OLIGOPOLY: MARKETS WITH ONLY A FEW SELLERS

- Because an oligopolistic market has only a small group of sellers, a key feature of oligopoly is the tension between cooperation and self-interest. The group of oligopolists is best off cooperating and acting like a monopolist—producing a small quantity of output and charging a price above marginal cost. Yet because each oligopolist cares only about its own profit, there are powerful incentives at work that hinder a group of firms from maintaining the monopoly outcome.

A DUOPOLY EXAMPLE

- To understand the behavior of oligopolies, let's consider an oligopoly with only two members, called a *duopoly*. Duopoly is the simplest type of oligopoly. Oligopolies with three or more members face the same problems as duopolies, so we do not lose much by starting with the simpler case.
- Imagine a town in which only two residents—Jack and Jill—own wells that produce water safe for drinking. Each Saturday, Jack and Jill decide how many gallons of water to pump, bring the water to town, and sell it for whatever price the market will bear. To keep things simple, suppose that Jack and Jill can pump as much water as they want without cost. That is, the marginal cost of water equals zero.

TABLE 1

The Demand Schedule for Water

Quantity	Price	Total Revenue (and total profit)
0 gallons	$120	$ 0
10	110	1,100
20	100	2,000
30	90	2,700
40	80	3,200
50	70	3,500
60	60	3,600
70	50	3,500
80	40	3,200
90	30	2,700
100	20	2,000
110	10	1,100
120	0	0

- Table 1 shows the town's demand schedule for water. The first column shows the total quantity demanded, and the second column shows the price. If the two well owners sell a total of 10 gallons of water, water goes for $110 a gallon. If they sell a total of 20 gallons, the price falls to $100 a gallon. And so on. If you graphed these two columns of numbers, you would get a standard downward-sloping demand curve.
- The last column in Table 1 shows the total revenue from the sale of water. It equals the quantity sold times the price. Because there is no cost to pumping water, the total revenue of the two producers equals their total profit.
- Let's now consider how the organization of the town's water industry affects the price of water and the quantity of water sold.

COMPETITION, MONOPOLIES, AND CARTELS

- Before considering the price and quantity of water that would result from the duopoly of Jack and Jill, let's discuss briefly what the outcome would be if the water market were either perfectly competitive or monopolistic. These two polar cases are natural benchmarks.
- If the market for water were perfectly competitive, the production decisions of each firm would drive price equal to marginal cost. Because we have assumed that the marginal cost of pumping additional water is zero, the

equilibrium price of water under perfect competition would be zero as well. The equilibrium quantity would be 120 gallons. The price of water would reflect the cost of producing it, and the efficient quantity of water would be produced and consumed.

- Now consider how a monopoly would behave. Table 1 shows that total profit is maximized at a quantity of 60 gallons and a price of $60 a gallon. A profit maximizing monopolist, therefore, would produce this quantity and charge this price. As is standard for monopolies, price would exceed marginal cost. The result would be inefficient, because the quantity of water produced and consumed would fall short of the socially efficient level of 120 gallons.
- What outcome should we expect from our duopolists?
- One possibility is that Jack and Jill get together and agree on the quantity of water to produce and the price to charge for it. Such an agreement among firms over production and price is called **collusion**, and the group of firms acting in unison is called a **cartel**.
- Once a cartel is formed, the market is in effect served by a monopoly, and we can apply our analysis from Chapter 15. That is, if Jack and Jill were to collude, they would agree on the monopoly outcome because that outcome maximizes the total profit that the producers can get from the market. Our two producers would produce a total of 60 gallons, which would be sold at a price of $60 a gallon. Once again, price exceeds marginal cost, and the outcome is socially inefficient.
- A cartel must agree not only on the total level of production but also on the amount produced by each member. In our case, Jack and Jill must agree on how to split between themselves the monopoly production of 60 gallons.

Each member of the cartel will want a larger share of the market because a larger market share means larger profit. If Jack and Jill agreed to split the market equally, each would produce 30 gallons, the price would be $60 a gallon, and each would get a profit of $1,800.

THE EQUILIBRIUM FOR AN OLIGOPOLY

- Oligopolists would like to form cartels and earn monopoly profits, but that is often impossible. Squabbling among cartel members over how to divide the profit in the market can make agreement among them difficult. In addition, antitrust laws prohibit explicit agreements among oligopolists as a matter of public policy.
- Even talking about pricing and production restrictions with competitors can be a criminal offense. Let's therefore consider what happens if Jack and Jill decide separately how much water to produce.
- At first, one might expect Jack and Jill to reach the monopoly outcome on their own, because this outcome maximizes their joint profit. In the absence of a binding agreement, however, the monopoly outcome is unlikely. To see why, imagine that Jack expects Jill to produce only 30 gallons (half of the monopoly quantity).
- Jack would reason as follows:

"I could produce 30 gallons as well. In this case, a total of 60 gallons of water would be sold at a price of $60 a gallon. My profit would be $1,800 (30 gallons × $60 a gallon). Alternatively, I could produce 40 gallons. In this case, a total of 70 gallons of water would be sold at a price of $50 a gallon. My profit would be $2,000 (40 gallons × $50 a gallon). Even though total

profit in the market would fall, my profit would be higher, because I would have a larger share of the market."

- Of course, Jill might reason the same way. If so, Jack and Jill would each bring 40 gallons to town. Total sales would be 80 gallons, and the price would fall to $40.
- Thus, if the duopolists individually pursue their own self-interest when deciding how much to produce, they produce a total quantity greater than the monopoly quantity, charge a price lower than the monopoly price, and earn total profit less than the monopoly profit.
- Although the logic of self-interest increases the duopoly's output above the monopoly level, it does not push the duopolists to reach the competitive allocation.
- Consider what happens when each duopolist is producing 40 gallons. The price is $40, and each duopolist makes a profit of $1,600. In this case, Jack's self interested logic leads to a different conclusion:

"Right now, my profit is $1,600. Suppose I increase my production to 50 gallons. In this case, a total of 90 gallons of water would be sold, and the price would be $30 a gallon. Then my profit would be only $1,500. Rather than increasing production and driving down the price, I am better off keeping my production at 40 gallons."

- The outcome in which Jack and Jill each produce 40 gallons looks like some sort of equilibrium. In fact, this outcome is called Nash equilibrium. (It is named after economic theorist John Nash, whose life was portrayed in the book and movie *A Beautiful Mind*.)
- **Nash equilibrium** is a situation in which economic actors interacting with one another each choose their best strategy given the strategies the others

have chosen. In this case, given that Jill is producing 40 gallons, the best strategy for Jack is to produce 40 gallons. Similarly, given that Jack is producing 40 gallons; the best strategy for Jill is to produce 40 gallons. Once they reach this Nash equilibrium, neither Jack nor Jill has an incentive to make a different decision.

- This example illustrates the tension between cooperation and self-interest. Oligopolists would be better off cooperating and reaching the monopoly outcome.
- Yet because they pursue their own self-interest, they do not end up reaching the monopoly outcome and maximizing their joint profit. Each oligopolist is tempted to raise production and capture a larger share of the market. As each of them tries to do this, total production rises, and the price falls. At the same time, self-interest does not drive the market all the way to the competitive outcome.
- Like monopolists, oligopolists are aware that increasing the amount they produce reduces the price of their product, which in turn affects profits. Therefore, they stop short of following the competitive firm's rule of producing up to the point where price equals marginal cost.
- In summary, *when firms in an oligopoly individually choose production to maximize profit, they produce a quantity of output greater than the level produced by monopoly and less than the level produced by competition. The oligopoly price is less than the monopoly price but greater than the competitive price (which equals marginal cost).*

HOW THE SIZE OF AN OLIGOPOLY AFFECTS THE MARKET OUTCOME

- We can use the insights from this analysis of duopoly to discuss how the size of an oligopoly is likely to affect the outcome in a market. Suppose, for instance, that John and Joan suddenly discover water sources on their property and join Jack and Jill in the water oligopoly.
- The demand schedule in Table 1 remains the same, but now more producers are available to satisfy this demand. How would an increase in the number of sellers from two to four affect the price and quantity of water in the town?
- If the sellers of water could form a cartel, they would once again try to maximize total profit by producing the monopoly quantity and charging the monopoly price. Just as when there were only two sellers, the members of the cartel would need to agree on production levels for each member and find some way to enforce the agreement. As the cartel grows larger, however, this outcome is less likely.
- Reaching and enforcing an agreement becomes more difficult as the size of the group increases. If the oligopolists do not form a cartel—perhaps because the antitrust laws prohibit it—they must each decide on their own how much water to produce.
- To see how the increase in the number of sellers affects the outcome, consider the decision facing each seller. At any time, each well owner has the option to raise production by 1 gallon. In making this decision, the well owner weighs two effects:
  - *The output effect:* Because price is above marginal cost, selling 1 more gallon of water at the going price will raise profit.
  - *The price effect:* Raising production will increase the total amount sold, which will lower the price of water and lower the profit on all the other gallons sold.

- If the output effect is larger than the price effect, the well owner will increase production. If the price effect is larger than the output effect, the owner will not raise production. (In fact, in this case, it is profitable to reduce production.)
- Each oligopolist continues to increase production until these two marginal effects exactly balance, taking the other firms' production as given.
- Now consider how the number of firms in the industry affects the marginal analysis of each oligopolist. The larger the number of sellers, the less each seller is concerned about its own impact on the market price. That is, as the oligopoly grows in size, the magnitude of the price effect falls. When the oligopoly grows very large, the price effect disappears altogether. That is, the production decision of an individual firm no longer affects the market price. In this extreme case, each firm takes the market price as given when deciding how much to produce.
- It increases production as long as price is above marginal cost. We can now see that a large oligopoly is essentially a group of competitive firms. A competitive firm considers only the output effect when deciding how much to produce: Because a competitive firm is a price taker, the price effect is absent.
- Thus, *as the number of sellers in an oligopoly grows larger, an oligopolistic market looks more and more like a competitive market. The price approaches marginal cost, and the quantity produced approaches the socially efficient level.*
- This analysis of oligopoly offers a new perspective on the effects of international trade. Imagine that Toyota and Honda are the only automakers in Japan, Volkswagen and BMW are the only automakers in Germany, and

Ford and General Motors are the only automakers in the United States. If these nations prohibited international trade in autos, each would have an auto oligopoly with only two members, and the market outcome would likely depart substantially from the competitive ideal.

THE ECONOMICS OF COOPERATION

- As we have seen, oligopolies would like to reach the monopoly outcome, but doing so requires cooperation, which at times is difficult to establish and maintain. In this section we look more closely at the problems that arise when cooperation among actors is desirable but difficult. To analyze the economics of cooperation,
- We need to learn a little about game theory.
- In particular, we focus on an important "game" called the **prisoners' dilemma**.
- This game provides insight into why cooperation is difficult. Many times in life, people fail to cooperate with one another even when cooperation would make them all better off. An oligopoly is just one example. The story of the prisoners' dilemma contains a general lesson that applies to any group trying to maintain cooperation among its members.

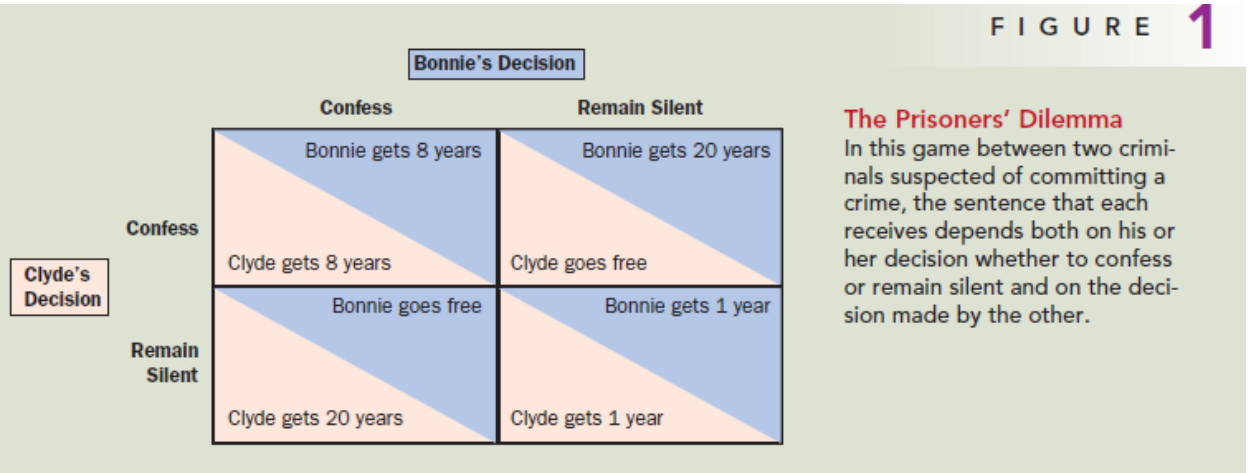
THE PRISONERS' DILEMMA

- The prisoners' dilemma is a story about two criminals who have been captured by the police. Let's call them Bonnie and Clyde.
- The police have enough evidence to convict Bonnie and Clyde of the minor crime of carrying an unregistered gun, so that each would spend a year in jail. The police also suspect that the two criminals have committed a bank

robbery together, but they lack hard evidence to convict them of this major crime. The police question Bonnie and Clyde in separate rooms, and they offer each of them the following deal:

"Right now, we can lock you up for 1 year. If you confess to the bank robbery and implicate your partner, however, we'll give you immunity and you can go free. Your partner will get 20 years in jail. But if you both confess to the crime, we won't need your testimony and we can avoid the cost of a trial, so you will each get an intermediate sentence of 8 years."

- If Bonnie and Clyde, heartless bank robbers that they are, care only about their own sentences, what would you expect them to do? Figure 1 shows their choices.



- Each prisoner has two strategies: confess or remain silent. The sentence each prisoner gets depends on the strategy he or she chooses and the strategy chosen by his or her partner in crime.
- Consider first Bonnie's decision. She reasons as follows: "I don't know what Clyde is going to do. If he remains silent, my best strategy is to confess, since then I'll go free rather than spending a year in jail. If he confesses, my

best strategy is still to confess, since then I'll spend 8 years in jail rather than 20. So, regardless of what Clyde does, I am better off confessing."

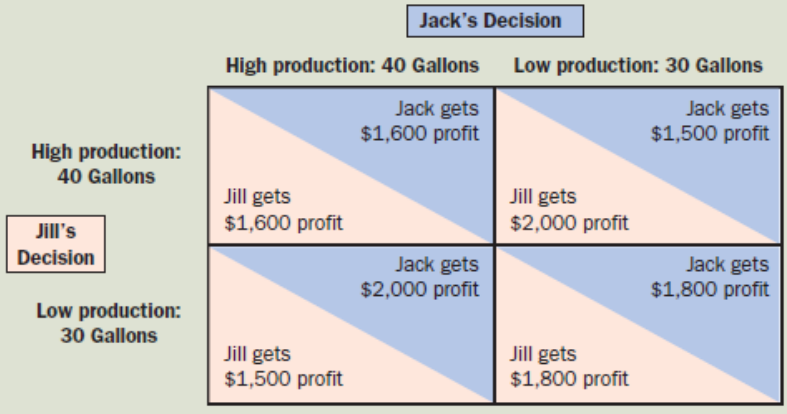
- In the language of game theory, a strategy is called a **dominant strategy** if it is the best strategy for a player to follow regardless of the strategies pursued by other players. In this case, confessing is a dominant strategy for Bonnie. She spends less time in jail if she confesses, regardless of whether Clyde confesses or remains silent.
- Now consider Clyde's decision. He faces the same choices as Bonnie, and he reasons in much the same way. Regardless of what Bonnie does, Clyde can reduce his jail time by confessing. In other words, confessing is also a dominant strategy for Clyde.
- In the end, both Bonnie and Clyde confess, and both spend 8 years in jail. Yet, from their standpoint, this is a terrible outcome. If they had *both* remained silent, both of them would have been better off, spending only 1 year in jail on the gun charge. Because each pursues his or her own interests, the two prisoners together reach an outcome that is worse for each of them.
- You might have thought that Bonnie and Clyde would have foreseen this situation and planned ahead. But even with advanced planning, they would still run into problems. Imagine that, before the police captured Bonnie and Clyde, the two criminals had made a pact not to confess. Clearly, this agreement would make them both better off *if* they both lived up to it, because they would each spend only 1 year in jail. But would the two criminals in fact remain silent, simply because they had agreed to? Once they are being questioned separately, the logic of self-interest takes over and leads them to confess. Cooperation between the two prisoners is difficult to maintain, because cooperation is individually irrational.

OLIGOPOLIES AS A PRISONERS' DILEMMA

- What does the prisoners' dilemma have to do with markets and imperfect competition?
- It turns out that the game oligopolists play in trying to reach the monopoly outcome is similar to the game that the two prisoners play in the prisoners' dilemma.
- Consider again the choices facing Jack and Jill. After prolonged negotiation, the two suppliers of water agree to keep production at 30 gallons, so that the price will be kept high and together they will earn the maximum profit. After they agree on production levels, however, each of them must decide whether to cooperate and live up to this agreement or to ignore it and produce at a higher level.

2 FIGURE

Jack and Jill's Oligopoly Game
In this game between Jack and Jill, the profit that each earns from selling water depends on both the quantity he or she chooses to sell and the quantity the other chooses to sell.



- Figure 2 shows how the profits of the two producers depend on the strategies they choose.
- Suppose you are Jack. You might reason as follows: "I could keep production low at 30 gallons as we agreed, or I could raise my production and sell 40 gallons.

- If Jill lives up to the agreement and keeps her production at 30 gallons, then I earn profit of $2,000 with high production and $1,800 with low production. In this case, I am better off with high production. If Jill fails to live up to the agreement and produces 40 gallons, then I earn $1,600 with high production and $1,500 with low production. Once again, I am better off with high production. So, regardless of what Jill chooses to do, I am better off reneging on our agreement and producing at a high level."
- Producing 40 gallons is a dominant strategy for Jack. Of course, Jill reasons in exactly the same way, and so both produce at the higher level of 40 gallons. The result is the inferior outcome (from Jack and Jill's standpoint) with low profits for each of the two producers. This example illustrates why oligopolies have trouble maintaining monopoly profits. The monopoly outcome is jointly rational for the oligopoly, but each oligopolist has an incentive to cheat. Just as self-interest drives the prisoners in the prisoners' dilemma to confess, self-interest makes it difficult for the oligopoly to maintain the cooperative outcome with low production, high prices, and monopoly profits.

OPEC AND THE WORLD OIL MARKET

- Our story about the town's market for water is fictional, but if we change water to crude oil, and Jack and Jill to Iran and Iraq, the story is close to being true. Much of the world's oil is produced by a few countries, mostly in the Middle East. These countries together make up an oligopoly. Their decisions about how much oil to pump are much the same as Jack and Jill's decisions about how much water to pump.
- The countries that produce most of the world's oil have formed a cartel, called the Organization of Petroleum Exporting Countries (OPEC). As

originally formed in 1960, OPEC included Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. By 1973, eight other nations had joined: Qatar, Indonesia, Libya, the United Arab Emirates, Algeria, Nigeria, Ecuador, and Gabon.

- These countries control about three fourths of the world's oil reserves. Like any cartel, OPEC tries to raise the price of its product through a coordinated reduction in quantity produced. OPEC tries to set production levels for each of the member countries.
- The problem that OPEC faces is much the same as the problem that Jack and Jill face in our story. The OPEC countries would like to maintain a high price of oil.
- But each member of the cartel is tempted to increase its production to get a larger share of the total profit. OPEC members frequently agree to reduce production but then cheat on their agreements.
- OPEC was most successful at maintaining cooperation and high prices in the period from 1973 to 1985. The price of crude oil rose from $3 a barrel in 1972 to $11 in 1974 and then to $35 in 1981. But in the mid-1980s, member countries began arguing about production levels, and OPEC became ineffective at maintaining cooperation. By 1986 the price of crude oil had fallen back to $13 a barrel.
- In recent years, the members of OPEC have continued to meet regularly, but the cartel has been less successful at reaching and enforcing agreements. Although the price of oil rose significantly in 2007 and 2008, the primary cause was increased demand in the world oil market, in part from a booming Chinese economy, rather than restricted supply. While this lack of cooperation among OPEC nations has reduced the profits of the oil-

producing nations below what they might have been, it has benefited consumers around the world.

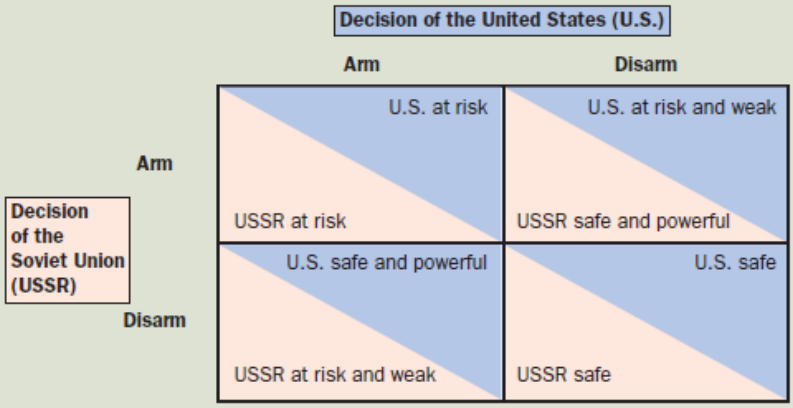
OTHER EXAMPLES OF THE PRISONERS' DILEMMA

- We have seen how the prisoners' dilemma can be used to understand the problem facing oligopolies. The same logic applies to many other situations as well. Here we consider two examples in which self-interest prevents cooperation and leads to an inferior outcome for the parties involved.
- **Arms Races** In the decades after World War II, the world's two superpowers— the United States and the Soviet Union—were engaged in a prolonged competition over military power. This topic motivated some of the early work on game theory. The game theorists pointed out that an arms race is much like the prisoners' dilemma.
- To see this, consider the decisions of the United States and the Soviet Union about whether to build new weapons or to disarm. Each country prefers to have more arms than the other because a larger arsenal would give it more influence in world affairs. But each country also prefers to live in a world safe from the other country's weapons.
- Figure 3 shows the deadly game. If the Soviet Union chooses to arm, the United States is better off doing the same to prevent the loss of power. If the Soviet Union chooses to disarm, the United States is better off arming because doing so would make it more powerful. For each country, arming is a dominant strategy. Thus, each country chooses to continue the arms race, resulting in the inferior outcome with both countries at risk.

- Throughout the era of the Cold War, the United States and the Soviet Union attempted to solve this problem through negotiation and agreements over arms control. The problems that the two countries faced were similar to those that oligopolists encounter in trying to maintain a cartel. Just as oligopolists argue over production levels, the United States and the Soviet Union argued over the amount of arms that each country would be allowed. And just as cartels have trouble enforcing production levels, the United States and the Soviet Union each feared that the other country would cheat on any agreement. In both arms races and oligopolies, the relentless logic of self-interest drives the participants toward a non cooperative outcome that is worse for each party.

FIGURE 3

An Arms-Race Game
In this game between two countries, the safety and power of each country depend on both its decision whether to arm and the decision made by the other country.

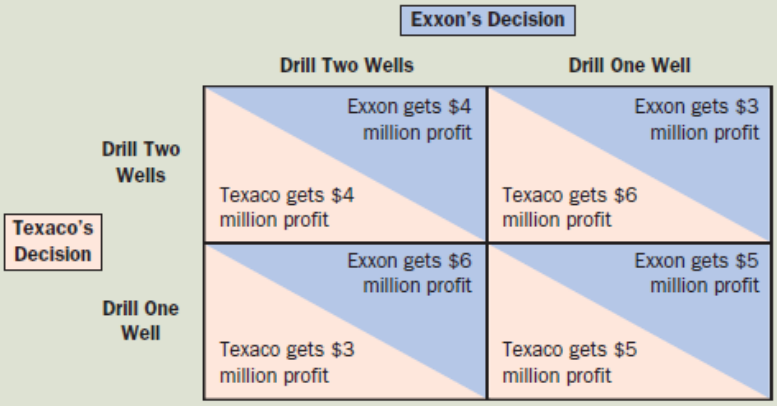


- **Common Resources** we saw that people tend to overuse common resources. One can view this problem as an example of the prisoners' dilemma.
- Imagine that two oil companies—Exxon and Texaco—own adjacent oil fields.
- Under the fields is a common pool of oil worth $12 million. Drilling a well to recover the oil costs $1 million. If each company drills one well, each will

get half of the oil and earn a $5 million profit ($6 million in revenue minus $1 million in costs). Because the pool of oil is a common resource, the companies will not use it efficiently. Suppose that either company could drill a second well. If one company has two of the three wells, that company gets two-thirds of the oil, which yields a profit of $6 million. The other company gets one-third of the oil, for a profit of$3 million. Yet if each company drills a second well, the two companies again split the oil. In this case, each bears the cost of a second well, so profit is only $4 million for each company.

- Figure 4 shows the game. Drilling two wells is a dominant strategy for each company. Once again, the self-interest of the two players leads them to an inferior outcome.

FIGURE 4



A Common-Resources Game
In this game between firms pumping oil from a common pool, the profit that each earns depends on both the number of wells it drills and the number of wells drilled by the other firm.