MAKING STRATEGY AND GAME THEORY

- Strategic managerial decisions: Characterized by interactive payoffs in which managers must explicitly consider the actions likely to be taken by their rivals in response to their decisions
- Nonstrategic managerial decisions: Do not involve other decision makers, so the reactions of other decision makers do not have to be considered

MAKING STRATEGY AND GAME THEORY

- Interactive: When the consequence of a manager's decision depends on both the manager's own action and the actions of others
  - There are no unconditional optimal strategies in game theory; the optimality of a strategy depends on the situation in which it is implemented.

STRATEGY BASICS

- All game theoretic models are defined by five parameters.

1. The players: A player is an entity that makes decisions; models describe the number and identities of players.
2. The feasible strategy set: Actions with a nonzero probability of occurring comprise the feasible strategy set.

STRATEGY BASICS

- All game theoretic models are defined by five parameters (cont'd).

3. The outcomes or consequences: The feasible strategies of all players intersect to define an outcome matrix.
4. The payoffs: Every outcome has a defined payoff for every player. Players are assumed to be rational, that is, to prefer a higher payoff to a lower one.
5. The order of play: Play may be simultaneous or nonsimultaneous, that is, sequential.

VISUAL REPRESENTATION

- Matrix form: Form that summarizes all possible outcomes
- Extensive form: Form that provides a road map of player decisions
- Game trees: Game trees are another name for extensive form games and are akin to decision trees.

VISUAL REPRESENTATION

- Examples
  - Figure 12.1: Two-Person Simultaneous Game
  - Figure 12.2: Allied-Barkley Pricing: Sequential
  - Figure 12.3: Allied-Barkley Pricing: Simultaneous
    - Uses information sets to use the extensive form to represent simultaneous decisions

A TWO-PERSON SIMULTANEOUS GAME

FIGURE 12.1

A Two-Person Simultaneous Game

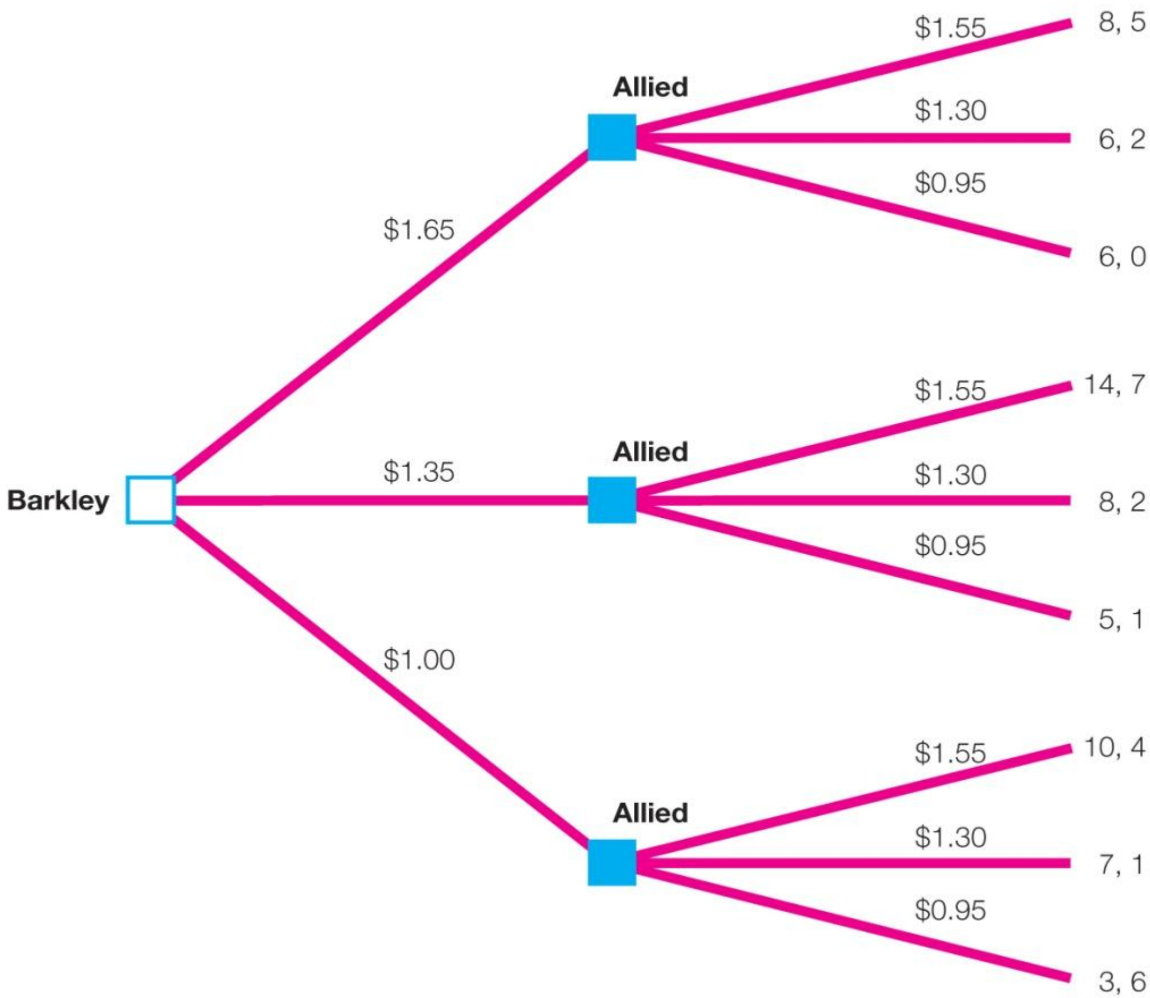
		Allied's strategy	
		Spend at current level	Increase spending
Barkley's strategy	Spend at current level	3, 4	2, 3
	Increase spending	4, 3	3, 2

Copyright @ W.W. & Company 2013

ALLIED–BARKLEY PRICING: SEQUENTIAL

FIGURE 12.2

Allied–Barkley Pricing: Sequential

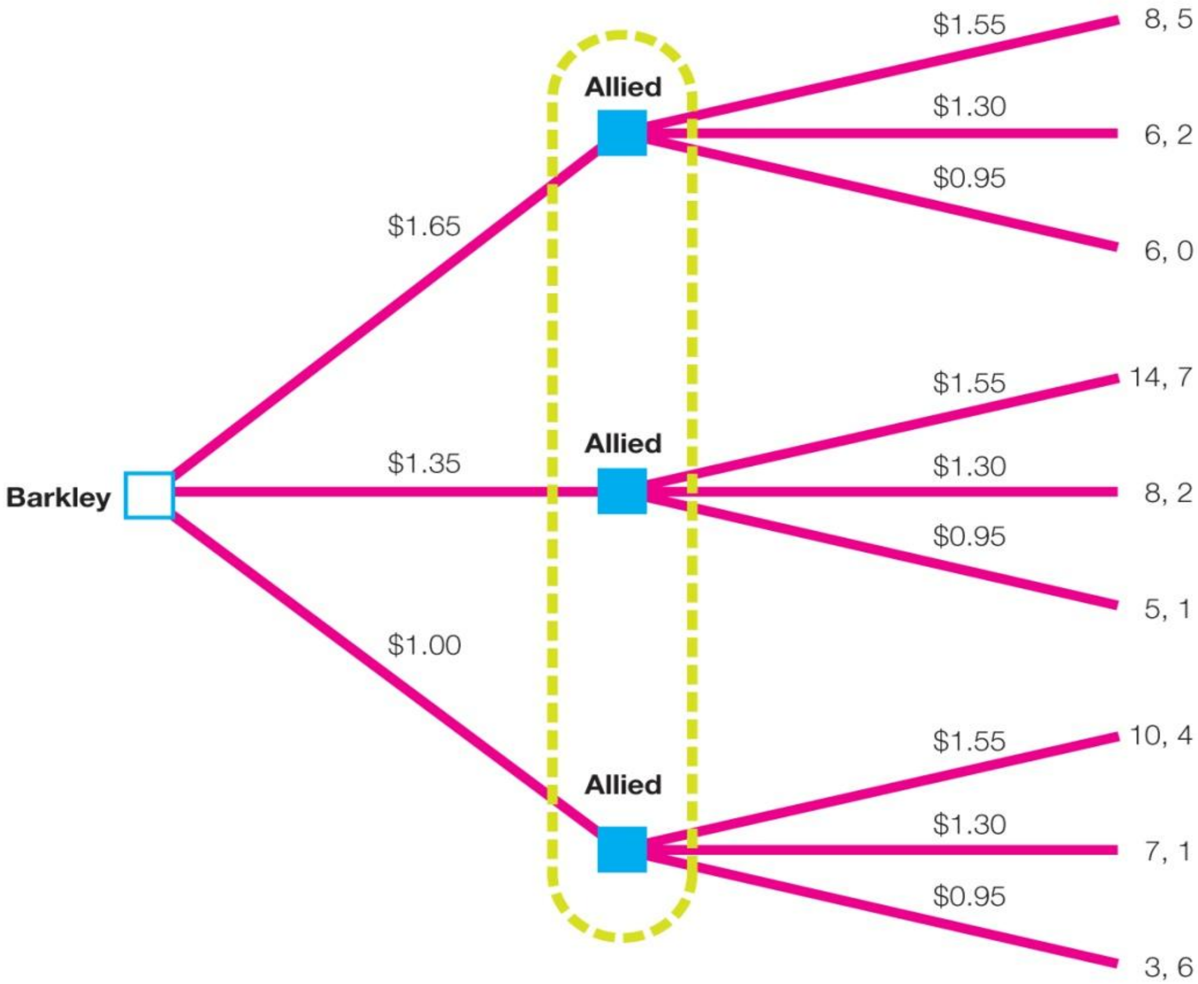


Managerial Economics, 8e
Copyright @ W.W. & Company 2013

ALLIED–BARKLEY PRICING: SIMULTANEOUS

FIGURE 12.3

Allied–Barkley Pricing: Simultaneous



Managerial Economics, 8e
Copyright @ W.W. & Company 2013

SOLUTION CONCEPTS AND EQUILIBRIA

- Solution Concepts
  - The key to the solution of game theory problems is the anticipation of the behavior of others.
- Equilibria
  - Equilibrium: When no player has an incentive to unilaterally change his or her strategy
  - No player is able to improve his or her payoff by unilaterally changing strategy.

DOMINANT STRATEGIES

- Dominant strategy: Strategy whose payout in any outcome is higher relative to all other feasible strategies
  - Strategy that is optimal regardless of the strategies selected by rivals
- Example: Dominant strategy
  - Figure 12.1: Two-Person Simultaneous Game
    - Barkley has a dominant strategy, which is to maintain the current spending level.
    - Allied has a dominant strategy, which is to increase spending.

DOMINANT STRATEGIES

- Example: Dominated strategy
  - Figure 12.4: Matrix Form Representation of Figure 12.2
    - Barkley has a dominated strategy, which is to charge $1.00. There is no circumstance under which this strategy would yield a payoff greater than the other feasible strategies.
    - Allied has two dominated strategies, given the elimination of a Barkley price of $1.00. These are to price at $0.95 and to price at $1.30.
  - Figure 12.5: Iterative Dominance
    - Shows the elimination of dominated strategies

MATRIX FORM REPRESENTATION OF FIGURE 12.2

FIGURE 12.4

Matrix Form Representation of Figure 12.2

		Allied's pricing strategies		
		$0.95	$1.30	$1.55
Barkley's pricing strategies	$1.00	3, 6	7, 1	10, 4
	$1.35	5, 1	8, 2	14, 7
	$1.65	6, 0	6, 2	8, 5

Copyright @ W.W. & Company 2013

ITERATIVE DOMINANCE

FIGURE 12.5

Iterative Dominance

A. Barkley's $1.00 strategy is eliminated.

		Allied's pricing strategies		
		$0.95	$1.30	$1.55
Barkley's pricing strategies	$1.35	5, 1	8, 2	14, 7
	$1.65	6, 0	6, 2	8, 5

B. Allied's $0.95 and $1.30 strategies are eliminated.

		Allied's pricing strategies
		$1.55
Barkley's pricing strategies	$1.35	14, 7
	$1.65	8, 5

Copyright @ W.W. & Company 2013

THE NASH EQUILIBRIUM

- Assuming that all players are rational, every player should choose the best strategy conditional on all other players doing the same.

THE NASH EQUILIBRIUM

- Model
  - Each of N players chooses a strategy si*, where i = 1, 2, 3, N.
  - An outcome of the game is represented as an array of strategies s* = (s1*, s2*, sN*).
  - The payoff to player i when s* is selected is B(s*).
  - A Nash equilibrium is an array of strategies such that
    Bi(s1*, s2*, sN*) $\geq$ Bi(s1', s2*, sN*) for all outcomes.
    - There is no array of strategies better than s* for any player.
    - This equilibrium is rational, optimal, and stable.

THE NASH EQUILIBRIUM

- Figure 12.6: New Product Introduction
  - Nash equilibrium is where Barkley produces product sigma and Allied produces product alpha.

NEW PRODUCT INTRODUCTION

FIGURE 12.6

New Product Introduction

		Allied		
		Product alpha	Product beta	Product zeta
Barkley	Product lambda	4, 6	9, 8	6, 10
	Product pi	6, 8	8, 9	7, 8
	Product sigma	9, 8	7, 7	5, 5

Copyright @ W.W. & Company 2013

NEW PRODUCT INTRODUCTION WITH OTHER'S BEHAVIOR

FIGURE 12.7

New Product Introduction with Other's Behavior

		Allied		
		Product alpha	Product beta	Product zeta
Barkley	Product lambda	4, 6	(B) 9, 8	6, 10 (A)
	Product pi	6, 8	8, 9 (A)	(B) 7, 8
	Product sigma	(B) 9, 8 (A)	7, 7	5, 5

Copyright @ W.W. & Company 2013

PAYOFFS FOR EACH CUSTOMER FROM USING FEDEX/UPS AND/OR DHL

FIGURE 12.8

Payoffs for Each Customer From Using FedEx/UPS and/or DHL

		Customer B	
		Use FedEx/UPS	Use DHL
Customer A	Use FedEx/UPS	**100**, 100	90, 90
	Use DHL	90, 90	**120**, 120

Copyright @ W.W. & Company 2013

PAYOFFS FOR EACH CUSTOMER FROM USING FEDEX/UPS AND/OR DHL AFTER DHL LOWERS RATES

FIGURE 12.9

Payoffs for Each Customer From Using FedEx/UPS and/or DHL after DHL Lowers Rates

		Customer B	
		Use FedEx/UPS	Use DHL
Customer A	Use FedEx/UPS	100, 100	100^{+}, $\underline{100}^{+}$
	Use DHL	**100^{+}**, 100^{+}	**130^{+}**, $\underline{130}^{+}$

Managerial Economics, 8e
Copyright @ W.W. & Company 2013

STRATEGIC FORESIGHT: THE USE OF BACKWARD INDUCTION

- Definitions
  - Strategic foresight: Manager's ability to make decisions today that are rational given what is anticipated in the future
  - Backward induction: Used in game theory to solve games by looking to the future, determining what strategy players will choose (anticipation), and then choosing an action that is rational, based on those beliefs
    - In sequential games, backward induction involves starting with the last decisions in the sequence and then working backward to the first decisions, identifying all optimal decisions.

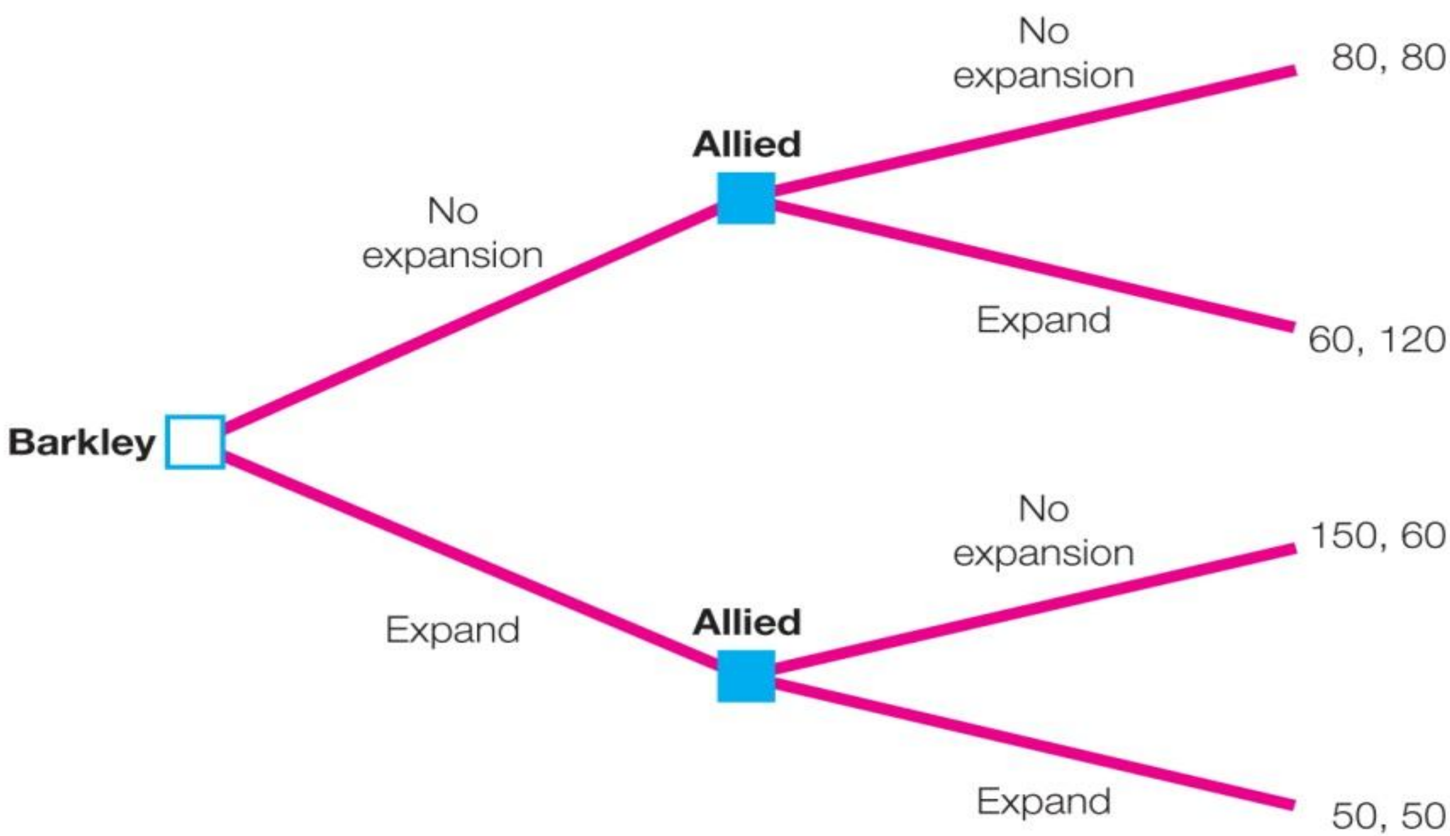
STRATEGIC FORESIGHT: THE USE OF BACKWARD INDUCTION

- Example
  - Figure 12.10: Allied-Barkley Expansion

ALLIED–BARKLEY EXPANSION DECISION

FIGURE 12.10

Allied–Barkley Expansion Decision



Managerial Economics, 8e
Copyright @ W.W. & Company 2013

STRATEGIC FORESIGHT: THE USE OF BACKWARD INDUCTION

- The Credibility of Commitments
  - Credible: When the costs of falsely making a commitment are greater than the associated benefits

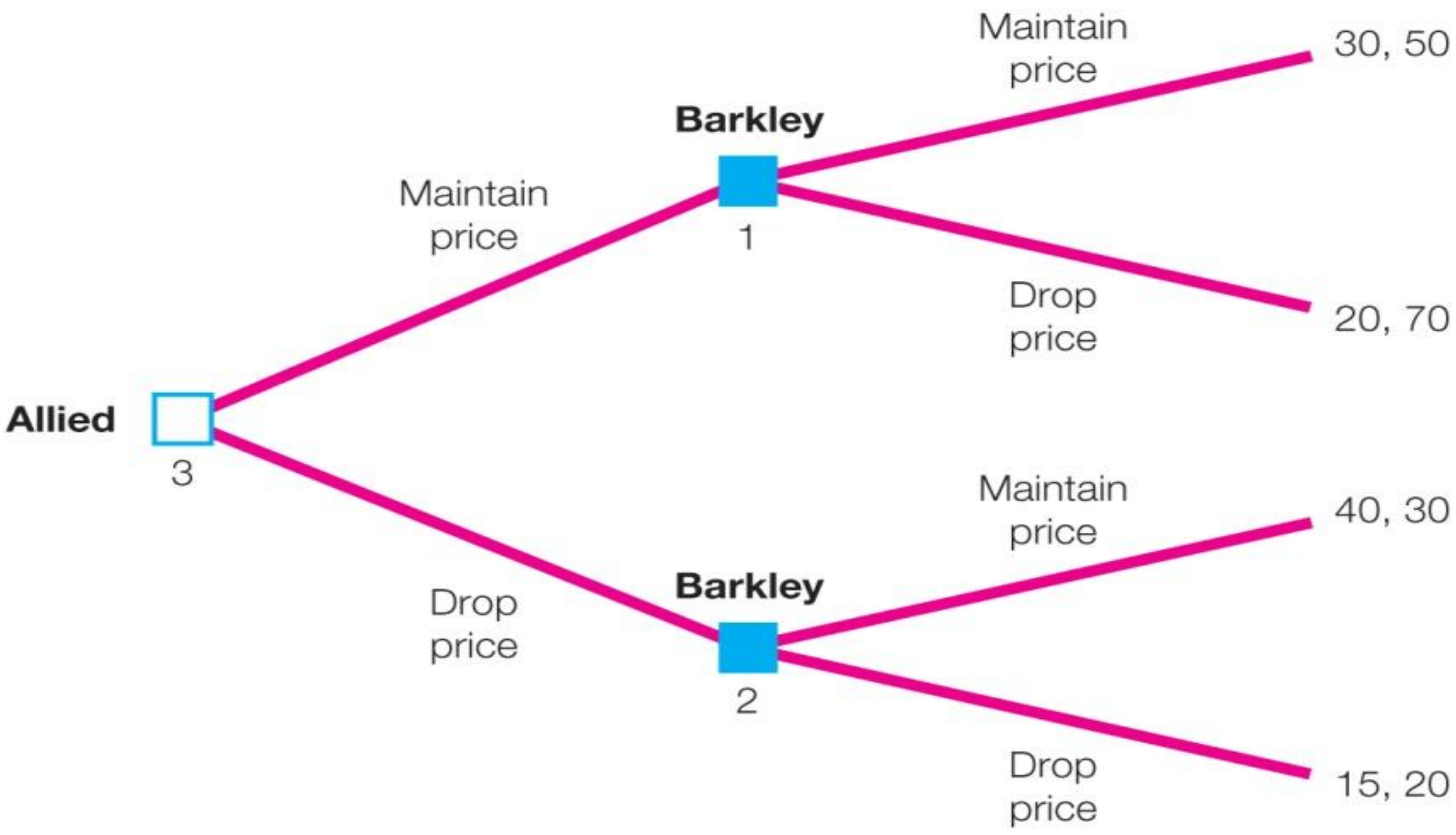
STRATEGIC FORESIGHT: THE USE OF BACKWARD INDUCTION

- The Credibility of Commitments (cont’d)
  - Example
    - Figure 12.12: Does Barkley Have a Credible Threat?
    - It is not in Barkley's interest to drop price in response to Allied’s price cut. The threat to do so is not credible.

DOES BARKLEY HAVE A CREDIBLE THREAT?

FIGURE 12.12

Does Barkley Have a Credible Threat?



Copyright @ W.W. & Company 2013

REPEATED GAMES

- Prisoner’s Dilemma
  - Allied and Barkley produce an identical product and have similar cost structures.
  - Each player must decide whether to price high or low.
  - Figure 12.13: Pricing as a Prisoner's Dilemma
    - The solution is for both to price low.
    - Both would be better off if both priced high.

PRICING AS A PRISONER'S DILEMMA

FIGURE 12.13

Pricing as a Prisoner's Dilemma

		Allied's pricing strategies	
		Price high	**Price low**
Barkley's pricing strategies	**Price high**	5, 5	1, 20
	Price low	20, 1	3, 3

Copyright @ W.W. & Company 2013

REPEATED GAMES

- Prisoner's Dilemma (cont'd)
  - Repeated play can lead to cooperative behavior in a prisoner's dilemma game.
    - Trust, reputation, promises, threats, and reciprocity are relevant only if there is repeated play.
    - Cooperative behavior is more likely if there is an infinite time horizon than if there is a finite time horizon.
    - If there is a finite time horizon, then the value of cooperation, and hence its likelihood, diminishes as the time horizon is approached. Backward induction implies that cooperation will not take place in this case.

REPEATED GAMES

- Prisoner’s Dilemma (cont’d)
  - Folk theorem: any type of behavior can be supported by an equilibrium (as long as the players believe there is a high probability that future interaction will occur).

INCOMPLETE INFORMATION GAMES

- Incomplete information games (IIG): A branch of game theory that loosens the restrictive assumption that all players have the same information
  - Asymmetric information is summarized in terms of player types. A type has characteristics unknown to other players that have different preference (payoff) functions.
    - Low-cost type and high-cost type
    - Tough type and soft type

INCOMPLETE INFORMATION GAMES

- Example
  - Figure 12.14: Tough or Soft Barkley Managers
    - If Barkley managers are tough, they will fight, and Allied will not enter the market.
    - If Barkley managers are soft, they will not fight, and Allied will enter the market.
- Tit for tat: Strategy in which players cooperate in the first period, and in all succeeding periods the players mimic the strategy of the other player in the preceding period.

TOUGH OR SOFT BARKLEY MANAGERS

FIGURE 12.14

Tough or Soft Barkley Managers

A. Barkley managers are tough.

Barkley's strategies		Allied's strategies: Enter the market	Allied's strategies: Do not enter the market
	Fight (price low)	6, 2	8, 3
	No fight (price high)	5, 4	2, 3

B. Barkley managers are soft.

Barkley's strategies		Allied's strategies: Enter the market	Allied's strategies: Do not enter the market
	Fight (price low)	2, 2	3, 3
	No fight (price high)	4, 4	7, 3

Copyright @ W.W. & Company 2013

REPUTATION BUILDING

- Reputation is a rent-generating asset.
  - Reputation requires a time horizon and incomplete information.
  - Reputation is based on a player’s history of behavior and involves inferring future behavior based on past behavior.

CAN RATING AGENCIES IMPROVE A BANK'S CAPITAL STRUCTURE?

		Bank A	
		HIGH capital	LOW capital
Bank B	HIGH capital	50, 50	10, 60
	LOW capital	**60**, 10	**20**, 20

Copyright @ W.W. & Company 2013

CAN RATING AGENCIES IMPROVE A BANK'S CAPITAL STRUCTURE?

		Bank A	
		HIGH capital	LOW capital
Bank B	HIGH capital	**50**, 50	**10**, 45
	LOW capital	45, 10	5, 5

Managerial Economics, 8e
Copyright @ W.W. & Company 2013

COORDINATION GAMES

- Coordination games have more than one Nash equilibrium, and the players' problem is which one to select.
- Matching Games
  - Two Nash equilibria
  - Problems in coordination arise from players' inability to communicate, players with different strategic models, and asymmetric information.

COORDINATION GAMES

- Matching Games (cont'd)
  - Figure 12.15: Product Coordination Game
    - Nash equilibrium is for one firm to produce for the industrial market and the other firm to produce for the consumer market.
    - Both firms would prefer the equilibrium with the higher payoff.

PRODUCT COORDINATION GAME

FIGURE 12.15

Product Coordination Game

		Allied's strategies	
		Produce for consumer market	Produce for industrial market
Barkley's strategies	Produce for consumer market	0, 0	7, 7
	Produce for industrial market	12, 12	0, 0

Managerial Economics, 8e
Copyright @ W.W. & Company 2013

COORDINATION GAMES

- Battle of the Sexes
  - Two Nash equilibria
  - Players prefer different equilibria.
  - Figure 12.16: Battle of the Sexes
    - Nash equilibrium is for to one to produce the high-end product and the other to produce the low-end product.
    - Both players prefer to produce the high-end product.

BATTLE OF THE SEXES

FIGURE 12.16

Battle of the Sexes

		Allied's strategies	
		High-end product	Low-end product
Barkley's strategies	High-end product	0, 0	11, 6
	Low-end product	6, 11	0, 0

Copyright @ W.W. & Company 2013

COORDINATION GAMES

- Figure 12.17: Stag Hunt or Assurance Games
  - Outcome (12, 12) is Pareto dominant, since both players are better off, but it is risk dominated because if one firm decides to shift and the other does not, then the player that shifts receives a payoff of zero.
  - Achieving the Pareto-dominant solution requires cooperation and trust because of the risk of reneging.

STAG HUNT OR ASSURANCE GAME

FIGURE 12.17

Stag Hunt or Assurance Game

		Allied's strategies	
		Stay with old standard	Shift to new standard
Barkley's strategies	Stay with old standard	6, 6	6, 0
	Shift to new standard	0, 6	12, 12

Copyright @ W.W. & Company 2013

COORDINATION GAMES

- First-Mover Games
  - Two Nash equilibria
  - Players prefer different equilibria.
  - Figure 12.18 First-Mover Advantage
    - Nash equilibrium is for one firm to produce the superior product and the other to produce the inferior product.
    - Both firms want to produce the superior product, which yields the higher payoff, by moving first.
    - Barkley is predicted to move first because the payoff is higher for Barkley and therefore Barkley can afford to spend more to speed up development.

FIRST–MOVER ADVANTAGE

FIGURE 12.18

First–Mover Advantage

		Allied's strategies	
		Produce superior product	Produce inferior product
Barkley's strategies	Produce superior product	25, 50	110, 70
	Produce inferior product	30, 140	20, 30

Copyright @ W.W. & Company 2013

COORDINATION GAMES

- First-Mover Games
  - Hawks and Doves
    - Two Nash equilibria
    - Players prefer different equilibria.
    - Figure 12.19: Hawks and Doves
      - Nash equilibrium is for one player to behave like a hawk and the other to behave like a dove.
      - Both players want to behave like a hawk, which yields the higher payoff.
      - If both players act like hawks, conflict ensues.

HAWKS AND DOVES

FIGURE 12.19

Hawks and Doves

		Country 1 strategy	
		Act like a hawk	Act like a dove
Country 2 strategy	Act like a hawk	−1, −1	10, 0
	Act like a dove	0, 10	5, 5

Copyright @ W.W. & Company 2013

STRICTLY COMPETITIVE GAMES

- Zero-sum games: A competitive game in which any gain by one player means a loss by another player
- Figure 12.20: Advertising Campaigns
  - Nash equilibrium is for Barkley to choose campaign 2 and for Allied to choose campaign A.

ADVERTISING CAMPAIGNS

FIGURE 12.20

Advertising Campaigns

		Allied		
		Campaign A	Campaign B	Campaign C
Barkley	Campaign 1	−5, 5	20, −20	−22, 22
	Campaign 2	−3, 3	7, −7	4, −4
	Campaign 3	−4, 4	−6, 6	17, −17

Copyright @ W.W. & Company 2013