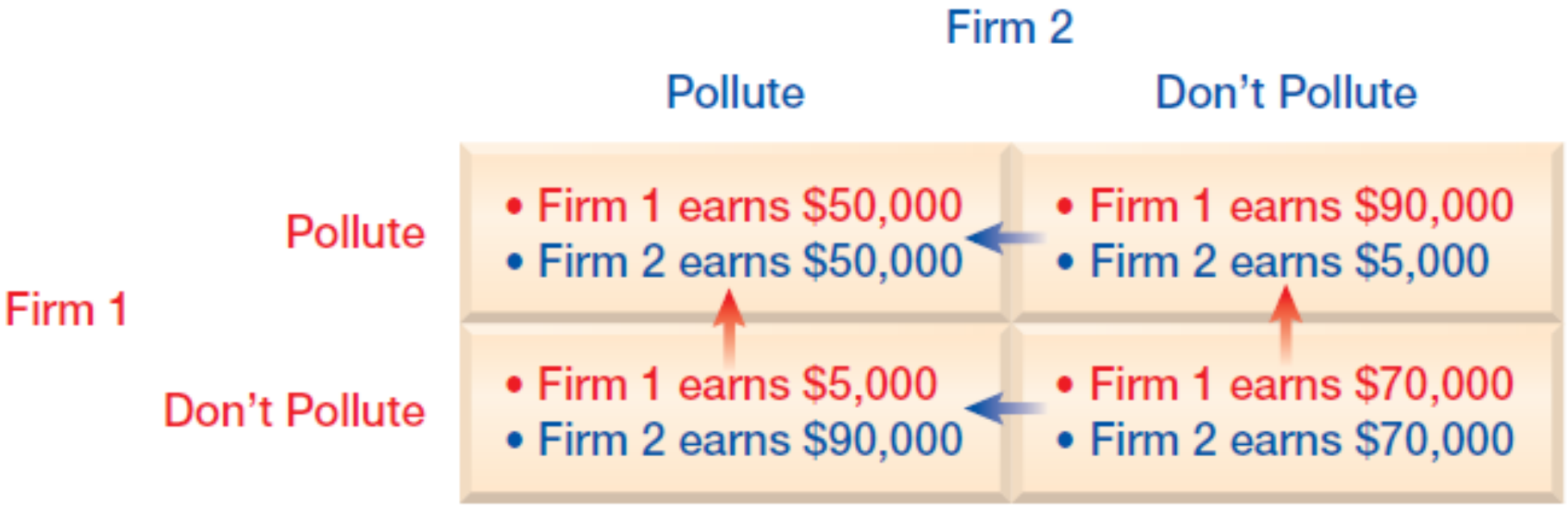
Elements of this game

1. The players: Polluter 1 and Polluter 2

2. The strategies: Pollute or not

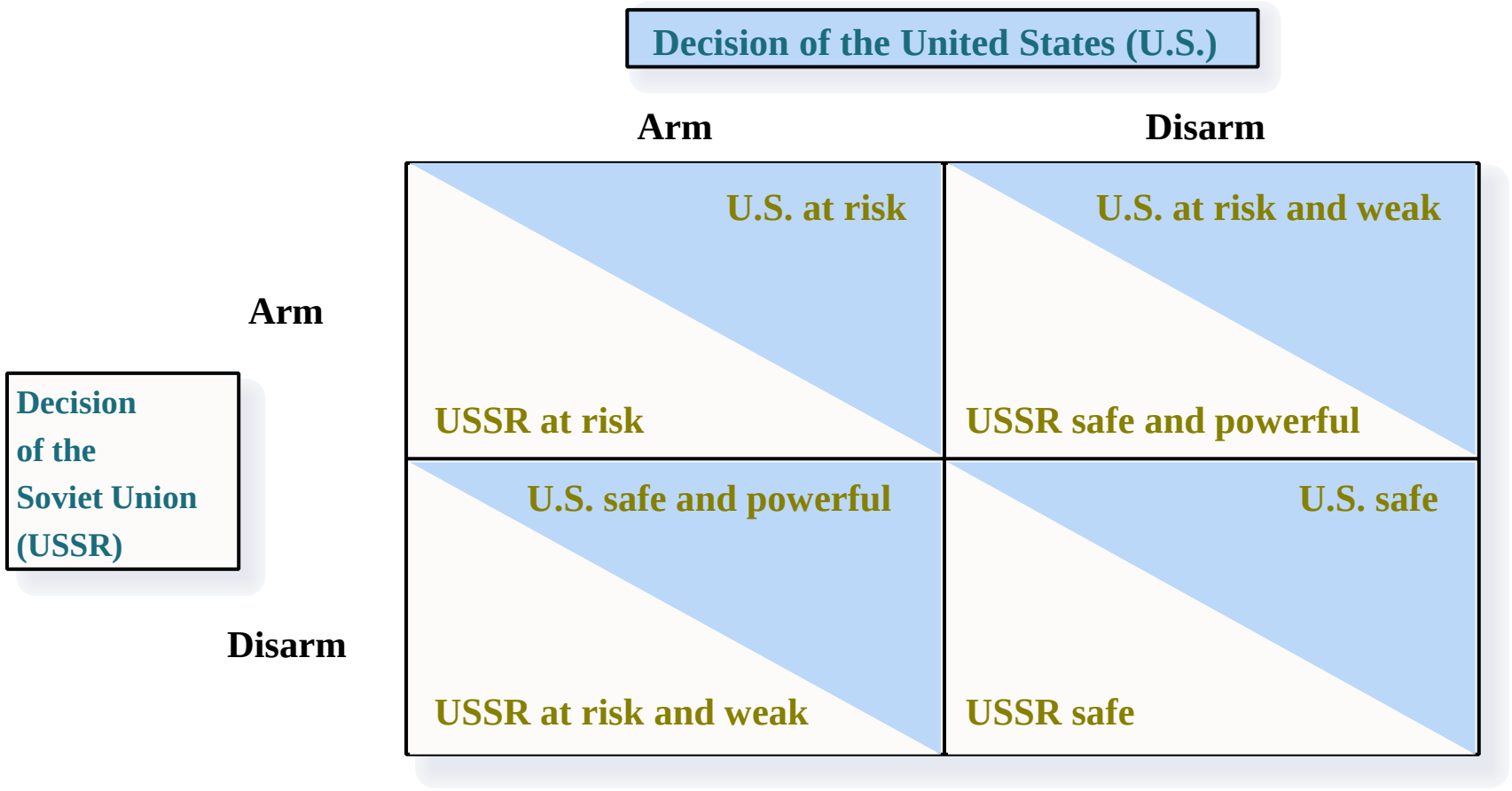
3. The payoff: Payoff matrix

Payoff Matrix for Two Polluting Plants



In 1970, Congress was considering banning cigarette advertising on TV. When they held hearings on the issue, no one from the cigarette industry showed up to argue against the legislation. Why?

An Arms-Race Game



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

A Zero-Sum Game: Penalty Kicks

Soccer example:

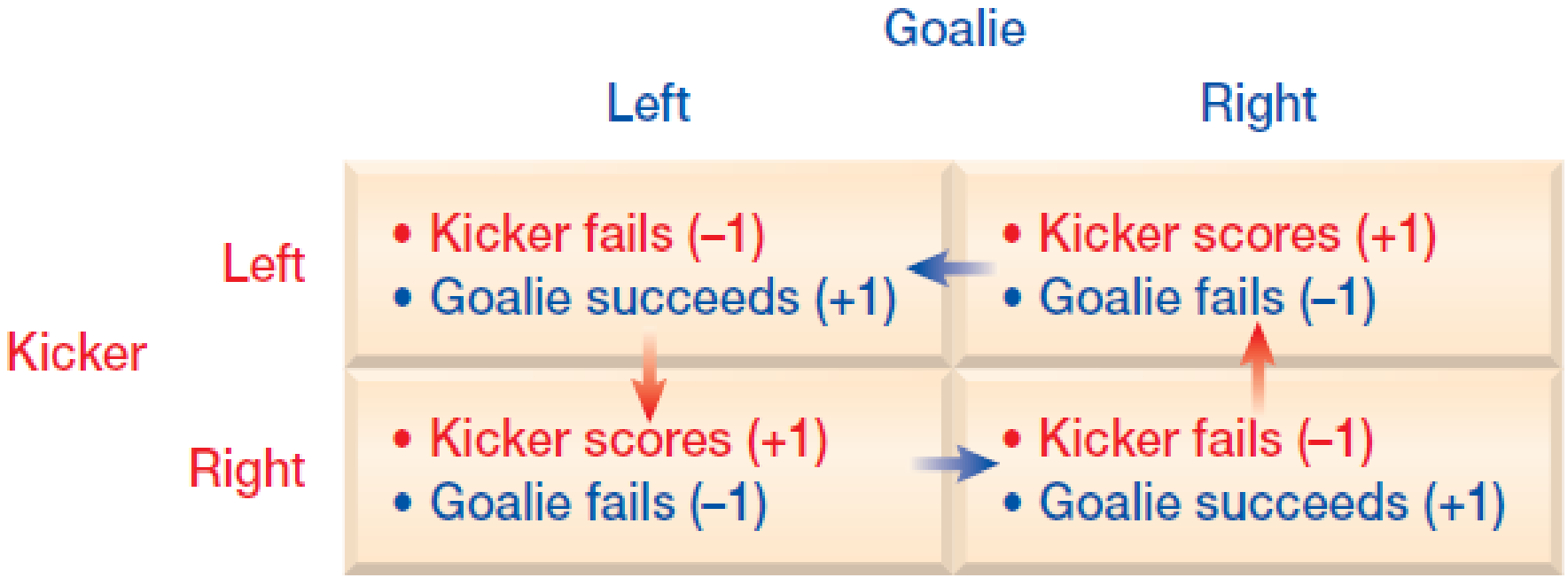
Elements of this game

1. The players: You and the goalie
2. The strategies: Kick right or left
3. The payoff: Payoff matrix

A Zero-Sum Game: Penalty Kicks

Zero-sum game

When one player wins, the other loses, so the payoffs sum to zero



So what should the penalty kicker and goalie do?

Always pick “right” or “left”?

Zero-Sum game: strategy randomize

Pure strategy

Choosing one strategy

Mixed strategy

Randomly choosing different strategies

In this soccer game, no pure strategy Nash Equilibrium. → Mixed strategy Nash Equilibrium

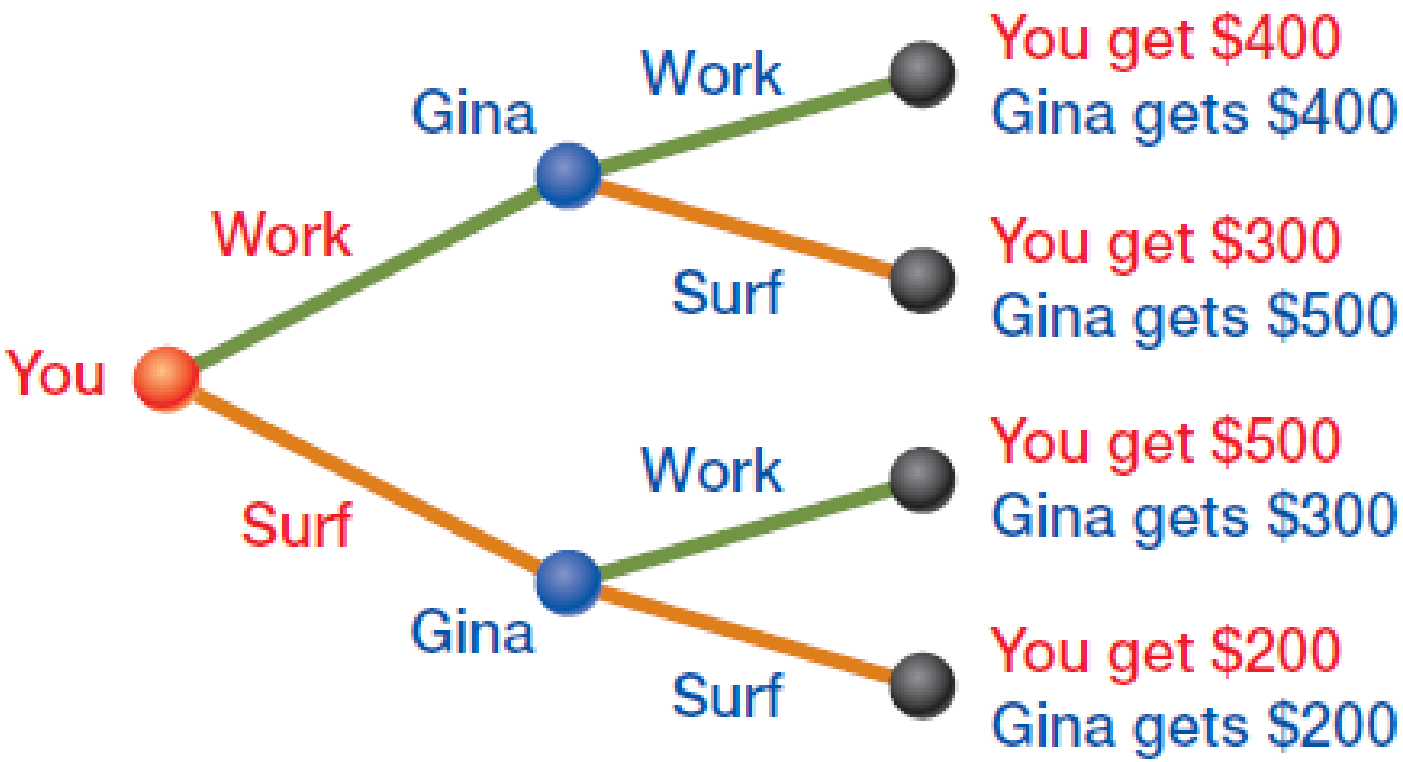
Extensive-form games

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

Game tree

Representation of an extensive form game

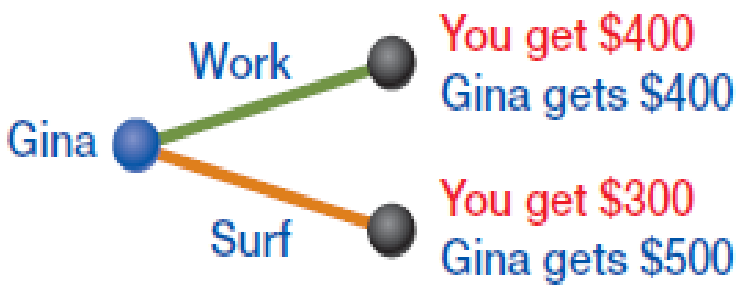
A Game Tree for the Work-or-Surf Game



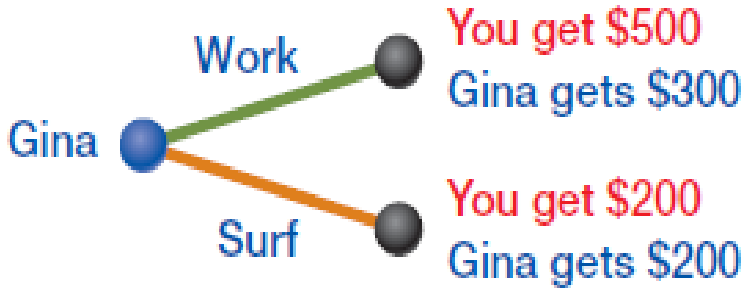
Backward induction

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

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



(a) Gina's Game Tree If You Decide to Work



(b) Gina's Game Tree If You Decide to Surf

Gina's two strategies:

Surf if you work (you earn $300)

Work if you surf (you earn $500)

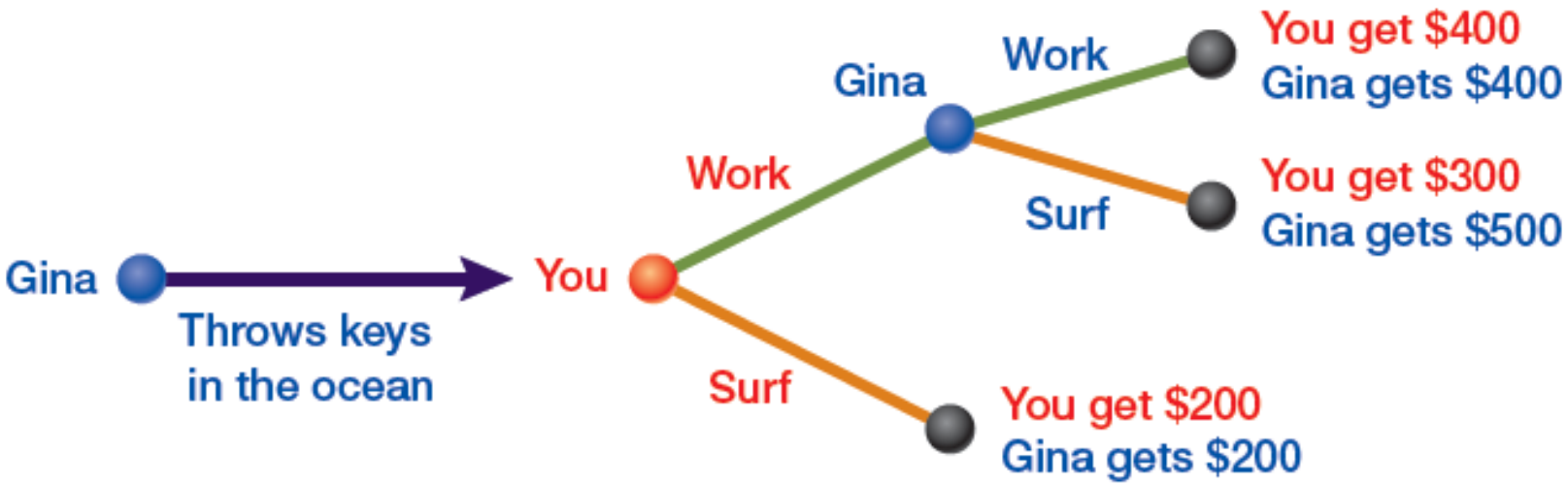
Since you now know what Gina will do as a result of each of your decisions, you can make the best decision…which is?

First-mover advantage

- The sequential game features a **first-mover advantage** if the first mover earns more benefits from being first.
- Is there any way that Gina can take away the first-mover advantage?
- Yes 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 has the same effect of a credible commitment.

Exhibit 13.14 An Extensive-Form Game with a Credible Commitment

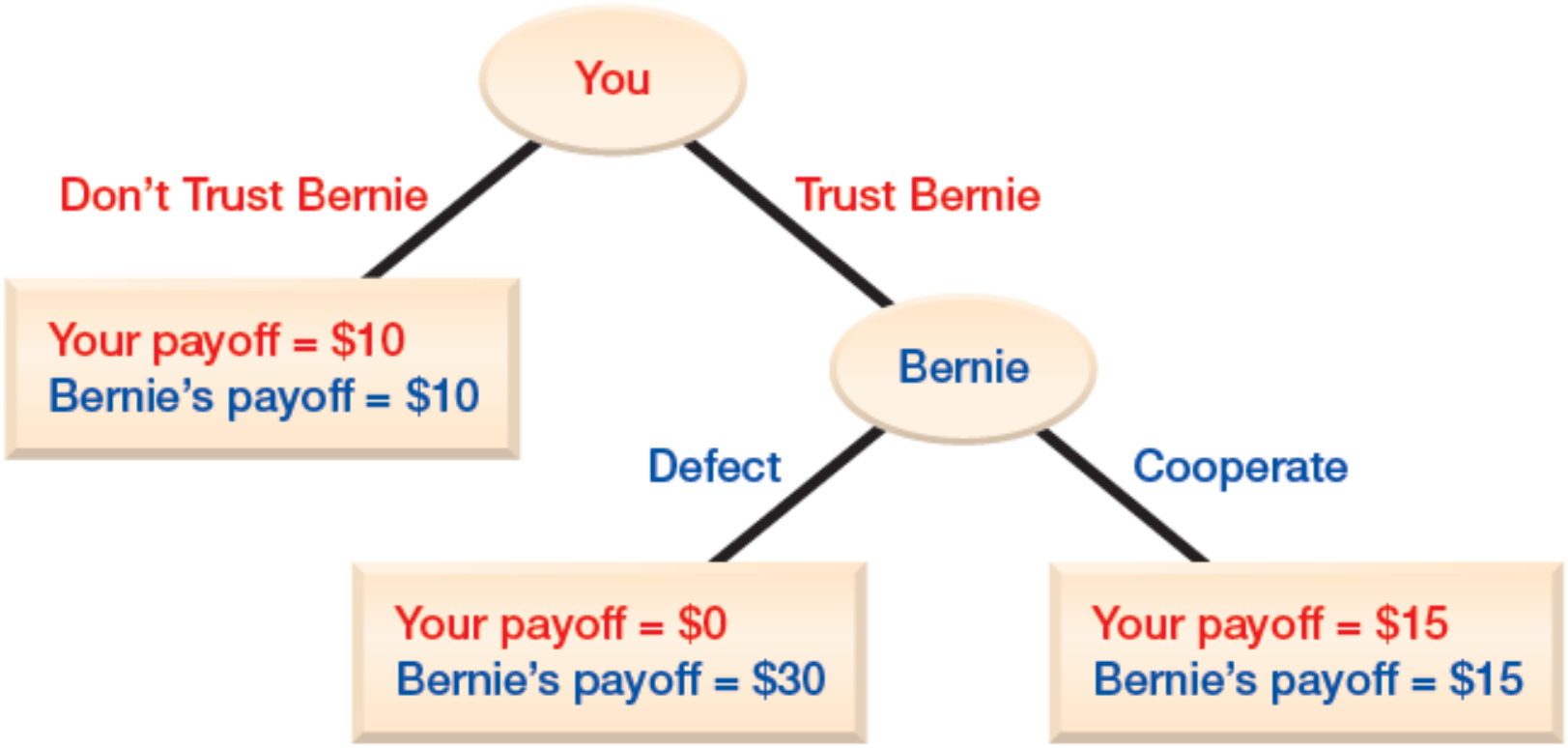
Could Gina do something to force us to work instead of surf?



Evidence-Based Economics Example:

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

A Trust Game between You and Bernie



A Trust Game between You and Bernie

- When you trust Bernie, 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.

囚犯困境有沒有解呢?

- 如果不是指玩一期，而是玩很多期，會發生什麼事情? 如果是玩3回合...

- 廠商之間的競爭常常是多回合的，可以設定懲罰機制。

- 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.

理論與真實世界的距離

- 真實世界大家都能理性計算, 做出最佳決策嗎?
- Beauty Contest Game:

  每個人提出一個數字，從0 – 100都可以。

  提出最接近所有人平均的2/3就是贏家。

Nash Equilibrium

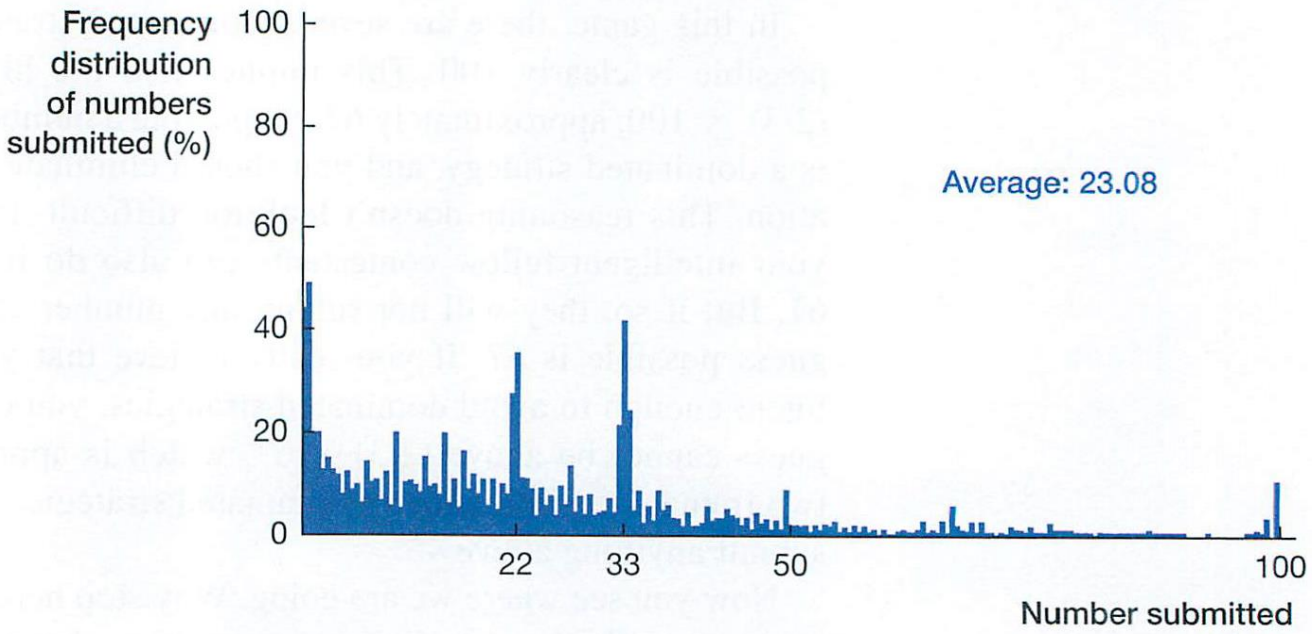
- A strategy is dominated if it yields lower payoffs than some other available strategy. No player should pick a dominated strategy.
- The highest possible winning guess is 67, picking a number above 67 is a dominated strategy.
- Picking a number above 67*(2/3) is dominated.
- In fact, all contestants submitting 0 is a Nash equilibrium.
- However, not all contestants are so sophisticated.

真實玩的結果

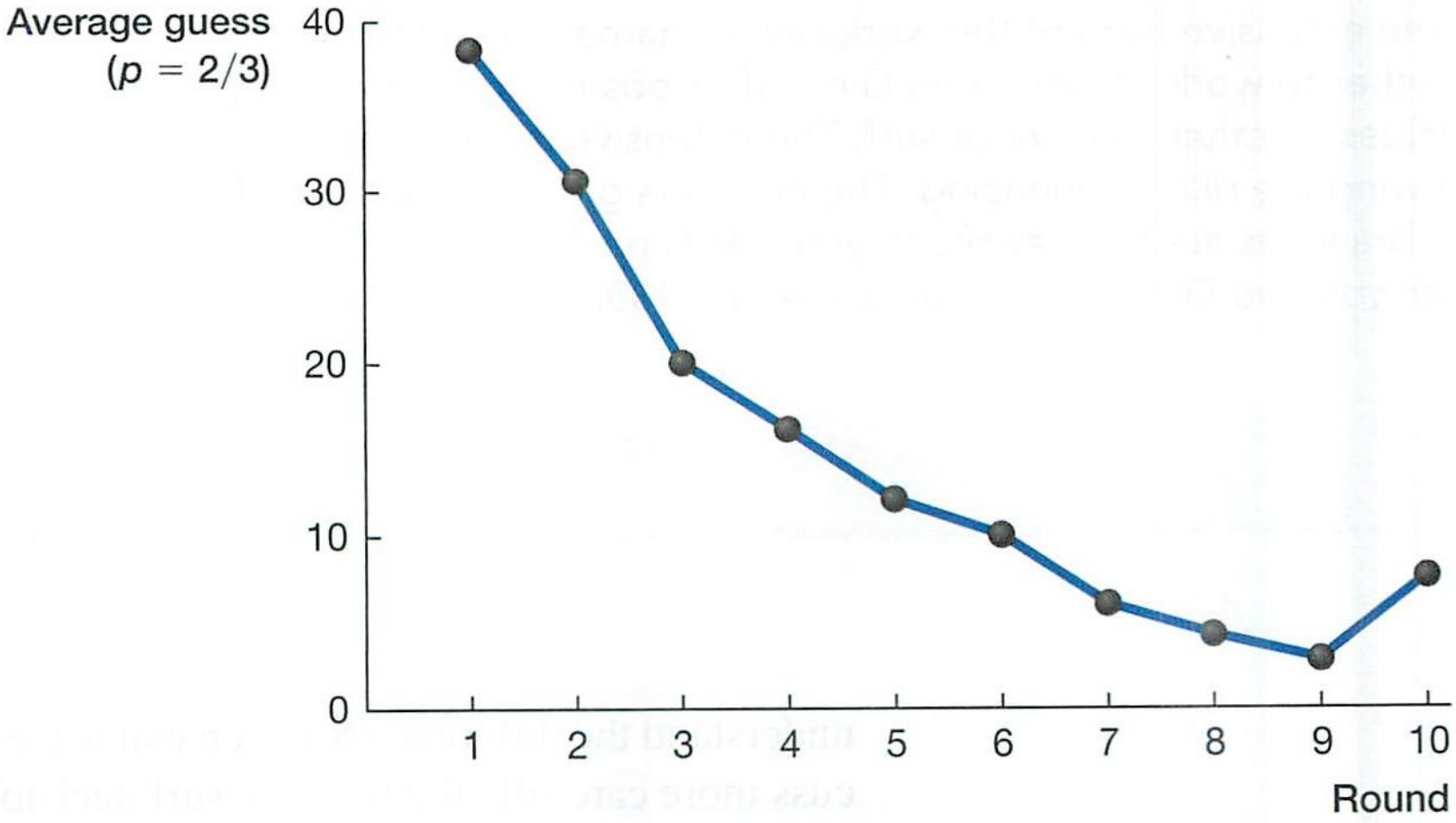
Exhibit 13.10 Lab Beauty Contests: Distribution of Numbers Submitted

This exhibit shows the proportion of subjects guessing the numbers between 0 and 100 in lab experiments on the beauty contest with $p = 2/3$.

Source: Antoni Bosch-Domènech, Rosemarie Nagel, Albert Satorra, and Jose García-Montalvo, "One, Two, (Three), Infinity: Newspaper and Lab Beauty-Contest Experiments," *American Economic Review* 92(5): 2002, 1687–1701.



如果讓人們玩多回合



Evidence-Based Economics Example:

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

- *“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.