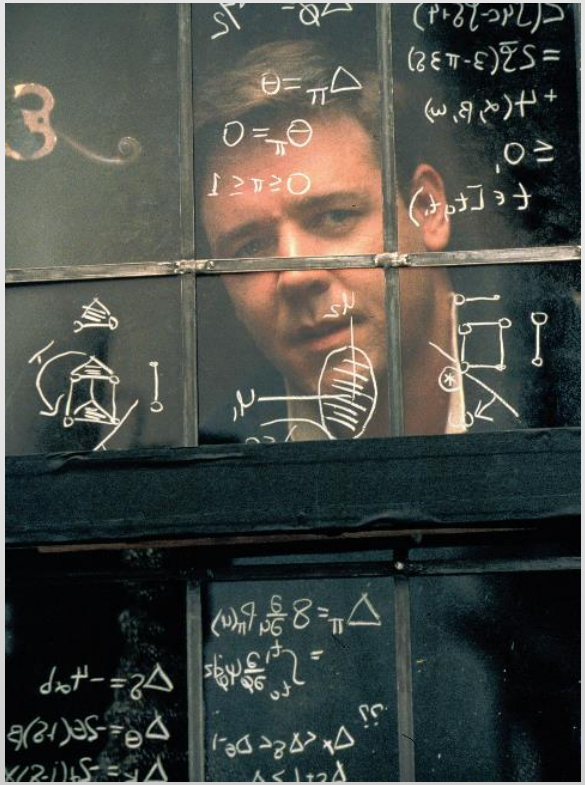
CHAPTER 11

Game Theory, Strategic Decision Making, and Behavioral Economics



All men can see the tactics whereby I conquer, but what none can see is the strategy out of which victory is evolved.

— Sun Tzu

Game Theory and the Economic Way of Thinking

- Game theory is formal economic reasoning applied to situations in which decisions are **interdependent**
- **Game theory is a very flexible tool that allows us to develop more precise models of situations that involve strategic interactions**

Game Theory and the Economic Way of Thinking

- **Formal game theory assumptions:**
  - Players are fully forward looking
  - Players always behave in a manner that gives them the highest payoff
  - Players expect all other players to behave in the same manner

Game Theory and Oligopolies

- Game theory is most commonly applied to oligopolies
- Oligopolies can produce similar **or** differentiated goods (cars, steel, etc)
- Oligopolies are **interdependent** since they compete with only a few other firms

Game Theory and Oligopolies

- Their pricing and output decisions must be strategic to avoid economic losses—their decisions are **mutually interdependent**

- **Game theory helps us analyze their strategies**

Payoff Matrix

- **Payoff matrix: a table that shows the outcome of every choice by every player, given the possible choices of all other players**
  - **The payoff matrix has three elements:**
    1. Players
    2. Strategies
    3. Payoffs

Payoff Matrix

This is a payoff matrix for Firm A and Firm B and their profits. The first entry in each cell column represents Firm A's profits and the second entry in each cell represents Firm B's profits.

Firm A		Firm B: Raise Price	Firm B: Lower Price
	Raise Price	**$100, $80**	**$80, $90**
	Lower Price	**$90, $75**	**$70, $80**

Payoff Matrix

The easiest way to analyze which strategy is best is to start with one player at a time. We will "box" Firm A's strategies and analyze them first.

Firm A	Firm B: Raise Price	Firm B: Lower Price
Raise Price	**$100, $80**	**$80, $90**
Lower Price	**$90, $75**	**$70, $80**

Payoff Matrix

Step 1: We will use an **X** to identify which strategy is best for **Firm A.**

- If Firm B raises its price, Firm A can raise its price for $100 in profit, or lower its price for $90 in profit.
- If Firm B lowers its price, Firm A can raise its price for $80 in profit, or lower its price for $70 in profit.

Firm A	Firm B: Raise Price	Firm B: Lower Price
Raise Price	X **$100, $80**	X **$80, $90**
Lower Price	**$90, $75**	**$70, $80**

Payoff Matrix

Step 2: We will use a ✓ to identify which strategy is best for **Firm B.**

- If Firm A raises its price, Firm B can raise its price for $80 in profit, or lower its price for $90 in profit.
- If Firm A lowers its price, Firm B can raise its price for $75 in profit, or lower its price for $80 in profit.

Firm A	Firm B: Raise Price	Firm B: Lower Price
Raise Price	X **$100, $80**	X **$80, $90** ✓
Lower Price	**$90, $75**	**$70, $80** ✓

Payoff Matrix

What is the best strategy for each Firm given the other player's choice?

- Firm A's best strategy is to **raise price.**
- Firm B's best strategy is to **lower price.**

Firm A	Firm B: Raise Price	Firm B: Lower Price
Raise Price	X **$100, $80**	X ✓ **$80, $90**
Lower Price	**$90, $75**	✓ **$70, $80**

Payoff Matrix

Firm A	Firm B: Raise Price	Firm B: Lower Price
Raise Price	X $100, $80	X ✓ $80, $90
Lower Price	$90, $75	✓ $70, $80

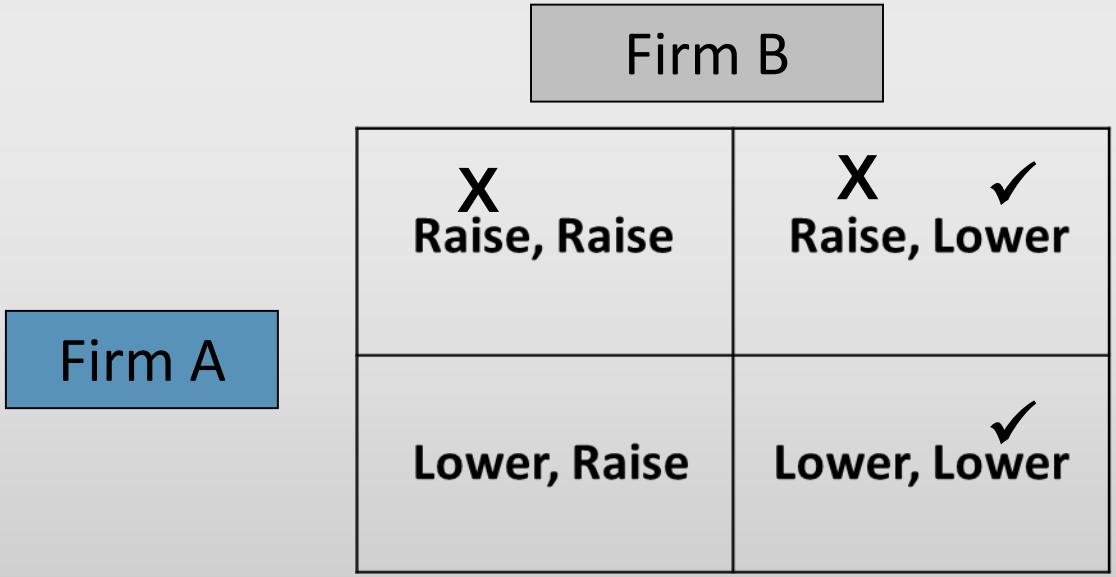
	X Raise, Raise	X ✓ Raise, Lower
	Lower, Raise	✓ Lower, Lower

Dominant Strategy

- In the previous example, both Firm A and B have a **dominant strategy:** the decision (strategy) you will make regardless of what your opponent does
- When looking at two firms, they **may or may not** have a dominant strategy
- If there is not a dominant strategy, the firm is **dependent** on what the other firm does

Dominant Strategy

- We look at the rows and columns to determine a dominant strategy.
- Since Firm A will raise its price no matter what Firm B does, its dominant strategy is to raise its price. Since Firm B will lower its price no matter what Firm A does, its dominant strategy is to lower its price.

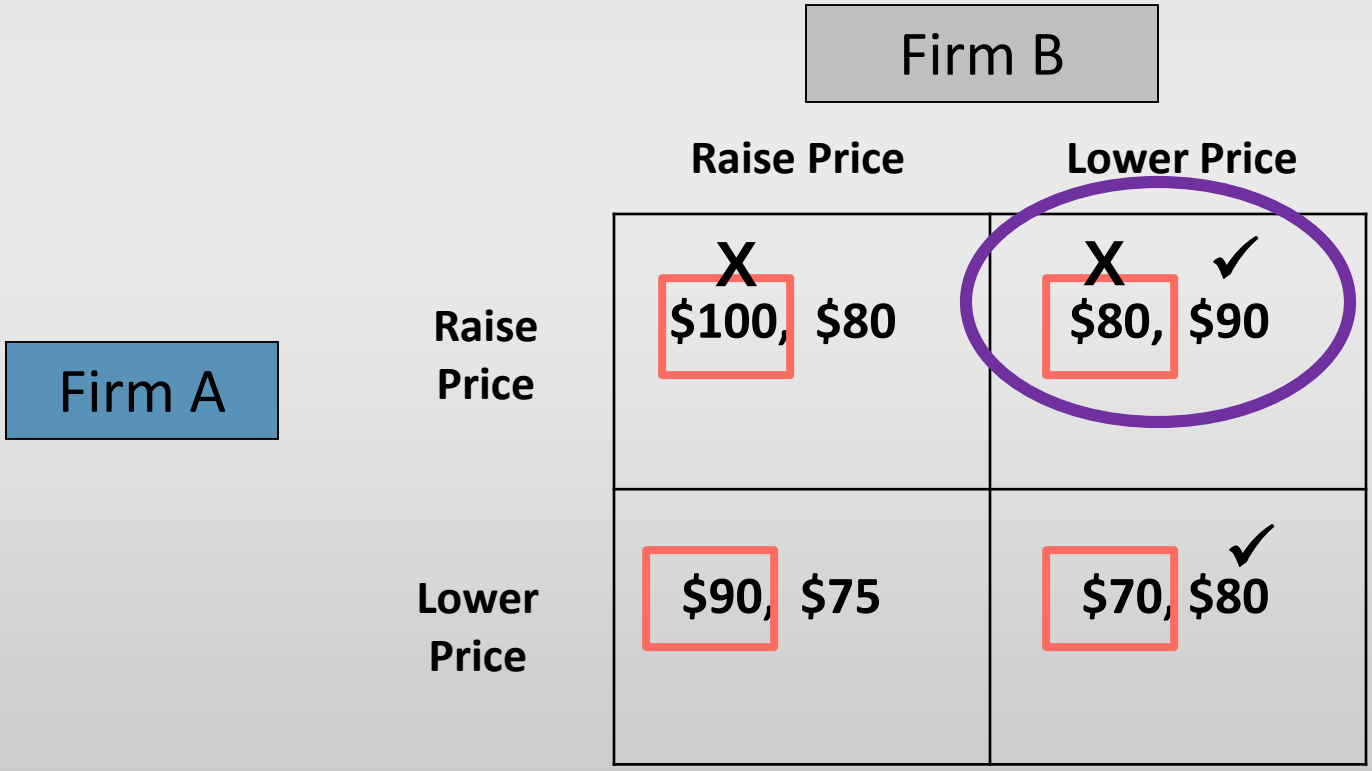


Nash Equilibrium

- A **Nash equilibrium** means no player can improve his or her payoff by changing his/her strategy on their own
  - A Nash equilibrium **doesn't** have to be the solution that is jointly best for all players
  - This appears when there is an "x" and a "✓" in one of the boxes of the matrix—this would be the decision each player/firm makes

Nash Equilibrium

- Below, there is a Nash equilibrium:



The Prisoner's Dilemma

- The **prisoner's dilemma** is a 2 person **non-cooperative** game that demonstrates the difficulty of cooperative behavior

The Prisoner's Dilemma: Example

- "If both you and the other prisoner confess, instead of being sentenced to the maximum 10 years in prison, the two of you will each serve only 5 years in jail. Further, if you confess and the other prisoner does not confess, in exchange for your serving as a witness for the prosecution, we will drop the charges for the lesser felony, and you will be set free. If, however, you don't confess and the other suspect does, you will be sentenced to the maximum 10 years in prison. If neither confesses, both will be charged with the lesser felony and serve 6 months."

Application: The Prisoner's Dilemma

This is a payoff matrix for Prisoner A and B. The first entry in each cell column represents Prisoner A's options and the second entry in each cell represents Prisoner B's options.

		B: CONFESS	B: DON'T CONFESS
A	CONFESS	5 years for A, 5 years for B	A goes free, 10 years for B
A	DON'T CONFESS	10 years for A, B goes free	6 months for A, 6 months for B

Application: The Prisoner's Dilemma

The easiest way to analyze is to start with one player at a time. We will "box" Prisoner A's strategies and analyze them first.

A \ B	CONFESS	DON'T CONFESS
CONFESS	5 years for A, 5 years for B	A goes free, 10 years for B
DON'T CONFESS	10 years for A, B goes free	6 months for A, 6 months for B

Application: The Prisoner's Dilemma

Step 1: We will use an **X** to identify which strategy is best for Prisoner A.

- If Prisoner B confesses, Prisoner A can confess for 5 years or not confess for 10 years.
- If Prisoner B does not confess, Prisoner A can confess and go free or don't confess for 6 months.

A \ B	CONFESS	DON'T CONFESS
CONFESS	X ✓ 5 years for A, 5 years for B	X A goes free, 10 years for B
DON'T CONFESS	10 years for A, B goes free ✓	6 months for A, 6 months for B

Application: The Prisoner's Dilemma

Step 2: We will use a ✓ to identify which strategy is best for Prisoner B.

- If Prisoner A confesses, Prisoner B can confess for 5 years or not confess for 10 years.
- If Prisoner A does not confess, Prisoner B can confess and go free or don't confess for 6 months.

A \ B	CONFESS	DON'T CONFESS
CONFESS	X ✓ 5 years for A, 5 years for B	X A goes free, 10 years for B
DON'T CONFESS	10 years for A, B goes free ✓	6 months for A, 6 months for B

Application: The Prisoner's Dilemma

- What is the best strategy for each Prisoner given the other Prisoner's choice? What is the outcome?
- Here, 5 years for Prisoner A and 5 years for Prisoner B is the best outcome.

A \ B	CONFESS	DON'T CONFESS
CONFESS	X ✓ 5 years for A, 5 years for B	X A goes free, 10 years for B
DON'T CONFESS	10 years for A, B goes free	6 months for A, 6 months for B

Application: The Prisoner's Dilemma

- **Why???**
  - Although **not confessing** is the best outcome for prisoner A and B, they cannot count on each other not to confess
  - As a result, the best combined outcome for them would be for each to confess and serve 5 years

Example: The Game Theory Framework

- Four "A" students partied the night before an exam and slept through the exam
- They tell the professor that the reason they missed the exam was that they were all in a car that had a flat tire
- The professor lets them make up the exam

Example: The Game Theory Framework

- **The exam had two questions: an essay relating to the course material and a screening question… which tire was flat?**
  - This is a **screening question:** its purpose is to reveal strategic information about the person who answers

An Overview of Game Theory as a Tool in Studying Strategic Interaction

- A **non-cooperative game** is a game in which each player is out for him- or herself and agreements are either not possible or not enforceable
- **Cooperative games** are games in which players can form coalitions and the coalition can enforce its will on its members

An Overview of Game Theory as a Tool in Studying Strategic Interaction

- **Sequential games** are games where players make decisions one after another
  - **Example:** Chess
- **Simultaneous move games** are games where players make their decisions at the same time as other players (for example, the prisoner's dilemma)

Strategies of Players

- **Backward induction:** you begin with a desired outcome and then determine the decisions that could have led you to that outcome

Strategies of Players

- A **dominant strategy** **is a strategy that is preferred by a player regardless of the opponent's move**
  - **Ex: Prisoner's dilemma**
- A **mixed strategy** is a strategy of choosing randomly among moves
  - Ex: Rock, paper, scissors

Informal Game Theory and Modern Behavioral Economics

- Informal game theory is often called behavioral game theory because it relies on empirical observation, not deductive logic alone, to determine the likely choices of individuals
  - So…it provides a framework for approaching questions

Behavioral Economics and Game Theory

- **Behavioral economists use experiments and have people play the formal games to explore the validity of the assumptions in formal game theory and how they might be revised**

Loss Aversion, Incorrect Inference, and Framing Effects

- **Framing effects** are the tendency of people to base their choices on how the choice is presented
  - **An early-bird special is a better advertisement than a surcharge for peak-time meals**
  - **Would you choose option A of saving 200 of 600 lives, or option B that will end lives of 400 of 600?**

Chapter Summary

- Game theory is a flexible approach that is useful when decisions are interdependent
- In the prisoner's dilemma game both players have a dominant strategy that leads to a jointly undesirable outcome
- A payoff matrix provides a summary of each player's strategies and how the outcomes of their choices depend on the actions of the other players
- A Nash equilibrium is an equilibrium of a game that results from a non-cooperative game when each player plays his or her best strategy

Chapter Summary

- A dominant strategy is preferred regardless of one's opponent's move. A mixed strategy is choosing randomly
- Behavioral economics examines deviations between formal game theoretical predictions and actual outcomes of games
- Loss aversion and framing effects are examples of findings in behavioral economics that challenge the traditional model's predictions
- The traditional model remains relevant because it only takes a few people to realize that money has been left on the table for the results of the standard model to hold