CHAPTER 13

Game Theory and Competitive Strategy

CHAPTER OUTLINE

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13.1 Gaming and Strategic Decisions

- **game** Situation in which players (participants) make strategic decisions that take into account each other's actions and responses.

- **payoff** Value associated with a possible outcome.

- **strategy** Rule or plan of action for playing a game.

- **optimal strategy** Strategy that maximizes a player's expected payoff.

If I believe that my competitors are rational and act to maximize their own payoffs, how should I take their behavior into account when making my decisions?

Determining optimal strategies can be difficult, even under conditions of complete symmetry and perfect information.

Noncooperative versus Cooperative Games

- **cooperative game** Game in which participants can negotiate binding contracts that allow them to plan joint strategies.

- **noncooperative game** Game in which negotiation and enforcement of binding contracts are not possible.

> *It is essential to understand your opponent’s point of view and to deduce his or her likely responses to your actions.*

Note that the fundamental difference between cooperative and noncooperative games lies in the *contracting possibilities.* In cooperative games, binding contracts are possible; in noncooperative games, they are not.

HOW TO BUY A DOLLAR BILL

A dollar bill is auctioned, but in an unusual way. The highest bidder receives the dollar in return for the amount bid. However, the second-highest bidder must also hand over the amount that he or she bid—and get nothing in return.

If you were playing this game, how much would you bid for the dollar bill?

Classroom experience shows that students often end up bidding more than a dollar for the dollar.

EXAMPLE 13.1 **ACQUIRING A COMPANY**

You represent Company *A*, which is considering acquiring Company *T*. You plan to offer cash for all of Company *T*'s shares, but you are unsure what price to offer. The value of Company *T* depends on the outcome of a major oil exploration project.

If the project succeeds, Company *T*'s value under current management could be as high as $100/share. *Company T will be worth 50 percent more under the management of Company A.* If the project fails, Company *T* is worth $0/share under either management. This offer must be made *now—before* the outcome of the exploration project is known.

You (Company A) will not know the results of the exploration project when submitting your price offer, but Company T will know the results when deciding whether to accept your offer. Also, Company T will accept any offer by Company A that is greater than the (per share) value of the company under current management.

You are considering price offers in the range $0/share (i.e., making no offer at all) to $150/share. *What price per share should you offer for Company T's stock?*

The typical response—to offer between $50 and $75 per share—is wrong. The answer is provided later in this chapter, but we urge you to try to find the answer on your own.

13.2 Dominant Strategies

- **dominant strategy** Strategy that is optimal no matter what an opponent does.

TABLE 13.1 PAYOFF MATRIX FOR ADVERTISING GAME

		Firm B	
		Advertise	**Don’t advertise**
Firm A	**Advertise**	10, 5	15, 0
	Don’t advertise	6, 8	10, 2

Advertising is a dominant strategy for Firm *A.* The same is true for Firm *B*: No matter what firm *A* does, Firm *B* does best by advertising. The outcome for this game is that *both firms will advertise*.

- **equilibrium in dominant strategies** Outcome of a game in which each firm is doing the best it can regardless of what its competitors are doing.

Unfortunately, not every game has a dominant strategy for each player.

TABLE 13.2 MODIFIED ADVERTISING GAME

		Firm 2	
		Advertise	**Don’t advertise**
Firm 1	**Advertise**	10, 5	10, 10
	Don’t advertise	6, 8	20, 2

Now Firm *A* has no dominant strategy. *Its optimal decision depends on what Firm B does.* If Firm *B* advertises, Firm *A* does best by advertising; but if Firm *B* does not advertise, Firm *A* also does best by not advertising.

13.3 The Nash Equilibrium Revisited

Dominant Strategies:	I’m doing the best I can no matter what you do. You’re doing the best you can no matter what I do.
Nash Equilibrium:	I’m doing the best I can given what you are doing. You’re doing the best you can given what I am doing.

THE PRODUCT CHOICE PROBLEM

Two new variations of cereal can be successfully introduced—provided that each variation is introduced by only one firm.

TABLE 13.3 PRODUCT CHOICE PROBLEM

		Firm 2	
		Crispy	**Sweet**
Firm 1	**Crispy**	–5, –5	10, 10
	Sweet	10, 10	–5, –5

In this game, each firm is indifferent about which product it produces—so long as it does not introduce the same product as its competitor. The strategy set given by the bottom left-hand corner of the payoff matrix is stable and constitutes a Nash equilibrium: Given the strategy of its opponent, each firm is doing the best it can and has no incentive to deviate.

THE BEACH LOCATION GAME

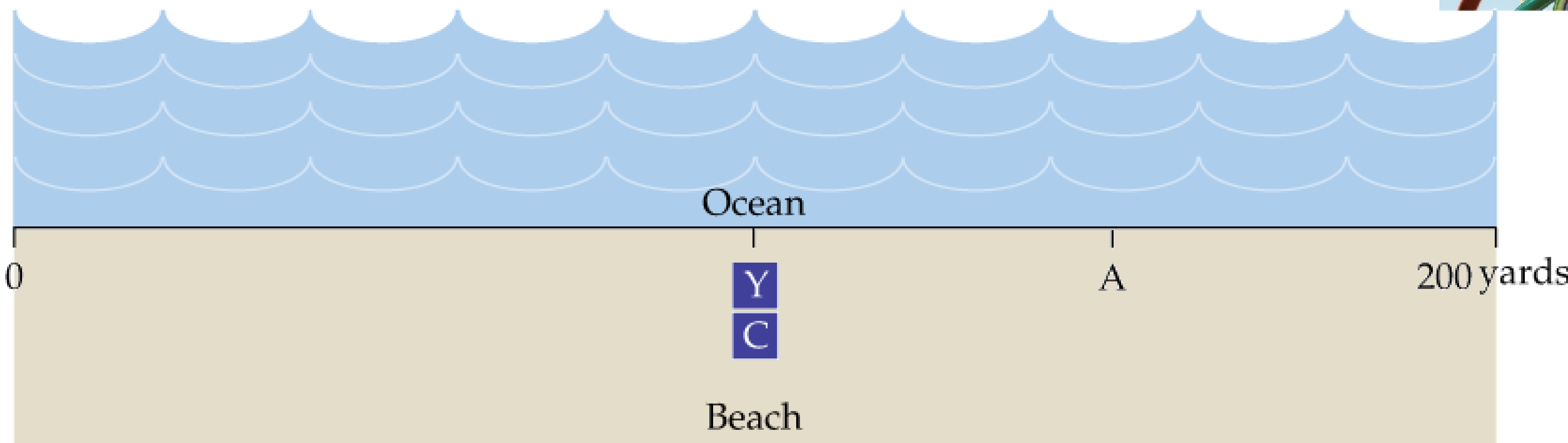


FIGURE 13.1

BEACH LOCATION GAME

You (*Y*) and a competitor (*C*) plan to sell soft drinks on a beach.

If sunbathers are spread evenly across the beach and will walk to the closest vendor, the two of you will locate next to each other at the center of the beach. This is the only Nash equilibrium.

If your competitor located at point *A*, you would want to move until you were just to the left, where you could capture three-fourths of all sales.

But your competitor would then want to move back to the center, and you would do the same.

Maximin Strategies

TABLE 13.4 MAXIMIN STRATEGY

		Firm 2	
		Don’t invest	**Invest**
Firm 1	**Don’t invest**	0, 0	–10, 10
	Invest	–100, 0	20, 10

In this game, the outcome (invest, invest) is a Nash equilibrium. But if you are concerned that the managers of Firm 2 might not be fully informed or rational—you might choose to play “don’t invest.” In that case, the worst that can happen is that you will lose $10 million; you no longer have a chance of losing $100 million.

- **maximin strategy** Strategy that maximizes the minimum gain that can be earned.

MAXIMIZING THE EXPECTED PAYOFF

If Firm 1 is unsure about what Firm 2 will do but can assign probabilities to each feasible action for Firm 2, it could instead use a strategy that *maximizes its expected payoff.*

THE PRISONERS’ DILEMMA

TABLE 13.5 PRISONERS’ DILEMMA

		Prisoner B	
		Confess	**Don’t confess**
Prisoner A	**Confess**	–5, –5	–1, –10
	Don’t confess	–10, –1	–2, –2

the ideal outcome is one in which neither prisoner confesses, so that both get two years in prison. Confessing, however, is a *dominant strategy* for each prisoner—it yields a higher payoff regardless of the strategy of the other prisoner.

Dominant strategies are also maximin strategies. The outcome in which both prisoners confess is both a Nash equilibrium and a maximin solution. Thus, in a very strong sense, it is rational for each prisoner to confess.

Mixed Strategies

- **pure strategy** Strategy in which a player makes a specific choice or takes a specific action.

MATCHING PENNIES

TABLE 13.6 MATCHING PENNIES

		Player B	
		Heads	**Tails**
Player A	**Heads**	1, –1	–1, 1
	Tails	–1, 1	1, –1

In this game, each player chooses heads or tails and the two players reveal their coins at the same time. If the coins match Player *A* wins and receives a dollar from Player *B*. If the coins do not match, Player *B* wins and receives a dollar from Player *A*.

Note that there is no Nash equilibrium in pure strategies for this game. No combination of heads or tails leaves both players satisfied—one player or the other will always want to change strategies.

- **mixed strategy** Strategy in which a player makes a random choice among two or more possible actions, based on a set of chosen probabilities..

Although there is no Nash equilibrium in pure strategies, there is a Nash equilibrium in mixed strategies.

In the matching pennies game, for example, Player *A* might simply flip the coin, thereby playing heads with probability 1/2 and playing tails with probability 1/2. In fact, if Player *A* follows this strategy and Player *B* does the same, we will have a Nash equilibrium: Both players will be doing the best they can given what the opponent is doing. Note that although the outcome is random, the *expected payoff* is 0 for each player.

It may seem strange to play a game by choosing actions randomly. But put yourself in the position of Player *A* and think what would happen if you followed a strategy other than just flipping the coin. Suppose you decided to play heads. If Player *B* knows this, she would play tails and you would lose. Even if Player *B* didn't know your strategy, if the game were played repeatedly, she could eventually discern your pattern of play and choose a strategy that countered it.

Once we allow for mixed strategies, every game has at least one Nash equilibrium.

THE BATTLE OF THE SEXES

TABLE 13.7 THE BATTLE OF THE SEXES

		Jim	
		Wrestling	**Opera**
Prisoner A	**Wrestling**	2, 1	0, 0
	Opera	0, 0	1, 2

There are two Nash equilibria in pure strategies for this game—the one in which Jim and Joan both watch mud wrestling, and the one in which they both go to the opera. This game also has an equilibrium in mixed strategies: Joan chooses wrestling with probability 2/3 and opera with probability 1/3, and Jim chooses wrestling with probability 1/3 and opera with probability 2/3.

Should we expect Jim and Joan to use these mixed strategies? Unless they're very risk loving or in some other way a strange couple, probably not. By agreeing to either form of entertainment, each will have a payoff of at least 1, which exceeds the expected payoff of 2/3 from randomizing.

13.4 Repeated Games

- **repeated game** Game in which actions are taken and payoffs received over and over again.

TABLE 13.8 PRICING PROBLEM

		Firm 2	
		Low price	**High price**
Firm 1	**Low price**	10, 10	100, –50
	High price	–50, 100	50, 50

Suppose this game is repeated over and over again—for example, you and your competitor simultaneously announce your prices on the first day of every month. Should you then play the game differently?

TIT-FOR-TAT STRATEGY

In the pricing problem above, the repeated game strategy that works best is the tit-for-tat strategy.

- **tit-for-tat strategy** Repeated-game strategy in which a player responds in kind to an opponent's previous play, cooperating with cooperative opponents and retaliating against uncooperative ones.

INFINITELY REPEATED GAME

When my competitor and I repeatedly set prices month after month, *forever,* cooperative behavior (i.e., charging a high price) is then the rational response to a tit-for-tat strategy. (This assumes that my competitor knows, or can figure out, that I am using a tit-for-tat strategy.) It is not rational to undercut.

With infinite repetition of the game, the *expected* gains from cooperation will outweigh those from undercutting. This will be true even if the probability that I am playing tit-for-tat (and so will continue cooperating) is small.

FINITE NUMBER OF REPETITIONS

Now suppose the game is repeated a *finite* number of times—say, *N* months. (*N* can be large as long as it is finite.) If my competitor (Firm 2) is rational *and believes that I am rational*.

In this case, both firms will not consider undercutting *until the last month,* before the game is over, so Firm 1 cannot retaliate.

However, Firm 2 *knows* that I will charge a low price in the last month. But then what about the next-to-last month? Because there will be no cooperation in the last month, anyway, Firm 2 figures that it should undercut and charge a low price in the next-to-last month. But, of course, I have figured this out too. In the end, the only rational outcome is for both of us to charge a low price every month.

TIT-FOR-TAT IN PRACTICE

The tit-for-tat strategy can sometimes work and cooperation can prevail. There are two primary reasons.

First, most managers don't know how long they will be competing with their rivals. The unravelling argument that begins with a clear expectation of undercutting in the last month no longer applies. As with an infinitely repeated game, it will be rational to play tit-for-tat.

Second, my competitor might have some doubt about the extent of my rationality. "*Perhaps,"* thinks my competitor, "Firm 1 will play tit-for-tat blindly, charging a high price as long as I charge a high price."

Just the *possibility* can make cooperative behavior a good strategy (until near the end) if the time horizon is long enough. Although my competitor's conjecture about how I am playing the game might be wrong, cooperative behavior is profitable *in expected value terms.* With a long time horizon, the sum of current and future profits, weighted by the probability that the conjecture is correct, can exceed the sum of profits from price competition, even if my competitor is the first to undercut.

Thus, in a repeated game, the prisoners' dilemma can have a cooperative outcome.

Sometimes cooperation breaks down or never begins because there are too many firms. More often, failure to cooperate is the result of rapidly shifting demand or cost conditions.

EXAMPLE 13.2 OLIGOPOLISTIC COOPERATION IN THE WATER METER INDUSTRY

For some four decades, almost all the water meters sold in the United States have been produced by four American companies: Rockwell International, Badger Meter, Neptune Water Meter Company, and Hersey Products.

Most buyers of water meters are municipal water utilities, who install the meters in order to measure water consumption and bill consumers accordingly.

With inelastic and stable demand and little threat of entry by new firms, the existing four firms could earn substantial monopoly profits if they set prices cooperatively. If, on the other hand, they compete aggressively, profits would fall to nearly competitive levels.

The firms thus face a prisoners' dilemma. Can cooperation prevail?

It can and *has* prevailed. There is rarely an attempt to undercut price, and each firm appears satisfied with its share of the market. All four firms have been earning returns on their investments that far exceed those in more competitive industries.

EXAMPLE 13.3 COMPETITION AND COLLUSION IN THE AIRLINE INDUSTRY

In March 1983, American Airlines proposed that all airlines adopt a uniform fare schedule based on mileage. This proposal would have done away with the many different fares then available. Most other major airlines reacted favorably to the plan and began to adopt it.

Was it really to “help reduce fare confusion”? No, the aim was to reduce price competition and achieve a collusive pricing arrangement. Prices had been driven down by competitive undercutting, as airlines competed for market share. The plan failed, a victim of the prisoners’ dilemma.

Each airline, therefore, has an incentive to lower fares in order to capture passengers from its competitors. In addition, the demand for air travel often fluctuates unpredictably. Such factors as these stand in the way of implicit price cooperation. Thus, aggressive competition has continued to be the rule in the airline industry. Discount airlines, reduction in fares in order to attract customers, and “fare shopping” in the Internet have forced several major airlines into bankruptcy and resulted in record losses for the industry.

13.5 Sequential Games

- **sequential game** Game in which players move in turn, responding to each other's actions and reactions.

The Stackelberg model discussed in Chapter 12 is an example of a sequential game; one firm sets output before the other does. There are many other examples of sequential games in advertising decisions, entry-deterring investment, and responses to government regulations.

In a sequential game, the key is to think through the possible actions and rational reactions of each player.

TABLE 13.9 MODIFIED PRODUCT CHOICE PROBLEM

		Firm 2	
		Crispy	**Sweet**
Firm 1	**Crispy**	–5, –5	10, 20
	Sweet	20, 10	–5, –5

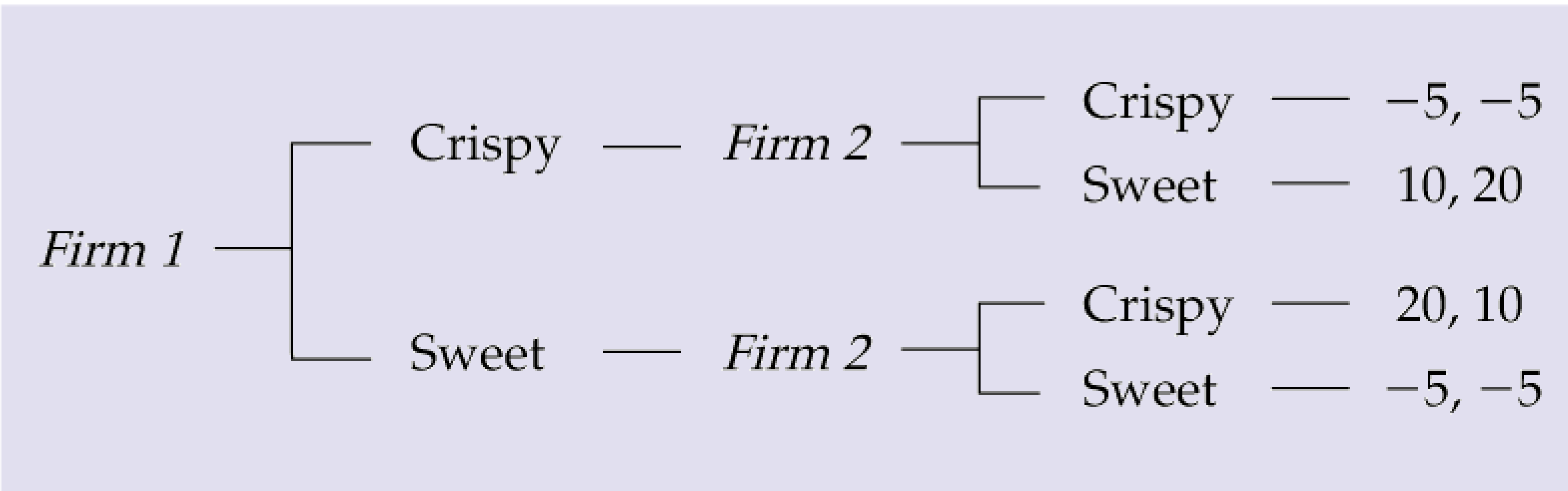
Suppose that both firms, in ignorance of each other's intentions, must announce their decisions independently and simultaneously. In that case, both will probably introduce the sweet cereal—and both will lose money. In a sequential game, Firm 1 introduces a new cereal, and then Firm 2 introduces one.

The Extensive Form of a Game

- **extensive form of a game** Representation of possible moves in a game in the form of a decision tree.

FIGURE 13.2

PRODUCE CHOICE GAME IN EXTENSIVE FORM



Although this outcome can be deduced from the payoff matrix in Table 13.9, sequential games are sometimes easier to visualize if we represent the possible moves in the form of a decision tree.

To find the solution to the extensive form game, work backward from the end.

The Advantage of Moving First

As in Chapter 12, we will use the example in which two duopolists face the market demand curve $P = 30 - Q$.

TABLE 13.10 CHOOSING OUTPUT

		FIRM 2		
		7.5	**10**	**15**
FIRM 1	**7.5**	112.50, 112.50	93.75, 125	56.25, 112.50
	10	125, 93.75	100, 100	50, 75
	15	112.50, 56.25	75, 50	0, 0

If both firms move simultaneously, the only solution to the game is that both produce 10 and earn 100. In this Cournot equilibrium each firm is doing the best it can given what its competitor is doing.

Compared to the Cournot outcome, when Firm 1 moves first, it does better—and Firm 2 does much worse.

13.6 Threats, Commitments, and Credibility

The product choice problem and the Stackelberg model are two examples of how a firm that moves first can create a *fait accompli* that gives it an advantage over its competitor.

In this section, we'll consider what determines *which* firm goes first. We will focus on the following question: *What actions can a firm take to gain advantage in the marketplace?*

Recall that in the Stackelberg model, the firm that moved first gained an advantage by *committing itself to a large output.* Making a commitment—constraining its future behavior—is crucial.

If Firm 2 knows that Firm 1 will respond by reducing the output that it first announced, Firm 2 would produce a large output. . The only way that Firm 1 can gain a first-mover advantage is by committing itself. In effect, *Firm 1 constrains Firm 2's behavior by constraining its own behavior.*

In the product-choice problem shown in Table 13.9, the firm that introduces its new breakfast cereal first will do best. Each has an incentive to *commit itself first to the sweet cereal.*

Firm 1 must constrain its own behavior in some way that convinces Firm 2 that Firm 1 has *no choice* but to produce the sweet cereal. Firm 1 might launch an expensive advertising campaign, or contract for the forward delivery of a large quantity of sugar (and make the contract public).

Firm 1 can't simply *threaten* Firm 2 because Firm 2 has little reason to believe the threat—and can make the same threat itself. A threat is useful only if it is credible.

Empty Threats

As in Chapter 12, we will use the example in which two duopolists face the market demand curve $P = 30 - Q$.

TABLE 13.11 PRICING OF COMPUTERS AND WORD PROCESSORS

		FIRM 2	
		High price	**Low price**
FIRM 1	**High price**	100, 80	80, 100
	Low price	20, 0	10, 20

As long as Firm 1 charges a high price for its computers, both firms can make a good deal of money. Firm 1 would prefer the outcome in the upper left-hand corner of the matrix. For Firm 2, however, charging a low price is clearly a dominant strategy. Thus the outcome in the upper right-hand corner will prevail (no matter which firm sets its price first).

Can Firm 1 induce Firm 2 to charge a high price by *threatening* to charge a low price if Firm 2 charges a low price? No. *Whatever* Firm 2 does, Firm 1 will be much worse off if it charges a low price. As a result, its threat is not credible.

Commitment and Credibility

TABLE 13.12 (a) PRODUCTION CHOICE PROBLEM

		Race Car Motors	
		Small cars	**Big Cars**
Far Out Engines	**Small engines**	3, 6	3, 0
	Big engines	1, 1	8, 3

Here we have a sequential game in which Race Car is the "leader." Race Car will do best by deciding to produce small cars. It knows that in response to this decision, Far Out will produce small engines, most of which Race Car will then buy. Can Far Out induce Race Car to produce big cars instead of small ones?

Suppose Far Out *threatens* to produce big engines. If Race Car believed Far Out's threat, it would produce big cars. But the threat is not credible. Far Out can make its threat credible by visibly and irreversibly reducing some of its own payoffs in the matrix, thereby constraining its own choices. It might do this by *shutting down or destroying some of its small engine production capacity.* This would result in the payoff matrix shown in Table 13.12(b).

Commitment and Credibility

TABLE 13.12 (b) MODIFIED PRODUCTION CHOICE PROBLEM

		Race Car Motors	
		Small cars	**Big Cars**
Far Out Engines	**Small engines**	0, 6	0, 0
	Big engines	1, 1	8, 3

Now Race Car *knows* that whatever kind of car it produces, Far Out will produce big engines. Now it is clearly in Race Car’s interest to produce large cars. By taking an action that *seemingly puts itself at a disadvantage*, Far Out has improved its outcome in the game.

Although strategic commitments of this kind can be effective, they are risky and depend heavily on having accurate knowledge of the payoff matrix and the industry. Suppose, for example, that Far Out commits itself to producing big engines but is surprised to find that another firm can produce small engines at a low cost. The commitment may then lead Far Out to bankruptcy rather than continued high profits.

THE ROLE OF REPUTATION

Developing the right kind of *reputation* can also give one a strategic advantage.

Suppose that the managers of Far Out Engines develop a reputation for being irrational—perhaps downright crazy. They threaten to produce big engines no matter what Race Car Motors does.

In gaming situations, the party that is known (or thought) to be a little crazy can have a significant advantage. Developing a reputation can be an especially important strategy in a repeated game.

A firm might find it advantageous to behave irrationally for several plays of the game. This might give it a reputation that will allow it to increase its long-run profits substantially.

Bargaining Strategy

TABLE 13.13 PRODUCTION DECISION

		Firm 2	
		Produce A	**Produce B**
Firm 1	**Produce A**	40, 5	50, 50
	Produce B	60, 40	5, 45

Here, the firms produce two complementary goods. Because producing *B* is a dominant strategy for Firm 2, (*A*, *B*) is the only Nash equilibrium.

Suppose, however, that Firms 1 and 2 are bargaining over to join a research consortium that a third firm is trying to form, and Firm 1 announces that it will join the consortium *only* if Firm 2 agrees to produce product *A.* In this case, it is indeed in Firm 2's interest to produce *A* (with Firm 1 producing *B*).

TABLE 13.14 DECISION TO JOIN CONSORTIUM

		Firm 2	
		Work alone	**Enter consortium**
Firm 1	**Work alone**	10, 10	10, 20
	Enter consortium	20, 10	40, 40

EXAMPLE 13.4 WAL-MART STORES' PREEMPTIVE INVESTMENT STRATEGY

How did Wal-Mart Stores succeed where others failed? The key was Wal-Mart's expansion strategy. To charge less than ordinary department stores and small retail stores, discount stores rely on size, no frills, and high inventory turnover.

Through the 1960s, the conventional wisdom held that a discount store could succeed only in a city with a population of 100,000 or more. Sam Walton disagreed and decided to open his stores in small Southwestern towns.

The stores succeeded because Wal-Mart had created 30 "local monopolies." Discount stores that had opened in larger towns and cities were competing with other discount stores, which drove down prices and profit margins. These small towns, however, had room for only one discount operation. There are a lot of small towns in the United States, so the issue became who would get to each town first. Wal-Mart now found itself in a *preemption game* of the sort illustrated by the payoff matrix in Table 13.15.

EXAMPLE 13.4 WAL-MART STORES' PREEMPTIVE INVESTMENT STRATEGY

TABLE 13.15 THE DISCOUNT STORE PREEMPTION GAME

		Company *X*	
		Enter	**Don't enter**
Wal-Mart	**Enter**	–10 , –10	20, 0
	Don't enter	0, 20	0, 0

This game has two Nash equilibria—the lower left-hand corner and the upper right-hand corner. Which equilibrium results depends on *who moves first*.

The trick, therefore, is to preempt—to set up stores in other small towns quickly, before Company *X* (or Company *Y* or *Z*) can do so. That is exactly what Wal-Mart did. By 1986, it had 1009 stores in operation and was earning an annual profit of $450 million. And while other discount chains were going under, Wal-Mart continued to grow. By 1999, Wal-Mart had become the world's largest retailer, with 2454 stores in the United States and another 729 stores in the rest of the world, and had annual sales of $138 billion.

In recent years, Wal-Mart has continued to preempt other retailers by opening new discount stores, warehouse stores (such as Sam's Club), and combination discount and grocery stores (Wal-Mart Supercenters) all over the world.

13.7 Entry Deterrence

To deter entry, *the incumbent firm must convince any potential competitor that entry will be unprofitable.*

TABLE 13.16 (a) **ENTRY POSSIBILITIES**

		Potential Entrant	
		Enter	**Stay out**
Incumbent	**High price (accommodation)**	100, 20	200, 0
	Low price (warfare)	70, –10	130, 0

If Firm *X* thinks you will be accommodating and maintain a high price after it has entered, it will find it profitable to enter and will do so.

Suppose you threaten to expand output and wage a price war in order to keep *X* out. If *X* takes the threat seriously, it will not enter the market because it can expect to lose $10 million. The threat, however, is not credible. As Table 13.16(a) shows, *once entry has occurred, it will be in your best interest to accommodate and maintain a high price.* Firm *X*'s rational move is to enter the market; the outcome will be the upper left-hand corner of the matrix.

TABLE 13.16 (b) **ENTRY DETERRENCE**

		Potential Entrant	
		Enter	**Stay out**
Incumbent	**High price (accommodation)**	50, 20	150, 0
	Low price (warfare)	70, –10	130, 0

If you can make an irrevocable commitment to invest in additional capacity, your threat to engage in competitive warfare is *completely credible.* With the additional capacity, you will do better in competitive warfare than you would by maintaining a high price. Meanwhile, having deterred entry, you can maintain a high price and earn a profit of $150 million.

If the game were to be *indefinitely repeated*, then the incumbent might have a *rational* incentive to engage in warfare whenever entry actually occurs. Why? Because short-term losses from warfare might be outweighed by longer-term gains from preventing entry.

Finally, by fostering an image of irrationality and belligerence, an incumbent firm might convince potential entrants that the risk of warfare is too high.

Strategic Trade Policy and International Competition

Given the virtues of free trade, how can government intervention in an international market ever be warranted? In certain situations, a country can benefit by adopting policies that give its domestic industries a competitive advantage.

By granting subsidies or tax breaks, the government can encourage domestic firms to expand faster than they would otherwise. This might prevent firms in other countries from entering the world market, so that the domestic industry can enjoy higher prices and greater sales.

Such a policy works by creating a credible threat to potential entrants. Large domestic firms, taking advantage of scale economies, would be able to satisfy world demand at a low price; if other firms entered, price would be driven below the point at which they could make a profit.

THE COMMERCIAL AIRCRAFT MARKET

Suppose that Boeing and Airbus (a European consortium that includes France, Germany, Britain, and Spain) are each considering developing a new aircraft. The ultimate payoff to each firm depends in part on what the other firm does. Suppose it is only economical for one firm to produce the new aircraft.

TABLE 13.17(a) DEVELOPMENT OF A NEW AIRCRAFT

		Airbus	
		Produce	**Don’t produce**
Boeing	**Produce**	–10, –10	100, 0
	Don’t produce	0, 100	0, 0

If Boeing has a head start in the development process, the outcome of the game is the upper right-hand corner of the payoff matrix.

European governments, of course, would prefer that Airbus produce the new aircraft. Can they change the outcome of this game? Suppose they commit to subsidizing Airbus and make this commitment before Boeing has committed itself to produce. If the European governments commit to a subsidy of 20 to Airbus if it produces the plane *regardless of what Boeing does*, the payoff matrix would change to the one in Table 13.17(b).

TABLE 13.17(b)	DEVELOPMENT OF AIRCRAFT AFTER EUROPEAN SUBSIDY		
		Airbus	
		Produce	**Don't produce**
Boeing	**Produce**	–10, –10	100, 0
	Don't produce	0, 120	0, 0

Boeing knows that even if it commits to producing, Airbus will produce as well, and Boeing will lose money. Thus Boeing will decide not to produce, and the outcome will be the one in the lower left-hand corner.

A subsidy of 20, then, changes the outcome from one in which Airbus does not produce and earns 0, to one in which it does produce and earns 120. Of this, 100 is a transfer of profit from the United States to Europe. From the European point of view, subsidizing Airbus yields a high return. European governments *did* commit to subsidizing Airbus, and during the 1980s, Airbus successfully introduced several new airplanes.

As commercial air travel grew, it became clear that both companies could profitably develop and sell new airplanes. Nonetheless, Boeing's market share would have been much larger without the European subsidies to Airbus.

EXAMPLE 13.5 DUPONT DETERS ENTRY IN THE TITANIUM DIOXIDE INDUSTRY

In the early 1970s, DuPont and National Lead each accounted for about a third of U.S. titanium dioxide sales. In 1972, DuPont was considering whether to expand capacity. New regulations and higher expected input prices would give DuPont a cost advantage. Because of these cost changes, DuPont anticipated that National Lead and some other producers would have to shut down part of their capacity. DuPont's competitors would in effect have to "reenter" the market by building new plants. Could DuPont deter them from taking this step?

DuPont considered the following strategy: invest nearly $400 million in increased production capacity—much more than what was actually needed. The idea was to *deter competitors from investing.*

Scale economies and movement down the learning curve would not only make it hard for other firms to compete, but would make credible the implicit threat that in the future, DuPont would fight rather than accommodate.

By 1975, however, things began to go awry. Demand grew by much less than expected, and environmental regulations were only weakly enforced, so competitors did not have to shut down capacity as expected. Finally, DuPont's strategy led to antitrust action by the Federal Trade Commission in 1978. The FTC claimed that DuPont was attempting to monopolize the market. DuPont won the case, but the decline in demand made its victory moot.

EXAMPLE 13.6 DIAPER WARS

For more than two decades, the disposable diaper industry in the United States has been dominated by two firms: Procter & Gamble and Kimberly-Clark. Competition, mostly in the form of *cost-reducing innovation* is intense. The key to success is to produce diapers in high volume and at low cost—about 3000 diapers per minute at about 10 cents per diaper. Improvements in the manufacturing process can result in a significant competitive advantage.

TABLE 13.18 COMPETING THROUGH R&D

		Kimberly-Clark	
		R&D	**No R&D**
P&G	**R&D**	40, 20	80, –20
	No R&D	–20 , 60	60, 40

Spending money on R&D is a dominant strategy.

In addition to brand name recognition, these two firms have accumulated so much technological knowhow and manufacturing proficiency that they would have a considerable cost advantage over any firm just entering the market.

13.8 Auctions

- **auction market** Market in which products are bought and sold through formal bidding processes.

Auctions are used for differentiated products, especially unique items that don’t have established market values, such as art, antiques, sports memorabilia and the rights to extract oil from a piece of land.

They are likely to be less time-consuming than one-on-one bargaining, and they encourage competition among buyers in a way that increases the seller’s revenue.

Auctions create large savings in transaction costs and thereby increases the efficiency of the market.

The design of an auction, which involves choosing the rules under which it operates, greatly affects its outcome. A seller will usually want an auction format that maximizes the revenue from the sale of the product. On the other hand, a buyer collecting bids from a group of potential sellers will want an auction that minimizes the expected cost of the product.

Auction Formats

- **English (**or **oral) auction** Auction in which a seller actively solicits progressively higher bids from a group of potential buyers.

- **Dutch auction** Auction in which a seller begins by offering an item at a relatively high price, then reduces it by fixed amounts until the item is sold.

- **sealed-bid auction** Auction in which all bids are made simultaneously in sealed envelopes, the winning bidder being the individual who has submitted the highest bid.

- **first-price auction** Auction in which the sales price is equal to the highest bid.

- **second-price auction** Auction in which the sales price is equal to the second-highest bid.

Valuation and Information

- **private-value auction** Auction in which each bidder knows his or her individual valuation of the object up for bid, with valuations differing from bidder to bidder.

- **common-value auction** Auction in which the item has the same value to all bidders, but bidders do not know that value precisely and their estimates of it vary.

Private-Value Auctions

In private-value auctions, bidders have different reservation prices for the offered item. For an open English auction, the bidding strategy is a choice of a price at which to stop bidding. For a Dutch auction, the strategy is the price at which the individual expects to make his or her only bid. For a sealed-bid auction, the strategy is the choice of bid to place in a sealed envelope. The payoff for winning is the difference between the winner's reservation price and the price paid; the payoff for losing is zero.

English oral auctions and second-price sealed-bid auctions generate nearly identical outcomes. In the second-price sealed-bid auction, bidding truthfully is a *dominant strategy*—there is no advantage to bidding below your reservation price. If you bid below your reservation price, you risk losing to the second-highest bidder. If you bid above your reservation price, you risk winning but receiving a negative payoff.

Similarly, in an English auction the dominant strategy is to continue bidding until the second person is unwilling to make a bid. Then the winning bid will be approximately equal to the reservation price of the second person. In any case, you should stop bidding *when the bidding reaches your reservation price.* If you continue beyond your reservation price, you will be guaranteed a negative payoff. Likewise, in the sealed-bid auction the winning bid will equal the reservation price of the second-highest bidder.

Common-Value Auctions

Suppose that you and four other people participate in an oral auction to purchase a large jar of pennies, which will go to the highest bid. Once you have estimated the number of pennies in the jar, what is your optimal bidding strategy? This is a classic common-value auction, because the jar has the same value for all bidders, but its value for you and other bidders is unknown.

You might be tempted to bid up to your own estimate of the number of pennies in the jar, and no higher, but this is not the best way to bid. If each bidder bids up to his or her estimate, *the winning bidder is likely to be the person with the largest positive error*—i.e., the person with the largest overestimate of the number of pennies.

THE WINNER'S CURSE

- **winner's curse** Situation in which the winner of a common-value auction is worse off as a consequence of overestimating the value of the item and thereby overbidding.

To avoid the winner's curse, you must reduce your maximum bid below your value estimate by an amount equal to the expected error of the winning bidder. The more precise your estimate, the less you need to reduce your bid. The winner's curse is more likely to be a problem in a sealed-bid auction than in a traditional English auction.

Maximizing Auction Revenue

Here are some useful tips for choosing the best auction format.

1. In a private-value auction, you should encourage as many bidders as possible.

2. In a common-value auction, you should (a) use an open rather than a sealed-bid auction because, as a general rule, an English (open) common-value auction will generate greater expected revenue than a sealed-bid auction; and (b) reveal information about the true value of the object being auctioned.

3. In a private-value auction, set a minimum bid equal to or even somewhat higher than the value to you of keeping the good for future sale.

In a common-value auction, the greater the uncertainty about the true value of the object, the greater the likelihood of an overbid, and therefore the greater the incentive for the bidder to reduce his bid.

However, the bidder faces less uncertainty in an English auction than in a sealed-bid auction because he can observe the prices at which other bidders drop out of the competition

Bidding and Collusion

Buyers can increase their bargaining power by reducing the number of bidders or the frequency of bidding. In some cases this can be accomplished legally through the formation of buying groups, but it may also be accomplished illegally through collusive agreements that violate the antitrust laws.

Collusion among buyers is not easy, because even if an “agreement” is reached, individual buyers will have an incentive to cheat by increasing their bids at the last minute in order to obtain the desired item. However, repeated auctions allow for participants to penalize those that break from the agreement by outbidding the “cheater” again and again.

Buyer collusion is more of a problem in open-bid auctions than in the case of sealed bids because open auctions offer the best opportunity for colluding bidders to detect and punish cheating.

EXAMPLE 13.7 AUCTIONING LEGAL SERVICES

In the United States, plaintiff attorneys often bring cases in which they represent classes of individuals who were allegedly harmed by defendants' actions that adversely affect human health or well-being. The attorneys are typically paid on a contingent fee basis, which means they are paid nothing if they lose the case, or a percentage of the amount recovered, typically around 30%.

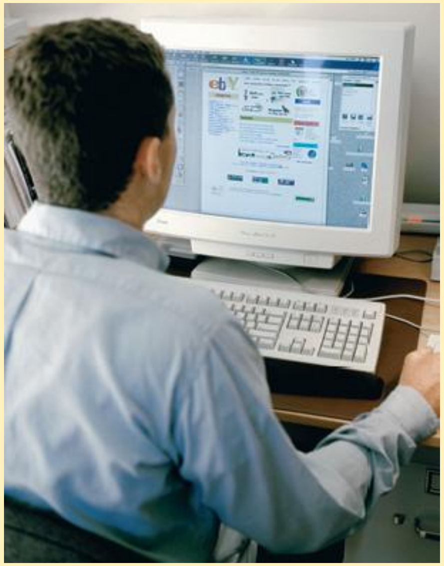
In some cases, the percentage fee awards have been seen as unreasonably large relative to the efforts made by the attorneys. What could be done about this? A number of federal judges had a solution: hold auctions in which attorneys bid for the right to represent the class of potential plaintiffs.

In a typical such auction, attorneys would offer a percentage fee as part of a sealed-bid process.

In one unusual auction following on a criminal verdict against auction houses Sotheby's and Christie's, Judge Lewis Kaplan of the Southern District of New York allowed law firms to offer a broader range of payment terms as part of their bids. It turned out that the winning bidder was the law firm of Boies, Schiller & Flexner. Months after taking the case, David Boies settled with defendants for $512 million, earning the attorneys a $26.75 million fee (25 percent of the $107 million excess over the minimum of $425 million) and generating just over $475 million for members of the class.

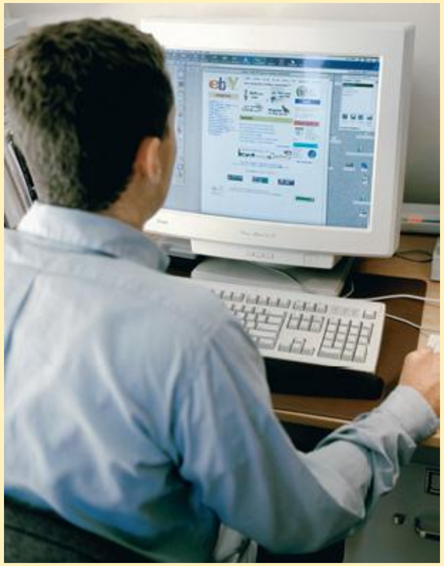
EXAMPLE 13.8 INTERNET AUCTIONS

The popularity of auctions has skyrocketed in recent years with the growth of the Internet. Indeed, the Internet has lowered transaction costs by so much that individuals anywhere in the world can now trade relatively low-value items without leaving the comfort of home. The most popular Internet auction site in the United States is **www.ebay.com**.



Internet auctions are subject to very strong *network externalities.* Both sellers and buyers gravitate to the auction site with the largest market share. In China, eBay had to compete with Taobao, whose managers decided not to charge sellers any commissions, so that most of its revenue was from advertising. While its revenue was limited by this strategy, Taobao quickly became the dominant Internet auction site in China. And eBay likewise lost out in Japan, this time to Yahoo! Japan Auctions, which aggressively obtained an early market share lead. The strong network effect then made it nearly impossible for eBay (or anyone else) to challenge Yahoo!'s dominance in Japan.

EXAMPLE 13.8 INTERNET AUCTIONS



eBay uses an increasing price auction which works roughly as follows: bids must be increased with minimum increments. The highest bidder at the close of the auction wins and pays the seller a price equal to the second-highest bid plus the minimum increment by which bids are increased. There is a fixed and known stopping time, which can cause bidders to place bids strategically at the end of the auction.

Many Internet auctions are dominated by private-value items. The emphasis of these auctions is on items of considerable value to particular bidders. You needn't worry so much about the prior history of bidding: The bids of others tell you about their preferences, but the value that you place on the object is personal to you. The winner's curse needn't be a concern: You can't be disappointed if your value for the object is more than what you paid for it.

eBay's profit from most auctions comes from the fees paid by the seller. The fee is like a tax. The burden of the fees will depend on the relative elasticities of demand and supply.

It is always possible that sellers may file spurious bids in order to manipulate the bidding process. Thus, "caveat emptor" (buyer beware) is a sound philosophy when buying items on the Internet.