CHAPTER 9

ECONOMICS OF STRATEGY: GAME THEORY

CHAPTER SUMMARY

This is the second chapter on the economics of strategy. Chapter 8 concentrates on the basic economics of value creation and capture, and the effects of competition in the marketplace. Chapter 9 uses game theory to analyze in greater detail interaction among a set of identifiable rivals. The chapter begins with an examination of simultaneous move games with nonrepeated interaction. Both pure and mixed strategies are presented. The chapter moves on to discuss sequential and repeated interactions. Repeated interactions are analyzed in greater detail in the appendix. Managerial implications are highlighted throughout the chapter and a mini-case is presented for discussion.

CHAPTER OUTLINE

GAME THEORY
  Academic Application: Game Theorists Win the Nobel Prize

SIMULTANEOUS-MOVE, NONREPEATED INTERACTION
  Analyzing the Payoffs
  Dominant Strategies
    Managerial Application: Stocklifting—A Dominant Strategy?
  Nash Equilibrium Revisited
    Nash Equilibrium
    Identifying a Nash Equilibrium
    Management Implications
    Academic Application: Are Nash Equilibria Likely?
  Competition versus Coordination
    Managerial Application: Coordination Problems with HDTV
    Managerial Application: Indian Ice Cream Wars
  Mixed Strategies
    Academic Application: A Mixed Strategy at Wimbledon
  Managerial Implications
    Managerial Application: Failure to Consider Strategic Interactions—The Paper Industry

SEQUENTIAL INTERACTION
  Extensive Form
  Backward Induction
  First-Mover Advantage
    Managerial Application: First-Mover Advantage—Walmart
  Strategic Moves
    Credibility
  Managerial Implications
    Managerial Application: Strategic Behavior—NBA
REPEATED STRATEGIC INTERACTION  
Managerial Application: It Pays to Think Sequentially  
Managerial Application: Boeing and Airbus Accused of Price Collusion

STRATEGIC INTERACTION AND ORGANIZATIONAL ARCHITECTURE  
Managerial Application: Auditing—A Mixed-Strategy Equilibrium

SUMMARY  
Managerial Application: Key Managerial Insights from Game Theory

APPENDIX: REPEATED INTERACTION AND THE TEAMMATES’ DILEMMA  
The Example  
Managerial Implications  
Appendix Problem

TEACHING THE CHAPTER

This chapter provides extended coverage of game theory, which is initially introduced in Chapter 6. Although the prisoner’s dilemma and Nash equilibrium are not new in this chapter, students will likely benefit from a review of these concepts before beginning coverage of the rest of the chapter. It is important for students to understand the differences between concepts in the chapter, but it is equally important for students to understand why this particular concept is different from the way firm’s decisions were analyzed in other chapters. What does this particular concept take into consideration that the analyses of other market structures do not? Rivals’ responses. The text provides numerous examples that can be covered or reviewed during class. The self-evaluation problems at the end of the chapter can be assigned as a group project during class so you can quickly determine whether students are learning the concepts. Since these problems have answers included at the end of the chapter, students can quickly determine on their own whether they understand the material and determine if they have questions. The review problems at the end of the chapter can also be assigned as a group project, since these answers are not included in the text, you will be able to determine whether they fully understand the material.

One of the most difficult concepts in the chapter is that of mixed strategies. Depending upon the goal of the instructor and the background of the students, you may want to spend more or less time on this topic. Students who do not have as much exposure to game theory or who are not as technically inclined will likely struggle with this topic. Students will benefit from doing a variety of problems so they can see how the structure of the game affects the equilibrium outcome (e.g., simultaneous move versus sequential move games).

The appendix offers a more complex scenario for those who would like to provide extended coverage of the topic. Full coverage of the appendix might be beyond the scope of some classes, however, many of the points can still be covered if they payoffs of the matrix are taken as given.

It is important to reiterate the points made in the final managerial application of the chapter:
**Understand your business setting.** Identify the relevant set of rivals and the nature of their interaction. What are their potential actions? What information will they have when they choose their actions? What are the consequences of their various actions? Is similar interaction among these rivals likely to be repeated either over time or across other markets?

**Place yourself behind your rival’s desk.** Absent specific reasons to believe otherwise, assume that your rival is knowledgeable, thoughtful, and purposeful, and ensure that your forecast of its future actions are consistent with that assumption.

**Look forward, reason backward.** Consider the entire sequence of decisions that are likely to be made over the course of this interaction. Look forward to the ultimate set of potential outcomes and then reason backward to determine your best strategy. This process identifies critical choices that your rivals face and highlights why you should understand the basis for their choices.

**With a first-mover advantage, move first.** If the business setting does not naturally permit you to implement your action first, consider whether you can credibly precommit to a particular action. Effective precommitment, by convincing your rivals of your future actions, can induce them to change their actions. This logic highlights the fact that maintaining flexibility undercuts your ability to precommit — in this sense, flexibility can be quite expensive.

**With a second-mover advantage, avoid moving first.** Delay implementation of actions where possible. Try to reduce the predictability of your actions. Finally, if you have to implement an action, maintain as much future flexibility to change your actions as possible.

**Repetition facilitates cooperation.** With repeated interaction among a given group of rivals, a broader array of choices typically is appropriate. Some form of cooperation is more likely where interaction is expected to be repeated either over time or across markets.

There are three *Analyzing Managerial Decisions* scenarios presented in this chapter. The first, “Favoring a Government Ban on Advertising”, asks students to construct a simple two person game to explain why companies might support this ban. This problem is a basic game theory application; however, students might struggle with having to design their own game if they have had only limited exposure to game theory previously. The second scenario, “Let’s Make a Deal,” uses the format of the popular game show to have students consider how they should respond to a rival’s actions. Students must consider what information they can learn from their rival’s behavior and determine how they can use this information to their advantage. The third scenario, “Holland Sweetener versus Monsanto,” is a comprehensive problem that asks students to not only derive the payoff matrix and determine the Nash equilibrium, but also to consider the entire scenario that affected the payoffs of the game. (See the Solutions Manual for the answers to these problems).
APPENDIX PROBLEM

The BQM Company frequently restructures. Employees regularly are transferred among departments and given different job assignments. Management argues that this action promotes a better trained and more responsive workforce. Do you see potential problems with this type of frequent restructuring? Does this mean that BQM is making a mistake? Explain.

One potential problem with this policy is that employees are less likely to form long-term relationships with co-workers. As discussed in the chapter, long-run relationships can promote cooperation and teamwork. This argument does not necessarily imply that BQM is making a mistake. The costs have to be compared to the benefits (such as the higher cross-trained workforce). To limit the costs, the company might accompany the frequent restructurings with policies that promote reputational concerns among co-workers. For example, if the performance of an employee on a given assignment is communicated to supervisors and co-workers at future job assignments, the employee will have increased incentives to avoid shirking.

REVIEW QUESTIONS

9–1. Some manufacturers that contract with the United States government have most favored nation clauses in their contracts. This provision makes the firm sell to the government at the lowest price it charges to any other customer. On the surface this provision seems to be advantageous to the government because it assures them the lowest price charged to any customer. Others argue, however, that the clause gives manufacturers more power in bargaining with other buyers. Explain how this increased bargaining power might occur.

These clauses are potentially a strategic commitment device (in a sequential bargaining situation). Nongovernment buyers realize that because of the contract clause the manufacturer is unlikely to give them big price concessions. (If it does it will cost the manufacturer lots of money from subsequently having to lower the price to the government.) Thus, these buyers have limited incentives to spend resources to bargain for price concessions. Depending on alternative sources of supply they may simply agree to higher prices. Thus, certain manufacturers might want to include these clauses in their government contracts because they foresee the additional power that they will have in subsequent bargaining situations.
9–2. Suppose Microsoft can produce a new sophisticated software product. However, it wants to do so only if Intel produces high-speed microprocessors. Otherwise, the software will not sell. Intel, in turn, wants to produce high-speed microprocessors only if there is popular software on the market that requires high-speed processing. Is this a game of competition or coordination? What is the equilibrium?

This is a game of coordination. There are two pure strategy equilibria: (1) both produce, and (2) both fail to produce. The two companies would prefer the first equilibrium.

9–3. What is the relation between a dominant strategy and a Nash equilibrium?

All dominant strategies are Nash equilibria. However, not all Nash equilibria are dominant strategies. Dominant strategies are optimal no matter what the other party does. Nash equilibrium strategies are strategies that are individually optimal given the strategy of the other party.

9–4. In this chapter we gave an example of coordination problems in the market for HDTVs. Show the game in strategic form using hypothetical payoffs of your choice. Use the arrow technique to identify the equilibria.

These numbers will vary depending on the student’s example. In each case, however, the arrows technique should be used to identify two equilibria: joint production and joint nonproduction. See figure 9.3 for a related example.

9–5. Some foolish teenagers play “chicken” on Friday nights. Two teenagers drive their cars at each other at high speeds. The first to swerve to the side is the “chicken” and loses. If both swerve out of the way, they are both chickens and both lose. Neither of the drivers wants to get into an accident. It causes a significant loss in utility (possibly death). However, both do not want to be known as a chicken. This causes some loss in utility. What is the equilibrium of this game? Do you think the two drivers will necessarily produce an equilibrium outcome? Do you think the chances are better or worse for achieving an equilibrium outcome if the two players know each other? Explain. Do you think it matters whether the two players have played the game before? Explain.
There are two pure strategy equilibria in this game. In each case, one of the drivers will swerve while the other will not. Unfortunately, there is no guarantee that an equilibrium outcome will be observed. Indeed, sometimes teenagers die in this foolish game (presumably either person would have swerved had he guessed that the other would not). Presumably, teenagers are more likely to reach an equilibrium outcome if they have played the game before and/or if they know the other person (or his reputation in the game). Having played the game before and/or knowing the reputation of the other person will help each player to make more informed choices of his rival's behavior and an equilibrium outcome is more likely.

9–6. Two basketball players, Barbara and Juanita, are the best offensive players on the school’s team. They know if they “cooperate” and work together offensively—feeding the ball to each other, providing screens for the other player etc.—they can each score 12 points. If one player “monopolizes” the offensive game, while the other player “cooperates,” however, the player who monopolizes the offensive game can score 18 points, while the other player can only score 2 points. If both players try to monopolize the offensive game, they each score 8 points. Construct a payoff matrix for the players that captures the essence of the decision of Barbara and Juanita to cooperate or monopolize the offensive game. If the players play only once, what strategy do you expect the players to adopt? If the players expect to play in many games together, what strategy do you expect the players to adopt? Explain.
This is a standard Prisoner’s dilemma. The equilibrium is for both not to cooperate. They are more likely to cooperate if they expect to play many games together. In the long run both will benefit if they figure out how to cooperate. If they expect to play together more times, in contrast to the one-shot game, they have incentives to consider the long run gains from cooperation.

9–7. General Electric has frequently placed managers together to work on teams. Often the work assignment is only for a short period of time. General Electric makes sure that the quality of an employee’s performance on a given assignment is recorded and shared with future teams. Why do you think they do this?

Teammates often face “teammate” (prisoner’s) dilemmas. Each hopes that the others will work, while it is in the individual’s interests not to work. If all employees shirk, the entire company and team suffers. These dilemmas are more likely to be resolved productively with repeat interaction because employees are concerned about the long-run implications of their actions. General Electric’s policy can be viewed as a way to increase the long-run costs of shirking (even though the teams are short-lived) and thus make it more likely that employees will not shirk.

9–8. Some managers commit undetected fraud in producing financial statements. Presumably, if the auditors were really diligent and the penalties for fraud were high enough, there would be no fraud. Does this mean that the accounting firms are not doing a good enough job in auditing? Explain.

If auditors detected all fraud, it is unlikely that any fraud would be committed. In this case, the auditors would be spending too much money on fraud detection (since no one is cheating). In this situation, it is likely that a mixed strategy will be observed. The auditors randomly audit and the manager’s sometimes cheat.

9–9. A labor leader has announced that her union will go on strike unless you grant the workers a significant pay raise. You realize that a strike will cost you more money than the pay raise. Should you concede to the wage increase? Explain.

Not necessarily. It is important to ask if the threat by the labor leader is credible. Is it really in the interests of labor to strike if you do not concede to the wage increase? The labor union leader may simply be making an “idle threat” in an attempt to get you to make a wage concession.
9–10. Suppose you are one of two producers of tennis balls. Both you and your competitor have zero marginal costs. Total demand for tennis balls is

\[ P = 60 - Q \]

Where Q = the sum of the outputs of you and your competitor.

a. Suppose you are in this situation only once. You and your competitor have to announce your individual outputs at the same time. You expect your competitor to choose the Nash equilibrium strategy. How much will you choose to produce and what is your expected profit?

This is a standard Cournot problem introduced in Chapter 6. Each firm (yours and the other) takes each other’s output as given. Thus, each firm’s demand curve is given by \( P = (60-Q_i^*) - Q_j \), where \( Q_i^* \) is the expectation of the other firm’s output and \( Q_j \) is the firm’s own output. Each firm will set its marginal revenue equal to zero (its marginal cost) yielding: \( Q_j = 30 - .5 Q_i^* \). Since the problem is symmetric for both firms, the outputs will be the same in equilibrium. Substituting \( Q_j \) for \( Q_i^* \) and solving indicates that both firms will choose an output of 20. Given a combined output of 40, the price is 20 and profits for each firm are 400. Given this analysis you should choose a quantity of 20. Given you expect that the other firm will choose this output, you do worse by choosing any other output.

b. Now suppose that you have to announce your output before your competitor does. How much will you choose to produce? What is your expected profit? Is it an advantage or a disadvantage to move first? Explain.

If you get to choose the output first, you should look forward and think about what the other firm will do given your choice. You know from the above analysis that it will set \( Q_j = 30 - .5Q_i^* \), where \( Q_i^* \) is your announced output. Correspondingly, your demand in this case is: \( P = 60 - (Q_i + 30 - .5 Q_i) \) or \( P = 30 - .5Q_i \). Setting your marginal revenue equal to zero and solving yields an optimal quantity of 30. Your rival will choose 15 and the resulting price in the marketplace is 15. You end up making 450 in this case rather than 400 when you moved together. It is an advantage to move first in this situation. By pre-committing to an output of 30 your rival optimally reduces his to 15. The result is you make higher profits. This is not an equilibrium in the simultaneous game since you have an incentive to increase output even more if you think your rival is only going to produce 15 units.
9–11. You are considering placing a bid over the Internet in an eBay auction for a rare oriental rug. You are not a dealer in these rugs, and you do not have a precise estimate of its market value. You do not want to buy the rug for more than its market value. However, you would like to buy it if you can get it below the market value. You expect that many people will participate in the auction (including rug dealers). eBay asks that you give them the maximum bid you are willing to make. They will start low; whenever you are outbid, they will raise your bid just enough to lead the auction. eBay quits bidding on your behalf once your maximum price is reached. Your best guess at the market value is $1,000. What should you bid?

Given your lack of information about the true value, it may be best for you not to participate at all. You will only obtain the rug if you are the highest bidder. If no informed bidder is willing to bid more than you for the item, it is likely that you have over-bid (i.e., there is a “winner’s curse”).

9-12. Formulate the following situation as an extensive form game (using a game tree) and solve it using backward induction. Bingo Corporation and Canal Corporation are the only competitors in the electronic organizer industry. Bingo Corporation is considering an R&D investment to improve its product. Bingo can choose from three levels of investment: High, Medium, and Low. Following Bingo’s investment, Canal Corporation will have to choose between continuing to compete by selling its current product or undertaking an R&D project of its own. Canal can only choose one level of investment, so its choices are Invest or Not Invest. The net payoffs to Bingo if it invests High, Medium, or Low given that Canal chooses to Invest would be $50, $40, and $30, respectively, and the corresponding net payoffs to Canal would be $5, $10, and $15. On the other hand, the net payoffs to Bingo if it invests High, Medium, or Low given that Canal chooses to Not Invest would be $100, $80, and $60, respectively, and the corresponding net payoffs to Canal would be $0, $15, and $20. What will Bingo choose to do in equilibrium, and what will Canal’s response be?
This game can be expressed in extensive form (as a game tree) as follows:

![Game Tree Diagram]

Payoffs:
- Bingo: 60, 30, 80, 40, 100, 50
- Canal: 20, 15, 15, 10, 0, 5

**The equilibrium moves for Canal at the second stage and for Bingo at the first stage are in bold. The overall equilibrium is for Bingo to invest the Medium amount and for Canal to Not Invest.**