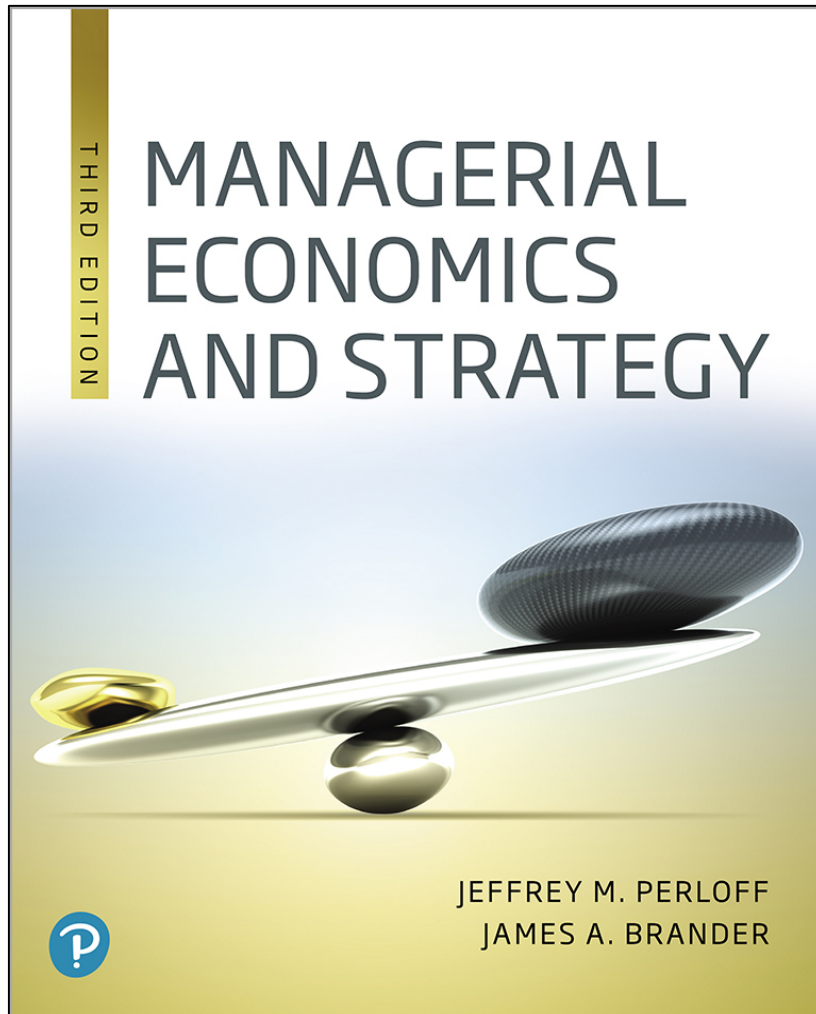


Managerial Economics and Strategy

Third Edition



Chapter 12

Game Theory and Business
Strategy

Managerial Problem

Dying to Work

- If the firm knows how dangerous a job is but potential employees do not, does it cause the firm to underinvest in safety? Can the government intervene to improve this situation?

Solution Approach

- We need to focus on **game theory**, a set of tools used to analyze strategic decision making. In deciding how much to invest in safety, firms take into account the safety investments of rivals.

Empirical Methods

- Oligopoly firms interact within a **game** as **players** that follow the **rules of the game**. Games can be **static** or **dynamic**.
- Players decide their **strategies** based on **payoffs**, level of **information**, and their **rationality**.
- The game optimal solution is a **Nash Equilibrium** and depends on information and rationality.
- Players determine transaction prices in bargaining and auction mechanisms.

Learning Objectives (1 of 2)

12.1 Oligopoly Games

Use payoff matrices to analyze oligopoly markets

12.2 Types of Nash Equilibria

Describe the different types of Nash equilibria

12.3 Information and Rationality

Explain the role of information and rationality in game theory

Learning Objectives (2 of 2)

12.4 Bargaining

Derive the outcome of a bargaining game

12.5 Auctions

Determine the optimal bidding strategy in an auction

12.1 Oligopoly Games (1 of 8)

A Game Between American and United Airlines

- Players and Rules
 - **Two players**, American and United, play a **static game** (only once) to decide how many passengers per quarter to fly. Their objective is to maximize profit.
 - **Rules**: Other than announcing their output levels **simultaneously**, firms cannot communicate (no side deals or coordination allowed).
 - **Complete information**: Firms know all strategies and payoffs.
- Strategies
 - Each firm's **strategy** is to take one of the two **actions**, choosing either a low output (48 k passengers per quarter) or a high output (64 k).
- Payoff Matrix or Profit Matrix
 - Both firms know all strategies and corresponding payoffs for each firm.
 - Table 12.1 summarizes this information. For instance, if American chooses high output ($q_A=64$) and United low output ($q_U=48$), American's profit is \$5.1 million and United's profit is \$3.8 million.

Table 12.1 Dominant Strategies in a Quantity-Setting Game

		<i>American Airlines</i>	
		$q_A = 64$	$q_A = 48$
<i>United Airlines</i>	$q_U = 64$	4.1	3.8
	$q_U = 48$	5.1	4.6

Note: Quantities are in thousands of passengers per quarter; (rounded) profits are in millions of dollars per quarter. The payoff to American Airlines is in the upper-right corner of each cell and the payoff to United Airlines is in the lower left.

12.1 Oligopoly Games (2 of 8)

Dominant Strategies

- If one is available, a rational player always uses a **dominant strategy**: A strategy that produces a higher profit than any other strategy the player can use no matter what its rivals do.
- Dominant strategies and game solution in Table 12.1
 - If United chooses the high-output strategy ($q_U = 64$), American's high-output strategy maximizes its profit.
 - If United chooses the low-output strategy ($q_U = 48$), American's high-output strategy maximizes its profit.
 - Thus, the high-output strategy is American's dominant strategy.
 - Similarly, United's high-output strategy is also a dominant strategy.
 - Because the high-output strategy is a dominant strategy for both firms, we can predict the **dominant strategy solution** of this game is $q_A = q_U = 64$.

12.1 Oligopoly Games (3 of 8)

Dominant Strategies

- Dominant strategy solution is not the best solution
 - A striking feature of this game is that the players choose strategies that do not maximize their joint or combined profit.
 - In Table 12.1, each firm could earn \$4.6 million if each chose low output ($q_A = q_U = 48$) rather than the \$4.1 million they actually earn by setting $q_A = q_U = 64$.
 - **Common Confusion:** Rival firms always choose a set of strategies that benefits all of them. This is not true in the Prisoner's Dilemma game.
- Prisoner's Dilemma game
 - **Prisoners' dilemma game:** All players have dominant strategies that lead to a profit that is inferior to what they could achieve if they cooperated.
 - Given that the players must act independently and simultaneously in this static game, their individual incentives cause them to choose strategies that do not maximize their joint profits.

12.1 Oligopoly Games (4 of 8)

Best Responses

- Many games do not have a dominant strategy solution. So, we use the approach of **best response**: The strategy that maximizes a player's profit given its beliefs about its rivals' strategies.
- A dominant strategy is a strategy that is a best response to **all possible** strategies that a rival might use. In the absence of one, each firm can determine its best response to **any possible** strategy chosen by its rivals.
- Best response is the basis for a **Nash equilibrium**: A set of strategies if, when all other players use these strategies, no player can obtain a higher profit by choosing a different strategy.
- A Nash equilibrium is self-enforcing.
- There are two steps to find a Nash equilibrium:
 - First step: Determine each firm's best response to any given strategy of the other firm.
 - Second step: Check whether there are any pairs of strategies (a cell in profit matrix) that are best responses for both firms, so the strategies are a Nash equilibrium in the cell.

12.1 Oligopoly Games (5 of 8)

A more complicated game between American and United to illustrate best responses

- Now both American and United can choose from three strategies: 96, 64, or 48 passengers. The profit matrix in Table 12.2 has nine cells (3×3).
- Same rules as before: Static simultaneous game, perfect information
- First Step: Best Responses in Table 12.2
 - If United chooses $q_U = 96$, American's best response is $q_A = 48$; if $q_U = 64$, American's best response is $q_A = 64$; and if $q_U = 48$, $q_A = 64$.
 - If American chooses $q_A = 96$, United's best response is $q_U = 48$; if $q_A = 64$, United's best response is $q_U = 64$; and if $q_A = 48$, $q_U = 64$.
- Second Step: Nash Equilibrium in Table 12.2
 - There is only one cell for it (both parts green): $q_A = q_U = 64$.
 - This is a Nash Equilibrium: Neither firm wants to deviate from its strategy. But, equilibrium does not maximize joint profits.

Table 12.2 Best Responses in a Quantity Setting Game

		American Airlines		
		$q_A = 96$	$q_A = 64$	$q_A = 48$
United Airlines	$q_U = 96$	0 0	2.0 3.1	2.3 4.6
	$q_U = 64$	3.1 2.0	4.1 4.1	3.8 5.1
	$q_U = 48$	4.6 2.3	5.1 3.8	4.6 4.6

Note: Quantities are in thousands of passengers per quarter; (rounded) profits are in millions of dollars per quarter.

12.1 Oligopoly Games (6 of 8)

Failure to Maximize Joint Profits

- **Common Confusion:** If firms in a market decide to advertise, doing so raises their profits. We'll show that, for some profit matrices, all the firms would benefit if they could agree not to advertise.
- In panel a of Table 12.3, two firms play a **static game** where a firm's advertising does not bring new customers into the market but only has the effect of stealing business from the rival firm.
 - Firms decide **simultaneously** to “advertise” or “do not advertise.” Advertising is a dominant strategy for both firms. In the resulting dominant strategy solution and Nash equilibrium, each firm earns 1 but would make 2 if neither firm advertised. **Solution does not maximize joint profits.**

12.1 Oligopoly Games (7 of 8)

Failure to Maximize Joint Profits

- In panel b of Table 12.3, firms play a **static game** in which advertising by a firm brings new customers to the market and helps both firms.
 - Firms decide **simultaneously** to “advertise” or “does not advertise.” Advertising is a dominant strategy for both firms. In the resulting dominant strategy solution and Nash equilibrium, each firm earns 4. **Solution does maximize joint profits.**
- Whether a Nash equilibrium maximizes the combined profit for the players depends on the profit matrix.

Table 12.3 Advertising Games: Prisoners' Dilemma or Joint-Profit Maximizing Outcome?

(a) Advertising Only Takes Customers from Rivals

		Firm 1	
		Do Not Advertise	Advertise
Firm 2	Do Not Advertise	2, 2	3, 0
	Advertise	0, 3	1, 1

(b) Advertising Attracts New Customers to the Market

		Firm 1	
		Do Not Advertise	Advertise
Firm 2	Do Not Advertise	2, 2	4, 3
	Advertise	3, 4	5, 5

12.1 Oligopoly Games (8 of 8)

Pricing Games in Two-Sided Markets

- A two-sided market is an economic platform that has two or more user groups that provide each other with network externalities (Chapter 9).
- MasterCard and Visa connect merchants and consumers. The more consumers who use a card, the more attractive accepting that card is to merchants. The more merchants who accept the card, the more likely consumers want to use it.
 - Prisoner's Dilemma game in Table 12.4. MasterCard and Visa are rivals, their pricing strategies are balanced pricing (both merchants and consumers pay fees), or unbalanced pricing (only merchants pay). Unbalanced pricing is the dominant strategy for each firm, and the Nash Equilibria gives 4 each. Firms would earn more if they used balanced pricing, 7 each.
- eHarmony and [Match.com](https://www.match.com) connect the two sides of a date.
 - Non-Prisoner's Dilemma game in Table 12.5. eHarmony and Match.com are dating platforms, their pricing strategies are balanced pricing (men and women pay), or unbalanced pricing (only one group pays). Balanced pricing is the dominant strategy for each firm. The solution maximizes the joint payoffs to the firms.

Table 12.4 Unbalanced Pricing in a Two-Sided Market

		Visa	
		Balanced	Unbalanced
MasterCard	Balanced	7 7	2 9
	Unbalanced	9 2	4 4

Table 12.5 Balanced Pricing in a Two-Sided Market

		<i>eHarmony</i>	
		<i>Balanced</i>	<i>Unbalanced</i>
<i>Match.com</i>	<i>Balanced</i>	7 7	5 6
	<i>Unbalanced</i>	6 5	4 4

12.2 Types of Nash Equilibria (1 of 8)

There are three types of Nash equilibria

- Unique Nash equilibrium
 - Only one combination of strategies is each firm's strategy a best response to its rival's strategy.
 - Examples are the Bertrand and Cournot models, and all games played so far.
- Multiple Nash equilibria
 - Many oligopoly games have more than one Nash equilibrium.
 - To predict the likely outcome of multiple equilibria, we may use additional criteria.
- Mixed strategy Nash equilibria
 - In the games we played so far, players were certain about what action to take at each rival's decision (**pure strategy**).
 - When players are not certain, they use a **mixed strategy**: A rule telling the player how to randomly choose among possible pure strategies.

12.2 Types of Nash Equilibria (2 of 8)

Multiple Equilibria

- Coordination Game: In Table 12.6, two network firms play a static game. Each firm chooses simultaneously and independently to schedule a show on Wednesday or Thursday.
 - If firms schedule it on different days, both earn 10. Otherwise, each loses 10.
- Best Responses: Neither network has a dominant strategy. For each network, its best choice depends on the choice of its rival.
 - In Table 12.6, if Network 1 opts for Wednesday, then Network 2 prefers Thursday. But, if Network 1 chooses Thursday, then Network 2 prefers Wednesday. Best responses are colored green.
- Two Nash equilibrium solutions: There are **two** cells with both firms' best responses (green cells)
 - These Nash equilibria have one firm broadcast on Wednesday and the other on Thursday.
 - We predict the networks would schedule shows on different nights. But, we cannot forecast which night each network will choose.

Table 12.6 Network Scheduling: A Coordination Game

		Network 1	
		Wednesday	Thursday
Network 2	Wednesday	-10 -10	10 10
	Thursday	10 10	-10 -10

12.2 Types of Nash Equilibria (3 of 8)

Cheap Talk

- Firms can engage in **credible cheap talk** if they communicate before the game and both have an incentive to be truthful (higher profits).
- If Network 1 announces in advance that it will broadcast on Wednesday, Network 2 will choose Thursday and both networks will benefit. The game becomes a **coordination game**.

The Pareto Criterion

- If cheap talk is not allowed or is not credible, it may be that one of the Nash equilibria provides a higher profit to all players than the other Nash equilibria.
- If so, we expect firms acting independently to select a solution that is better for all parties (Pareto Criterion), even without communicating. In Table 12.7, there are two Nash equilibria, but we expect firms to choose the one with the higher profits.
- Unfortunately, we cannot always use cheap talk or the Pareto criterion to predict the outcome in a game with multiple equilibria.

Table 12.7 The Pareto Criterion in a Network Scheduling Coordination Game

		Network 1	
		Wednesday	Thursday
Network 2	Wednesday	-10 -10	10 10
	Thursday	15 15	-10 -10

12.2 Types of Nash Equilibria (4 of 8)

Mixed Strategy Equilibria



How business decisions are made.

12.2 Types of Nash Equilibria (5 of 8)

Mixed Strategy Equilibria

- So far, we assumed that each firm uses a **pure strategy**: An action that a player takes in every possible situation in a game.
 - A pure strategy is a rule telling the player with certainty what action to take at each decision point in a game.
- In the following games, a firm uses a **mixed strategy**: A player chooses among possible pure strategies according to probabilities that the player sets.
 - A mixed strategy is a rule telling the player which method to use to randomly choose among possible pure strategies. The method could be a dice to throw or a coin to flip.
- A pure strategy can be viewed as a special case of a mixed strategy: A player assigns a probability of one to a single pure strategy and zero to all other possible pure strategies.
- A mixed strategy that assigns positive probabilities to two or more actions is called **non-pure** mixed strategy.

12.2 Types of Nash Equilibria (6 of 8)

Only Mixed-Strategy Equilibria

- Design Competition Game: Two firms, upstart and established, compete for an architectural contract and simultaneously decide if their proposed designs are traditional or modern.
- The **profit matrix** is in Table 12.8. If both firms adopt the same design, then the established firm wins. However, if the firms adopt different designs, the upstart firm wins the contract.
 - The **best responses** for the upstart are a modern design if the established firm uses a traditional design, and a traditional design if the rival picks modern.
 - The **best responses** for the established are a modern design if the upstart firm uses a modern design, and a traditional design if the rival picks traditional.
- Pure strategies have no Nash equilibrium
 - Given the best responses, for each cell, one firm or the other regrets their design choices.
 - Thus, if both firms use pure strategies, this game has no Nash equilibrium.

Table 12.8 Mixed Strategies in a Design Competition

		Established Firm	
		Traditional	Modern
Upstart	Traditional	20 -2	-2 20
	Modern	-2 20	20 -2

12.2 Types of Nash Equilibria (7 of 8)

Only Mixed-Strategy Equilibria

- Mixed strategy Nash equilibrium: If each firm chooses a traditional design with probability $\frac{1}{2}$, this design game has a mixed-strategy Nash equilibrium.
 - The probability that a firm chooses a given style is $\frac{1}{2}$ and the probability that both firms choose the same cell is $\frac{1}{4}$. Each of the four cells in Table 12.6 is equally likely to be chosen with probability $\frac{1}{4}$.
 - The established firm's expected profit—the firm's profit in each possible outcome times the probability of that outcome—is 9, the highest possible. The firm just flips a coin to choose between its two possible actions.
 - Similarly, the upstart's expected profit is 9 and flips a coin too.
- Why would each firm use a mixed strategy of $\frac{1}{2}$?
 - Because it is in their best interest to flip a coin.
 - If the upstart firm knows the established firm will choose traditional design with probability $> \frac{1}{2}$ or 1, then the upstart picks modern for certain and wins the contract. So, it is best for the traditional firm to flip a coin (probability = $\frac{1}{2}$).

12.2 Types of Nash Equilibria (8 of 8)

Both Pure- and Mixed-Strategy Equilibria

- Two firms are considering opening gas stations at the same location but only one station would operate profitably (small demand). If both firms enter, each loses 2.
- The profit matrix is in Table 12.9. Neither firm has a dominant strategy. Each firm's best action depends on what the other firm does. There are 3 Nash Equilibria.
- Three Nash equilibria in total
 - **Two Nash equilibria with pure strategies:** Firm 1 **enters** and Firm 2 **does not enter**, or Firm 2 **enters** and Firm 1 **does not enter**.
 - How do the players know which outcome will arise? They **don't** know. Cheap talk is no help.
 - **One mixed-strategy Nash equilibrium:** Each firm enters with probability $1/3$.
 - No firm could raise its expected profit by changing its mixed strategy.

Table 12.9 Nash Equilibria in an Entry Game

		<i>Firm 1</i>	
		<i>Do Not Enter</i>	<i>Enter</i>
<i>Firm 2</i>	<i>Do Not Enter</i>	0, 0	0, 1
	<i>Enter</i>	1, 0	-2, -2

12.3 Information and Rationality (1 of 5)

The Logic of Incomplete Information and Rationality

- We have assumed so far firms have **complete information**: Know all strategies and profits.
 - However, in more complex games, firms have **incomplete information**.
 - Incomplete information may occur because of **private information** or **high transaction costs**.
- We have assumed so far players act **rationally**: They use all their available information to determine their best strategies (maximizing profit strategies).
 - However, players may have limited powers of calculation, or be unable to determine their best strategies (**bounded rationality**).
- When firms have incomplete information or bounded rationality, the Nash equilibria are different from games with full information and rationality.

12.3 Information and Rationality (2 of 5)

Incomplete Information

- Investment game: Google and Samsung must decide “to invest” or “do not invest” in complementary products that “go together.” (Chrome OS and Chromebook, respectively)
- In Table 12.10, there is a profit asymmetry: A Chromebook with no Chrome OS has no value at all, but Chrome OS with no Chromebook still has value.
- Assume complete information in Table 12.10
 - If each firm has full information, Google’s dominant strategy is “to invest” and Samsung’s best response to it is “to invest.”
 - The solution is a unique Nash equilibrium with both firms investing.
- Assume incomplete information in Table 12.10
 - With private information, Samsung does not know Google’s dominant strategy is always “to invest.”
 - Given its limited information, Samsung weights a modest gain versus a big loss. If it thinks it is likely Google will not invest (big loss), then Samsung does not invest.
 - Samsung and Google fail to coordinate their strategies.

Table 12.10 Complementary Investment Game

		Samsung	
		Do Not Invest	Invest
Google	Do Not Invest	00	0-25
	Invest	50	2020

12.3 Information and Rationality (3 of 5)

Managerial Implication: Solving Coordination Problems

- Managers often worry about whether their products will work with other products.
 - For example, it is important for smartphones to work with headphones, with car audio systems, and with hearing aids produced by other companies.
- To work together, each of these products must use the same technical standard.
- Managers may be reluctant to invest in adopting a particular technical standard unless they are confident other companies will use the same standard.
 - Smartphones use the Bluetooth standard, as do many car audio systems, headphones, and hearing aids. How did so many different companies agree to coordinate on the Bluetooth standard?
 - This coordination is handled by the Bluetooth Special Interest Group, a not-for-profit standard setting organization (SSO) with over 33,000 member companies who use the Bluetooth standard as of 2018.
 - SSOs look for patent-holders to agree to license the technology on a “fair, reasonable, and nondiscriminatory” basis.

12.3 Information and Rationality (4 of 5)

Rationality

- We normally assume that rational players consistently choose actions that are in their best interests given the information they have. They are able to choose profit-maximizing strategies.

Bounded Rationality

- However, actual games are more complex. Managers with limited powers of calculation or logical inference (**bounded rationality**) try to maximize profits. But, due to their cognitive limitations, do not always succeed.

Maximin Strategies

- In very complex games, a manager with bounded rationality may use a **rule of thumb** approach, perhaps using a rule that has worked in the past.
- A **maximin** strategy maximizes the minimum profit. This approach ensures the best possible profit if your rival takes the action that is worst for you.
- The maximin solution for the game in Table 12.10 is for Google to invest and for Samsung not to invest.

12.3 Information and Rationality (5 of 5)

Managerial Implication: Using Game Theory to Make Business Decisions

- When making strategic decisions, managers should consider five principles based on game theory:
 1. **Dominance.** A manager who has a dominant strategy—a strategy that is always best no matter what rivals do—should use it.
 2. **Best Response.** A manager who does not have a dominant strategy should determine the best responses to the strategies that rivals might use.
 3. **Point of View.** A manager should consider possible strategies from the rival's vantage point, try to predict which strategy the rival will choose, and select the best response to that strategy.
 4. **Coordination.** When doing so increases profit, a manager should coordinate with other firms through pre-play communication (cheap talk) or by using legal contracts.
 5. **Randomize.** A manager may be able to earn a higher profit by using a mixed strategy to keep rivals guessing.

12.4 Bargaining (1 of 4)

- Bargaining is important in our personal lives. Car buyers bargain with car dealers, married couples and roommates bargain over responsibility for household chores, and teenagers bargain with their parents over anything.
- Bargaining is also common in business situations. Managers and employees bargain over wages and working conditions, firms bargain downstream with suppliers and bargain upstream with distributors.

Bargaining Games

- **Bargaining games:** Any situation in which two or more parties with different interests or objectives negotiate voluntarily over the terms of some interaction, such as the transfer of a good from one party to another.
 - For simplicity, we will focus on two-person bargaining games.
- The solution for bargaining games is called **Nash Bargaining Solution**.
- Nash Bargaining solution $\neq$ Nash Equilibrium. The Nash equilibrium is for noncooperative games where players do not negotiate quantities or prices.

12.4 Bargaining (2 of 4)

The Nash Bargaining Solution

- The Nash bargaining solution to a cooperative game is **efficient** in the sense that there is no alternative outcome that would be better for both parties or strictly better for one party and no worse for the other.
- The game in Table 12.1 (American Versus United) becomes a bargaining game if rules allow firms to bargain over their output levels and reach a binding agreement.
- Follow three steps to find a Nash bargaining solution:
 - First, find the profit at the **disagreement point**: The outcome that arises if no agreement is reached, call it d . In Table 12.1, $d_A = d_U = 4.1$.
 - Second, if a proposed agreement is reached, the firm earns a profit of π and a **net surplus**, $\pi - d$. In Table 12.1, $\pi_A - d_A$ and $\pi_U - d_U$
 - Third, the Nash bargaining solution is the outcome in which each firm receives a nonnegative surplus and in which the product of the net surplus of the two firms (called the **Nash product, NP**) is maximized. In Table 12.1,
$$NP = (\pi_A - d_A) \times (\pi_U - d_U).$$

12.4 Bargaining (3 of 4)

The Nash Bargaining Solution

- Maximize $NP = (\pi_A - d_A) \times (\pi_U - d_U)$
 - There are four possible outcomes in Table 12.1. In the upper left cell, in which each firm produces the large output, the $NP = 0$ because each firm has zero net surplus. In the lower left cell and in the upper right cell, $NP < 0$. In the lower right cell, where each firm produces the small output and earns 4.6, $NP = (4.6 - 4.1) \times (4.6 - 4.1) = 0.25$, maximum NP .
 - So, the Nash bargaining equilibrium predicts both American and United fly 48 thousand passengers.
- If the firms could bargain about how they set their output levels in an oligopoly game, they could reach an efficient outcome that maximizes the Nash product.
 - Such an agreement creates a cartel and raises the firms' profits. The gain to firms from such a cartel agreement is more than offset by lost surplus for consumers (Chapter 11). Consequently, such agreements are illegal in most developed countries under antitrust or competition laws.

12.4 Bargaining (4 of 4)

Inefficiency in Bargaining

- The Nash bargaining solution presumes that the parties achieve an efficient outcome where neither party could be made better off without harming the other party.
- However in the real world, bargaining frequently yields inefficient outcomes.
- Reasons for Inefficient Outcomes
 - The bargaining process takes time, which delays the start of the benefit flow and therefore reduces the value of benefits overall, for instance a strike.
 - Usually in a strike, negotiators fail to quickly reach an agreement due to bounded rationality or incomplete information about the other side's profits. The parties do the best they can but are unable to determine the best possible strategies and therefore they make mistakes that are costly to both parties.

12.5 Auctions (1 of 8)

- An **auction** is a sale in which a good or service is sold to the highest bidder.
 - In **auction games**, players called **bidders** devise bidding strategies without knowing other players' payoff functions.
 - A bidder needs to know the **rules of the game**: The number of units being sold, the format of the bidding, and the value that potential bidders place on the good.
- Real Scenarios for Auction Games
 - **Government-related games**: Government procurement auctions; auctions for electricity and transport markets; auctions to concede portions of the airwaves for radio stations, mobile phones, and wireless internet access.
 - **Market transaction games**: Goods commonly sold at auction are natural resources such as timber and drilling rights for oil, as well as houses, cars, agricultural produce, horses, antiques, and art. And of course, goods online in sites like eBay.

12.5 Auctions (2 of 8)

Elements of Auctions

Number of units

- Auctions can be used to sell one or many units of a good.

Format of bidding

- **English auction:** Ascending-bid auction process where the good is sold to the last bidder for the highest bid. Common to sell antiques.
- **Dutch auction:** Descending-bid auction process where the seller reduces the price until someone accepts it and buys at that price.
- **Sealed-bid auction:** Bidders submit a bid simultaneously without seeing anyone else's bid and the highest bidder wins. In a **first-price auction**, the winner pays its own, highest bid. In a **second-price auction**, the winner pays the amount bid by the second-highest bidder.
- **Double auction:** All potential buyers and sellers make public offers stating prices at which they are willing to buy or sell.

12.5 Auctions (3 of 8)

Elements of Auctions

Value

- **Private value:** Individual bidders know how much the good is worth to them but not how much other bidders value it.
- **Common value:** The good has the same value to everyone, but no bidder knows exactly what that value is.

12.5 Auctions (4 of 8)

Bidding Strategies in Private-Value Auctions

Second-Price Auction Strategies

- Second-Price Auction Game Rules: Traditional sealed-bid, second-price auction. Each bidder places a different private value on a single, indivisible good.
 - The amount that you bid affects whether you win, but it does not affect how much you pay if you win, which equals the second-highest bid.
- Bidding your highest value is your best strategy (weakly dominates all others).
 - Suppose that you value a folk art carving at \$100. If you bid \$100 and win, your $CS = 100$ —second price. If you bid less than \$100, your risk not winning. If you bid more than \$100, your risk ending up with a negative CS .
 - So, bidding \$100 leaves you **as well off as, or better off** than, bidding any other value.

12.5 Auctions (5 of 8)

English Auction Strategy

- English Auction Game Rules: Ascending-bid auction process where the good is sold to the last bidder for the highest bid. Each bidder has a private value for a single, indivisible good.
 - The amount that you bid affects whether you win and pay.
- Your best strategy is to raise the current highest bid as long as your bid is less than the value you place on the good.
 - Suppose that you value a folk art carving at \$100. If you bid an amount b and win, your surplus is $\$100 - b$. Your surplus is positive or zero for $b \leq 100$. But, negative if $b > 100$. So, it is best to raise bids up to \$100 and stop there.
- If all participants bid up to their value, the winner will pay slightly more than the value of the second-highest bidder. Thus, the outcome is essentially the same as in the sealed-bid, second-price auction.

12.5 Auctions (6 of 8)

Equivalence of Auction Outcomes

- Dutch auction rules: Descending-bid auction process where the seller reduces the price until someone accepts the offered price and buys at that price.
- Sealed-bid rules: Bidders submit a bid simultaneously without seeing anyone else's bid, the highest bidder wins and pays its own bid.
 - In both games, each bidder has a private value for a single, indivisible good.
 - The amount that you bid affects whether you win and pay.
- The **best strategy for both games** is to bid an amount that is equal to or slightly greater than what you expect will be the second-highest bid, given that your value is the highest.
 - Bidders **shave** their bids to less than their value to balance the effect of decreasing the probability of winning and increasing CS. The bid depends on the beliefs about the strategies of rivals.
 - Thus, the expected outcome is the **same** under each format for private-value auctions: The winner is the person with the highest value, and the winner pays roughly the second-highest value.

12.5 Auctions (7 of 8)

The Winner's Curse

- The **winner's curse** occurs in **common-value auctions**: The winner's bid exceeds the common-value item's value. So, the winner ends up paying too much.
 - The overbidding occurs when there is uncertainty about the true value of the good, as is in timber land auctions.
- Best strategy to avoid the winner's curse
 - Rational bidders shade or reduce their bids below their estimates.
 - The amount of reduction depends on the number of other bidders, because the more bidders, the more likely that the winning bid is an overestimate.
- Bounded rationality and the winner's curse
 - Although rational managers should avoid the winner's curse, there is strong empirical evidence for the winner's curse (corporate acquisition market).
 - One explanation is bounded rationality.

12.5 Auctions (8 of 8)

Managerial Implication: Auction Design

- Managers who sell assets using auctions need to understand how an auction's design affects bidders' behavior.
- Because intelligent bidders shade their bids, sellers of common-value goods can do better with an English auction than with a sealed-bid auction. In an English auction, bidders may revise their views about the object's value as they watch others bid.
 - Many sellers have learned this lesson. For example, online auction sites such as eBay do not use sealed-bid auctions, choosing modified English auctions or other types of auctions instead.
 - Many governments have failed to learn it. They continue to rely heavily on sealed-bid auctions even though it is likely they would earn more money if they used an English auction to sell lumber, rights to airwaves, and other property.

Managerial Solution

Dying to Work

- If the firm knows how dangerous a job is but potential employees do not, does it cause the firm to underinvest in safety? Can the government intervene to improve this situation?

Solution

- The firms are engaged in a prisoners' dilemma game.
- The firms underinvest in safety because each firm bears the full cost of its safety investments but derives only some of the benefits.
- This outcome results because workers cannot tell which firm is safer.
- If the government or a union were to collect and provide workers with firm-specific safety information at relatively low costs, the firms might opt to invest.

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