Chapter 9
Cartels

People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices.

Adam Smith, The Wealth of Nations (1776)

We have seen in previous chapters how equilibrium price is substantially higher in monopoly than in perfectly competitive markets. In this chapter, we begin to investigate how price and output are determined in oligopoly markets that lie between these polar extremes. There are two types of oligopoly models, those that assume cooperative behavior and those that assume noncooperative behavior. In this chapter, we focus on cooperative settings or cooperative games. In the next two chapters we discuss noncooperative models.

When firms within the same industry cooperate or collude, their goal is to maximize joint or industry profits, the sum of profits from every firm in the industry. Collusion can be explicit or tacit. **Explicit collusion** occurs when firms establish a formal cartel agreement that determines price or production levels. When firms coordinate without explicit communication, contract, or agreement, they are engaging in **tacit collusion**.[1] A group of firms that explicitly collude is called a **cartel**.

Collusion raises firm profits and is socially inefficient. For this reason, collusion is illegal in the USA and in most developed countries, as discussed in Chap. 1. Just because it is illegal does not mean that it does not occur, however. There are plenty of smart managers in search of higher profits who have tried to circumvent the law and collude with competitors. In the early twentieth century, for example, the head of the US Steel Company, Judge Elbert H. Gary, regularly hosted Sunday dinners

[1] It is sometimes called conscious parallelism, as firms make strategic moves in concert without being formal members of a cartel. Concert actions do not necessarily imply collusion, however, as competitive firms may behave in unison as well. For further discussion, see Scherer and Ross (1990, Chap. 9).

V.J. Tremblay and C.H. Tremblay, *New Perspectives on Industrial Organization*, Springer Texts in Business and Economics, DOI 10.1007/978-1-4614-3241-8_9,

with leaders from competing companies to discuss and set steel prices. In the 1950s, General Electric, Westinghouse, and several smaller companies colluded on the price of industrial electronic equipment. From 2000 to 2006, six companies participated in an international conspiracy to fix prices of liquid crystal display (LCD) panels. LCD panels are used in televisions, computer monitors, cell phones, iPods, and other electronic devices. Firms adversely affected include such companies as Apple, Dell, and Motorola (US Department of Justice 2008, 2009).

In the last 30 years, there are numerous examples where airline companies have attempted to collude on price. A dramatic example occurred in 1982 while American Airlines and Braniff Airways were in the midst of fierce price competition. On February 21, 1982, Robert Crandall, president of America, called Howard Putman, president of Braniff, to discuss price. This conversation was taped by Putman and went like this (New York Times, February 24 1983):

Crandall: I think it's dumb as hell for Christ's sake, all right, to sit here and pound the !@#$%! out of each other and neither one of us making a !@#$%! dime.
Putnam: Well...
Crandall: I mean, you know, !@#$%!, what the hell is the point of it?
Putnam: But if you're going to overlay every route of American's on top of every route that Braniff has—I just can't sit here and allow you to bury us without giving our best effort.
Crandall: Oh sure, but Eastern and Delta do the same thing in Atlanta and have for years.
Putnam: Do you have a suggestion for me?
Crandall: Yes, I have a suggestion for you. Raise your !@#$%! fares 20 percent. I'll raise mine the next morning.
Putnam: Robert, we...
Crandall: You'll make more money, and I will, too.
Putman: We can't talk about pricing!
Crandall: Oh !@#$%!, Howard. We can talk about any !@#$%! thing we want to talk about.

Although this conversation was not a violation of the Sherman Act because Putman never agreed to the offer, it illustrates how easy it can be to communicate an offer to collude.

If convicted of collusive behavior in the USA, firms are subject to huge fines which have increased steadily over the last decade and a half. Before 1994, the largest corporate fine was $6 million. Since 1996, however, 18 firms have been fined $100 million or more for price-fixing agreements (see Table 9.1). Total antitrust fines have increased by over 400% from 2000 to 2009, reaching $1 billion in 2009. In addition, individuals who violate US antitrust laws are being sent to jail more frequently today. In the 1990s, only 37% of violators were sentenced to jail. This number has risen steadily over the past 10 years, reaching 80% by 2009.[2]

[2] These data derive from Hammond (2005, 2010).

Table 9.1 Cartel violators yielding a corporate fine of $100 million or more

Defendant	Year	Product	Country	Fine ($ millions)
F. Hoffmann-La Roche	1999	Vitamins	Switzerland	500
LG Display Co. and LG Display America	2009	LCD panels	Korea	400
Societe Air France and KLM	2008	Air transportation	France/the Netherlands	350
Korean Air Lines	2007	Air transportation	Korea	300
British Airways	2007	Air transportation	UK	300
Samsung Electronics and Semiconductor	2006	DRAM	Korea	300
BASF AG	1999	Vitamins	Germany	225
HI MEI Optoelectronics	2010	LCD panels	Taiwan	220
Hynix Semiconductor	2005	DRAM	Korea	185
Infineon Technologies AG	2004	DRAM	Germany	160
SGL Carbon AG	1999	Graphite electrodes	Germany	135
Mitsubishi	2001	Graphite electrodes	Japan	134
Sharp	2009	LCD panels	Japan	120
Cargolux Airlines	2009	Air transportation	Luxembourg	119
Japan Airlines	2008	Air transportation	Japan	110
UCAR	1998	Graphite electrodes	USA	110
Lan Cargo SA and Aeorlinhas Brasileiras SA	2009	Air transportation	Chile/Brazil	109
Archer Daniels Midland	1996	Lycine and citric acid	USA	100

Source: US Department of Justice, Antitrust Division, http://www.usdoj.gov/atr

In this chapter, we will address four fundamental questions regarding the behavior of firms who form a cartel:

- What motivates firms to form a cartel, in spite of strict antitrust enforcement?
- How do firms make price and output decisions when they are members of a cartel?
- What are the welfare implications of cartels?
- What economic and institutional factors encourage or discourage cartel formation?

Once the economics of a cartel is understood, we will discuss the empirical evidence and provide several case studies of relatively successful cartels.

9.1 Cartel Theory

From the firm's perspective, the main purpose of a cartel is to earn greater profit by behaving cooperatively rather than competitively. If firms within an industry form a **perfect cartel**, all firms work together to maximize joint industry profits. In this section, we discuss how members of a perfect cartel behave and analyze the fundamental problems with establishing and maintaining an effective cartel.

9.1.1 Coordination: Output and Price Determination

When firms within an industry form a cartel, their goal is to maximize joint or industry profits with respect to their choice of price or output levels. To model this idea, we consider a simple oligopoly market with two firms (1 and 2), called a duopoly. Firms produce homogeneous products, and their choice variable is output.[3] Later we will discuss price competition and the effect of product differentiation.

To illustrate, consider a market where both inverse demand and cost functions are linear and take the following familiar form:

$$p = a - bQ, \tag{9.1}$$

$$\mathrm{TC}_i = cq_i, \tag{9.2}$$

where p is price, subscript i represents firm 1 or 2, q_i is firm i's output, $Q = q_1 + q_2$, and TC_i is firm i's total cost. For this specification, parameter a is the intercept of inverse demand, $-b$ is the slope of inverse demand, and c is average and marginal cost (which is the same for both firms). Parameters a, b, and c are positive, and $a - c > 0$. Equations (9.1) and (9.2) produce the following profit equation for firm i:

$$\begin{aligned}\pi_i &= \mathrm{TR}_i - \mathrm{TC}_i \\ &= pq_i - cq_i = (p - c)q_i \\ &= aq_i - bq_i^2 - bq_iq_j - cq_i,\end{aligned} \tag{9.3}$$

where TR_i is the total revenue of firm i and subscript j represents firm i's competitor.

The profit-maximizing problem facing the cartel is to choose q_1 and q_2 so as to maximize joint profits. Joint profits (Π) are defined as

$$\begin{aligned}\Pi &= \pi_1 + \pi_2 = (p - c)(q_1 + q_2) \\ &= \left(aq_1 - bq_1^2 - bq_1q_2 - cq_1\right) + \left(aq_2 - bq_2^2 - bq_2q_1 - cq_2\right).\end{aligned} \tag{9.4}$$

[3] This problem is identical to that of a multiplant monopolist, except that 1 and 2 refer to production plants, not firms, in the multiplant monopoly problem.

The solution to this problem requires that two first-order conditions hold:

$$\begin{aligned}\frac{\partial \Pi}{\partial q_1} &= \frac{\partial \pi_1}{\partial q_1} + \frac{\partial \pi_2}{\partial q_1} = \mathrm{MR}_1 - \mathrm{MC}_1 + E_1 \\ &= (a - 2bq_1 - bq_2) - c + (-bq_2) \\ &= a - 2bq_1 - 2bq_2 - c = 0, \end{aligned} \tag{9.5}$$

$$\begin{aligned}\frac{\partial \Pi}{\partial q_2} &= \frac{\partial \pi_1}{\partial q_2} + \frac{\partial \pi_2}{\partial q_2} = E_2 + \mathrm{MR}_2 - \mathrm{MC}_2 \\ &= (-bq_1) + (a - 2bq_2 - bq_1) - c \\ &= a - 2bq_1 - 2bq_2 - c = 0, \end{aligned} \tag{9.6}$$

where MR_i is firm i's marginal revenue, MC_i is firm i's marginal cost (c), and E_i is the external effect that an increase in q_i has on firm j's profits ($\partial \pi_j / \partial q_i = -bq_j$). Normally, we would solve these functions simultaneously to identify the optimal values of q_1 and q_2, but this is impossible here, because both first-order conditions are identical ($a - 2bq_1 - 2bq_2 - c = 0$) and cannot be solved for q_1 and q_2. Thus, a cartel faces a **coordination problem**: the output or market shares for each firm are not readily apparent.

Nevertheless, we are able to identify the optimal value of total output (Q^*). Substituting $q_1 = Q^* - q_2$ into the common first-order condition and solving for Q^* gives $Q^* = (a - c)/(2b)$. At this level of output, the cartel price is $p^* = (a + c)/(2)$ and cartel profits are $\Pi^* = (a - c)^2/(4b)$. Notice that this is simply the monopoly solution (see Chap. 6). Thus, firms in a cartel will produce the monopoly level of output, sell at the monopoly price, and earn (as an industry) monopoly profits. This is not surprising, because the goals of a cartel and a monopolist are the same: to maximize industry profits.[4] You can see why firms in relatively competitive markets

[4] We can see this by considering a more general model, where the objective is to maximize $\Pi = p(Q) \cdot Q - \mathrm{TC}_1 - \mathrm{TC}_2$ with respect to q_1 and q_2, where TC_i is firm i's total cost. The first-order conditions are

$$\frac{\partial \Pi}{\partial q_1} = p + \frac{\partial p}{\partial q_1} Q - \mathrm{MC}_1 = 0,$$

$$\frac{\partial \Pi}{\partial q_2} = p + \frac{\partial p}{\partial q_2} Q - \mathrm{MC}_2 = 0,$$

where MC_i is firm i's marginal cost. These conditions imply that the marginal revenue for the industry must equal marginal cost of production, whether produced by firm 1 or firm 2. Notice how the first-order condition for an individual firm that maximizes its own profit is different from the first equation above. For firm 1, the difference is that the second term within the equal signs in the first equation above would be multiplied by q_1 instead of Q. This means that when firm 1 considers increasing q_1, it pays attention to the effect that this has on the total revenue of the entire industry, rather than just its own total revenue, when it is a member of the cartel. Because $\partial p / \partial q_1$ and $Q > q_1$, the firm's marginal benefit of producing an additional unit of output is less under a cartel. Thus, each firm will produce less output in a cartel setting.

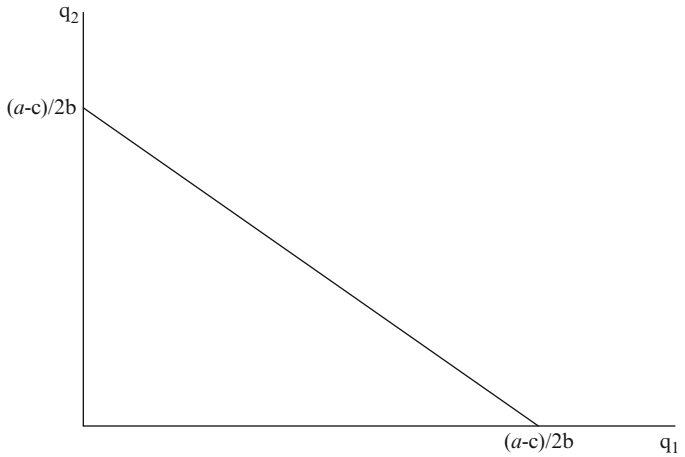

Fig. 9.1 Output combinations that maximize total industry profit in a cartel

would want to form a cartel, as industry profits generally increase as we move from a competitive to a monopoly outcome.

Given that the cartel and monopoly outcomes are the same, many of the insights of monopoly theory carry over to cartel theory. First, the solution will be the same, whether the choice variable is output or price. That is, the cartel solution remains the monopoly solution when firms cooperate on price instead of on output. Second, a cartel transfers wealth from consumers to producers. Third, a cartel outcome is allocatively inefficient and, therefore, socially undesirable. By cutting production below the competitive level, the cartel (or monopoly) price exceeds marginal cost, creating a deadweight or efficiency loss just like in monopoly.

One question still remains: how is output (and therefore profits) distributed among firms? The problem becomes more apparent when we look more closely at the common first-order condition. Solving either (9.5) or (9.6) for q_2 gives $q_2 = Q^* - q_1 = (a - c)/(2b) - q_1$. As depicted in Fig. 9.1, the function is linear, has a slope of -1, and intercepts of $(a - c)/(2b)$. The line identifies all values of q_1 and q_2 that sum to the monopoly level of output, $Q^* = (a - c)/(2b)$. We call this the **output-distribution line**. It indicates that firm 1's cartel level of output ranges from 0 to the monopoly level of output, given that $q_1 = Q^* - q_2$. Thus, the cartel agreement must specify both Q^* (or p^*) and the distribution of output among cartel participants. Once these are identified, the distribution of profits is determined.

We can illustrate the cartel's indeterminacy problem graphically with isoprofit equations. Firm 1's **isoprofit equation** describes all combinations of q_1 and q_2 that represent a constant level of profit, k, for firm 1. Solving firm 1's profit function in

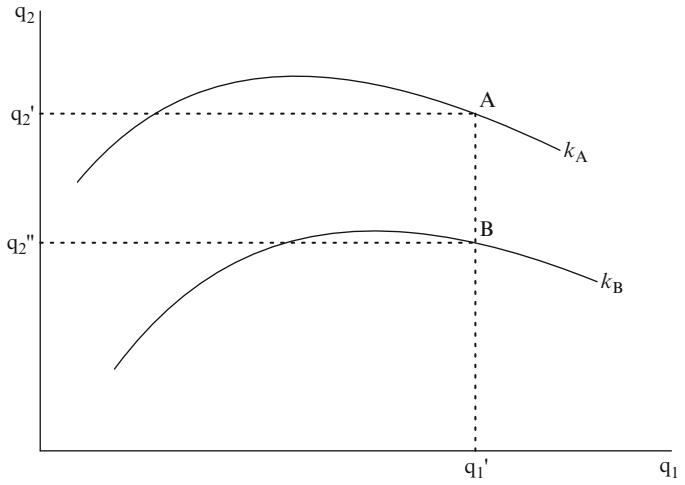

Fig. 9.2 Firm 1's isoprofit curves

(9.3) for q_2 produces its isoprofit equation: $q_2 = \left(aq_1 - cq_1 - bq_1^2 - k\right)/(bq_1)$.[5] Two isoprofit curves are illustrated in Fig. 9.2 for different values of k. Given that the isoprofit equation is quadratic, each curve is concave to the q_1 axis, with a lower isoprofit curve implying greater profits for firm 1 (i.e., $k_B > k_A$). The reason for this is that for a given value of q_1 (e.g., q_1'), firm 1's profits increase as q_2 falls (from q_2' to q_2''), as indicated by firm 1's profit equation above. Parallel results hold for firm 2; the only differences are that its isoprofit curve is concave to the q_2 axis and its profits are higher for isoprofit curves that are closer to the q_2 axis.

Joint profits are maximized when the isoprofit curves of firms 1 and 2 are tangent, which takes place on the output-distribution line. To illustrate, consider Fig. 9.3 where firm 1 produces q_{1x} (on isoprofit curve π_{1x}) and firm 2 produces q_{2x} (on isoprofit curve π_{2x}). This is not a cartel outcome because the output pair (q_{1x}, q_{2x}) is not on the output-distribution line. If both firms cut production equally, each firm would move to an isoprofit curve that is closer to its output axes. Thus, the profits of both firms, and therefore industry profits, would rise. Once a tangency is reached at point y, for example, it is impossible to raise industry profits by adjusting firm output, and firms are on the output-distribution line. In other words, industry profits reach a maximum when production takes place on the line and isoprofits are tangent.

Moving from one point to another on the output-distribution line simply redistributes production and profits between firms. Moving up and to the left raises firm 2's profits and lowers firm 1's profits. Moving down the line benefits firm 1 at the expense of firm 2. Taken together, this means that once the optimal distribution

[5] This equation maps out a curve that is much like an indifference curve in consumer theory and an isoquant in production theory. For an isoprofit function, profit is held constant rather than utility (in an indifference curve) or firm production (in an isoquant). For a review of indifference curves and isoquants, see Bernheim and Whinston (2008), Pindyck and Rubenfield (2009), or Varian (2010).

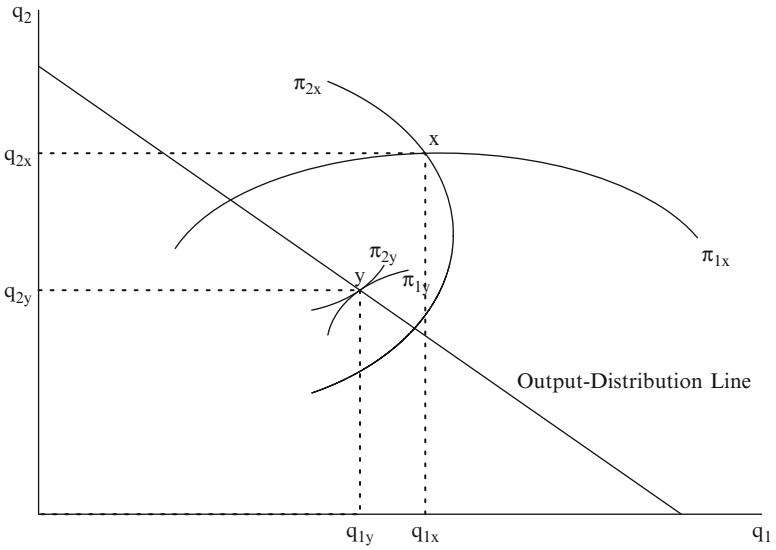

Fig. 9.3 Firm isoprofit curves and cartel output combinations

of output is determined, at q_{1y} and q_{2y} in this example, the distribution of profits is identified by isoprofits π_{1y} and π_{2y}.

9.1.2 The Fundamental Weakness of a Cartel: The Cartel Dilemma

A cartel is attractive to producers in all industries because it guarantees the highest possible profit for the industry (i.e., the monopoly profit). In spite of this fact, Stigler (1964) showed that cartels are surprisingly difficult to maintain in the long run. Although abiding by a cartel agreement produces the best outcome for the group, it is not profit maximizing for an individual firm. In our duopoly example, if firm *j* produces the cartel level of output, it is profit maximizing for firm *i* to produce more than the cartel level of output. Thus, firms have an incentive to cheat on the cartel agreement, which may induce firms to expand output and ignite a price war.[6] This is the **cartel dilemma**: what is in the best interest of the cartel is not in the best interest of individual firms.

Because this dilemma is so important, we illustrate it in three ways. First, we use a graph of the output-distribution line and isoprofit curves. Figure 9.4 depicts a symmetric cartel solution at point *y*, where respective output and isoprofit levels

[6] In a price war, each firm has an incentive to undercut the price of its competitor, which can lead to competitive pricing. We discuss the details of price undercutting in the next chapter.

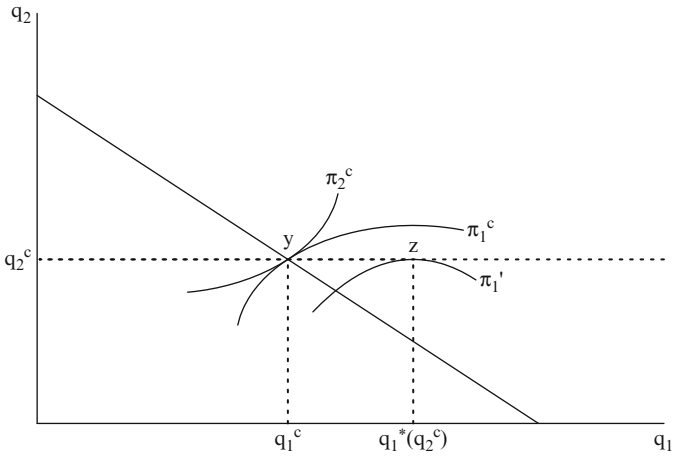

Fig. 9.4 Firm 1's best reply to firm 2's cartel level of output (q_2^c)

are q_1^c, q_2^c, π_1^c, and π_2^c. Notice that when firm 2 produces the cartel output of q_2^c, firm 1's best reply (i.e., its optimal response) is not q_1^c. Instead, firm 1 will choose the level of output that maximizes its profits, given that firm 2 holds output at q_2^c. The given output constraint of firm 2 is shown by the line passing from q_2^c through point y.

Firm 1's best reply to q_2^c is $q_1^*(q_2^c)$, which occurs where firm 1's isoprofit curve is tangent to the constraint line at point z. This increases firm 1's profits (i.e., $\pi_1' > \pi_1^c$) and causes firm 2's profits to decrease. The point is that when firm 2 produces the cartel level of output, firm 1's best reply is to produce more than the cartel level of output. The same argument applies to firm 2. This demonstrates Stigler's point that each firm has an incentive to cheat on the cartel agreement by increasing production.

Another way to illustrate this idea is with a concrete example. Consider our duopoly model above with linear demand and cost functions. For simplicity, assume that $a = 12$, $b = 1$, and $c = 0$. If we consider a symmetric outcome where production is distributed evenly between firms, then the cartel solution is

$$Q^* = 6; \quad q_i^* = \frac{Q^*}{2} = 3; \quad p^* = 6; \quad \pi_i^* = 18. \tag{9.7}$$

But if firm 1 produces 4 units of output and firm 2 continues to produce 3, then firm 1's profits increase to 20 and firm 2's profits fall to 15. Thus, industry profits fall from 36 to 35.[7] Even though firm 1 does better by boosting production beyond the cartel level, the industry is worse off. This is a classic externality problem.

[7] That is, when $q_1 = 4$ and $q_2 = 3$, firm 1's profit equals $(12 - q_1 - q_2)q_1 = 20$ and firm 2's profit equals $(12 - q_1 - q_2)q_2 = 15$.

Fig. 9.5 The cartel dilemma in a duopoly market

		Firm 2 3	**Firm 2** 4
Firm 1	3	18, 18	15, 20
	4	20, 15	16, 16

An increase in firm 1's production increases its profits even though it also leads to a lower price. This damages firm 2 (i.e., it imposes a negative externality on firm 2), because firm 2's output is fixed at 3. Assuming that firm 1 is concerned with its profits alone, it will ignore the damage it causes firm 2 and will step up production. The same argument applies to firm 2. Thus, a cartel dilemma exists, because each firm wants to push production beyond the cartel level.

The cartel dilemma is fundamentally the same as that of a prisoners' dilemma. These dilemma's occur when what is best for the group is not what is best for each individual player (whether prisoners or firms). The cartel dilemma is described by the payoff matrix in Fig. 9.5. The matrix is based on the example above except that a firm's only choice is to produce 3 units of output (the cartel level) or 4 units. Joint profits are maximized when both firms produce output of 3. Yet, each firm's dominant strategy is to produce 4. For example, if firm 2 produces 3 units, firm 1's best reply is to produce 4 units; if firm 2 produces 4 units, firm 1's best reply is to produce 4 units. Both firms have an incentive to produce more output than they would under a cartel agreement. Notice that the outcome where both firms produce 4 units of output is the dominant-strategy or Nash equilibrium that we discussed in Chap. 3.[8]

The most general way to demonstrate the cartel dilemma is to review the first-order conditions of the cartel's problem in (9.5) and (9.6), which imply that

$$\frac{\partial \pi_i}{\partial q_i} + \frac{\partial \pi_j}{\partial q_i} = 0. \tag{9.8}$$

Because an increase in q_i reduces the demand for j's product, $\partial \pi_j / \partial q_i < 0$. Thus, for the equality in (9.8) to hold, which is required to maximize joint profits, it must

[8] In the next chapter, we will see that this is a special type of Nash equilibrium, first investigated by Cournot (1838).

be true that $\partial \pi_i / \partial q_i > 0$ when evaluated at the cartel level of output. This means that when both firms produce the cartel level of output, firm i can increase its profits by producing more output. Just as before, each firm has an incentive to cheat on a cartel arrangement by increasing output.

With product differentiation, the problem is fundamentally the same. Consider the case with multicharacteristic differentiation. Firm i's inverse demand is $p_i = a - b \cdot q_i - d \cdot q_j$, where $d = b$ in the homogeneous goods case and d is less than b but positive when the goods are imperfect substitutes. The rest of the analysis is the same as above. The only difference is that given product differentiation, equilibrium prices, output levels, and profits need not be the same for both firms. In this case, the cartel behaves like a monopolist that produces two differentiated goods, an issue we take up in Chap. 13. In practice, however, differentiation can make it more complicated for firms to coordinate on price.

9.1.3 Other Cartel Weaknesses

Although the cartel dilemma is an important deterrent to cartel success, other factors can also make it difficult to maintain a cartel. One is the degree of antitrust enforcement. Stricter enforcement and penalties for violators reduce the net benefits of forming and sustaining a cartel. Furthermore, cartel members cannot take a company to court for violating an illegal cartel agreement or contract. Illegal contracts are not enforceable and, therefore, cannot be used to overcome the cartel dilemma. Cartel agreements must be struck and enforced in secret, which makes it more difficult to observe cheating and to discipline cheaters. Detecting cheating is especially problematic when there are many firms in the industry, because monitoring and enforcement costs increase with the number of firms (Stigler 1964).

Firm heterogeneity can also be a problem, as it raises the cost of negotiating a cartel agreement. An acceptable output distribution will be more difficult to identify if some firms have lower costs or if technology is changing rapidly. When products are differentiated, they need not sell at the same price, making it more difficult to identify cartel prices.

In addition, the detection of cheaters can be especially difficult in markets where there is considerable demand fluctuation. An increase in production of brand 1 in response to an increase in demand could cause firm 2 to mistakenly believe that firm 1 is cheating. Firm 2 might step up production or start a price war.

Even if all of these problems can be overcome, cartel profits can induce entry of new competitors in markets with low entry barriers. With zero entry barriers, positive economic profits will attract new entrants. Over time, each firm's share of output and monopoly profits will get smaller and smaller as more firms enter, making the cartel unsustainable in the long run.

In summary, collusion is less likely to occur when:

- Cartels are illegal and expected antitrust penalties are steep.[9]
- There are many firms in the market.
- Firms have dissimilar costs and produce differentiated products.
- Demand and cost conditions are unstable.
- Entry barriers are low.

9.2 Strategies That Facilitate Collusion

Cartels will exist when the expected benefits of forming a cartel are at least as high as the cost of establishing and enforcing a cartel agreement. Even though there are obstacles to maintaining a cartel, firms have a tremendous economic incentive to overcome them. Here, we discuss three strategies that firms use to prevent cheating and facilitate a collusive outcome.

9.2.1 Market Division

Perhaps the simplest way to facilitate collusion is to divide the market so that each firm serves a different set of customers or geographic regions. Each firm becomes a monopoly with respect to its own set of customers, eliminating the need to coordinate on price or production levels. Another advantage of this scheme is that firms only need to monitor their own subset of customers, making it easier to detect cheating. In essence, the cartel acts as a price discriminating monopolist, with each firm setting the monopoly price in each submarket. When prices differ among producers, however, resale between different groups of customers must be preventable for this scheme to be successful.

Of the 605 price-fixing cases in the USA from 1910 to 1972, Fraas and Greer (1977) found that 26% involved cartels that divided up markets geographically. A classic example of this occurred from 1928 through 1972 when a two-country cartel called Mercurio Europeo kept the price of mercury at near monopoly levels: suppliers in Spain served the USA and suppliers in Italy served customers in Europe.

[9] In this case, firms play a game with antitrust authorities, which may cause them to limit price below the joint profit-maximizing level to avoid antitrust scrutiny.

Fig. 9.6 The cartel dilemma pricing game

		Firm 2 p_C	**Firm 2** p_L
Firm 1	p_C	20, 20	17, 22
	p_L	22, 17	18, 18

9.2.2 Most-Favored-Customer Clause

One strategy used to diminish the incentive to cheat on a cartel is known as a **most-favored-customer clause**, which is sometimes called a low-price guarantee.[10] The clause guarantees that if a customer purchases a product today and the product is discounted in the next several months, the customer will receive a rebate for the difference in the price. With such a rebate clause in effect, a firm will be less likely to lower its price today because it must pay out rebates to all customers who purchased the product in the last several months. In other words, it substantially lowers the payoff from cutting today's price.

To show how a most-favored-customer clause can facilitate collusion, we analyze a simple duopoly problem where firms 1 and 2 play a static game. Firms can choose to set price equal to the cartel price (p_C) or at a lower, more competitive price (p_L). Payoffs are described in Fig. 9.6. You can see that firms face a classic cartel dilemma in prices. Although joint profits are maximized when both firms set price equal to p_C, each firm's dominant strategy is to cheat on the cartel and choose p_L. Thus, the Nash and dominant-strategy equilibrium is the competitive price pair (p_L, p_L).

Now assume that these firms both implement a most-favored-customer clause. With this clause in place, a firm must send out rebates worth a total of R dollars to previous customers if the firm offers a low price today. Figure 9.7 presents the rebate payoff structure. Notice that the rebate clause reduces the attractiveness of cheating by imposing a penalty on cheaters. In this example, if R is greater than 2, then each

[10] This is sometimes called a most-favored-nation clause (Salop 1986).

Fig. 9.7 The cartel dilemma with most-favored-customer clause

		Firm 2 p_C	Firm 2 p_L
Firm 1	p_C	20, 20	17, 22-R
	p_L	22-R, 17	18-R, 18-R

firm's dominant strategy changes from p_L to p_C. The Nash and dominant-strategy equilibrium becomes the cartel outcome. Thus, a simple change in the pricing contract with consumers can support collusion.[11]

9.2.3 Meet-the-Competition Clause

Another strategy that firms use to support collusion is a **meet-the-competition clause**[12] in which a store guarantees to match the low price of any competitor. Such a clause appears to be valuable to you as a consumer, as it seems to guarantee the lowest possible price. Just the opposite may occur, however. One problem is that it encourages customers to monitor prices and report a cheater to rival stores. This alleviates monitoring costs to cartel members, which may help solidify cartel pricing.

A meet-the-competition clause also eliminates any short-run gain from cheating. Continuing with the same duopoly pricing model described above but without a meet-the-competition clause, payoffs are those found in Fig. 9.6. Again, the Nash or dominant-strategy equilibrium is for both firms to cheat on the cartel and set a low price. With a meet-the-competition clause in effect, however, neither firm is able to undercut its competitor, effectively eliminating the price pairs (p_C, p_L) and (p_L, p_C) as possibilities. That is, if firm i cheats by setting price equal to p_L, firm j's price automatically reverts to p_L. Thus, the only possible outcomes are (p_C, p_C) and (p_L, p_L). Given these options, neither firm has an incentive to deviate from the higher cartel price, making the cartel outcome the Nash equilibrium.

[11] Chen and Liu (2011) point out that there may be other reasons for implementing a most-favored-customer clause. In their study of electronics retailers, they found that Best Buy introduced such a clause in order to gain market share from its chief competitors.

[12] See Salop (1986) for more detailed discussion.

9.2.4 *Trigger Strategy*

In most real-world cartels, firms compete time and time again in the marketplace. In a repeated game, firms may develop a strategy that facilitates collusion even though they have no formal contract. Friedman (1971) proposed that firms may use a **trigger strategy** to attain a collusive outcome in an infinitely repeated game. Assuming two firms, a trigger strategy is defined as follows:

- If firm *j* cooperated in the past, firm *i* cooperates today.
- If firm *j* did not cooperate in the past, this triggers a more competitive response from firm *i* today and forever after.[13]

When applied to price competition, it is called a trigger-price strategy. It turns out that under certain circumstances a trigger strategy can support collusion. That is, it may be in the self-interest of firms to cooperate in every period.

Consider the choices that each firm faces today, at time $t = 0$. To begin, assume that both firms behaved cooperatively in the past and split cartel profits equally, with each firm's share of cartel profits identified as π^{C} (half the monopoly profits, $\pi^{C} = \pi^{M}/2$). A trigger strategy produces the following outcomes:

- If firm *i* cheats in the current period, it earns π^{*} today. But from period $t + 1$ on, competition becomes tougher and the firm earns the present value of the stream of profits from a more competitive environment, π^{x}_{PV}.
- If firm *i* cooperates in the current period, it earns the present value of the stream of cartel profits today and forever after, π^{C}_{PV}.

Thus, a trigger strategy will support cooperation if firms earn more from cooperation than from cheating. This occurs when the present value stream of profits from cooperating (π^{C}_{PV}) exceeds the present value stream of profits from cheating ($\pi^{*} + \pi^{x}_{PV}$), or

$$\pi^{C}_{PV} > \pi^{*} + \pi^{x}_{PV}. \tag{9.9}$$

From discussion of the cartel dilemma in the previous section, we know that $\pi^{*} > \pi^{C}$. We also know that $\pi^{C}_{PV} > \pi^{x}_{PV}$, because cartel profits are higher than profits in a more competitive setting. Thus, the inequality in (9.9) will hold if π^{x}_{PV} is sufficiently low.

Two forces affect the incentive to cooperate. The net benefit from cooperation increases as cheating triggers a harsher response, which lowers π^{x}_{PV}. The net benefit also increases as future dollars become more valuable (i.e., the future is less heavily discounted). To see how discounting influences the incentive to cooperate, consider the numerical example for the duopoly pricing game described in Fig. 9.6, where

[13] Normally, firm *i* is assumed to revert to a Nash equilibrium price or output strategy once firm *j* cheats.

firms can choose the cartel price p_C or to cheat by selling at a low price, p_L. In this case, $\pi^C = 20$, $\pi^* = 22$, and $\pi^x = 18$. At one extreme, if future dollars are not discounted at all (the discount factor, D, equals 1, as discussed in Chap. 2), then the inequality in (9.9) becomes

$$\begin{aligned} \sum_{t=0}^{\infty} 20_t &> 22 + \sum_{t=1}^{\infty} 18_t, \\ 20 + \sum_{t=1}^{\infty} 20_t - \sum_{t=1}^{\infty} 18_t &> 22, \\ 20 + \sum_{t=1}^{\infty} 2_t &> 22. \end{aligned} \tag{9.10}$$

This inequality clearly holds, making it optimal for each firm to cooperate. Alternatively, if future dollars do not matter at all (i.e., the discount factor equals 0), then the inequality in (9.9) is

$$20 > 22, \tag{9.11}$$

which does not hold. In this case, it pays to cheat because retaliation tomorrow is of no consequence. Thus, the trigger strategy will support collusion as long as the future is not too heavily discounted (i.e., the discount factor is sufficiently close to 1).

We generalize this result, assuming homogeneous goods and fierce competition in response to cheating that pushes π^x to zero. With homogeneous goods, an incremental decrease in price below p_C causes π^* to be approximately equal to monopoly profit (π^M).[14] With n firms, (9.9) becomes

$$\sum_{t=0}^{\infty} D^t \frac{\pi^M}{n} > \pi^M, \tag{9.12}$$

where D is the discount factor.[15] Notice that the benefits from cooperation, captured by the left-hand side of the inequality in (9.12), increase in D and decrease in n. This is called the **fundamental principle of collusion**: a trigger strategy is more likely to support collusion when there are fewer competitors and future dollars are more highly valued (i.e., D is higher). We will prove this result more formally and identify the cutoff value of the discount factor in Chap. 11.

[14] The reason is that with homogeneous goods, all consumers will buy from the low-priced producer. Thus, that firm will sell approximately the monopoly output and its competitors will sell nothing. This is consistent with a Bertrand outcome, which we will discuss in Chap. 10.

[15] Note that when D is less than 1, the left-hand side of the inequality does not sum to infinity.

9.3 Empirical Evidence

In this section, we provide a brief summary of the evidence regarding the economics of cartel activity.[16] The evidence shows that perfect cartels rarely exist in the real world. In most cases, cartels are imperfect because not all firms in the industry are members of the cartel. Thus, the monopoly outcome is rarely achieved. At the same time, the empirical evidence from the USA includes only those cases that were detected by antitrust authorities. The evidence is based on a sample that excludes undetected cartels that may have different characteristics than those of detected cartels. In any case, the available evidence is generally consistent with theory.

First, the evidence shows that collusion leads to considerably higher prices and profits.[17] For example, Griffin (1989) studied 54 international cartels from 1888 to 1984 and found that the average markup of price over marginal cost was 45%. In the graphite electrode market in the USA, Levenstein and Suslow (2004) found that prices rose by over 50% during the cartel period, 1992 to 1997. In his econometric study of auction prices of foreclosed properties in Washington, DC, Kwoka (1997) found that a cartel of real estate buyers suppressed auction prices by 30–45%.[18] After reviewing 200 cartel studies, Connor and Lande (2005) found that cartel activity led to an increase in average median prices by about 32% for international cartels and 18% for domestic cartels. Assuming that a lower price markup reduces the probability of being detected by antitrust authorities, this difference may reflect the fact that US anti-cartel enforcement is generally tougher than in other countries.

The results are less definitive regarding cartel stability. After reviewing 50 cartel cases, Levenstein and Suslow (2004) found that the average duration of a cartel was 5.4 years. Nevertheless, the world's most successful cartel, the DeBeers diamond cartel, has lasted for 100 years. Of course, many attempts to form a cartel fail, as we saw in the introduction between American Airlines and Braniff Airways.

This brings us to the next question: what factors determine cartel success? Consistent with the cartel dilemma, the evidence shows that cheating is a critical cause of cartel failure. In his sample of 29 international cartels, Eckbo (1976) found that 59% ended because of internal conflicts. Although still substantial, lower estimates are found by Griffin (1989), at 33%, and Suslow (2005), at 24%.

The evidence also shows that entry is another factor that undermines cartel success. In a review of 19 case studies, Levenstein and Suslow (2006) found that entry was the most common cause of cartel breakdown. Consistent with this research, Symeonidis (2003) found that collusion is more likely in markets with

[16] For more extensive reviews, see Scherer and Ross (1990, Chaps. 6–9), Waldman and Jensen (2006, Chaps. 9 and 10), and Levenstein and Suslow (2006).

[17] The notable exception is the study by Asch and Seneca (1975), which found that colluding firms earned lower profits than noncolluding firms. Their empirical model does not control for industry differences or other important determinants of profitability, however. Another potential concern is that cartels may form in less profitable industries.

[18] For a review of auction theory and a discussion of eBay auctions, see Hasker and Sickles (2010).

Table 9.2 Market conditions facilitating collusion in the markets for lysine, citric acid, and synthetic vitamins A and E in the 1990s

Market condition	Lysine	Citric acid	Vitamins A and E
High entry barriers (sunk costs)	Yes	Yes	Yes
Seller concentration (CR_4)			
Global market	>95%	>80%	>95%
US market	>97%	90%	100%
Number of cartel participants	4 or 5	4 or 5	3
Homogeneous products	Perfect	High	High
Annual market growth	10%, steady	8%, steady	2–3%, steady

CR_4 is the four-firm concentration ratio.
Source: Connor (2003).

high natural barriers to entry. The erection of strategic barriers, as in merchant shipping cartels (Morton 1997), has also been used to maintain a successful cartel. Finally, Levenstein (1995) argues that attempts to cartelize the salt industry during the nineteenth century failed because of insufficient barriers to entry.

The level of industry concentration also matters. Hay and Kelley (1974) found that cartel duration increased with concentration. Of the 605 US price-fixing cases from 1910 to 1972, Fraas and Greer (1977) found that the median number of firms involved in a cartel was 8. In their review of the evidence, Levenstein and Suslow (2006) found that most cartels involve industries that are relatively concentrated. When this is not the case, industry trade associations or governments played an important role in organizing and supporting a cartel agreement.[19]

Other factors also play a role. In most cases, global cartels involve products that are homogeneous or nearly homogeneous (Hay and Kelley 1974; Connor 2003). In addition, unexpected demand and cost shocks can destabilize a cartel by raising the cost of monitoring a cartel agreement. An unanticipated demand decrease can cause an individual firm to believe that competitors have cheated on a price agreement, which can trigger a price war in a misguided effort to enforce cooperation (Green and Porter 1984).[20] After reviewing the evidence, Levenstein and Suslow (2006, 66) conclude that "demand instability appears to destabilize cartels."

These general findings are consistent with those found by Connor (2003) in his study of successful cartels for lysine, citric acid, and vitamins A and E. His main results are summarized in Table 9.2. Connor's findings confirm that these successful cartels had stiff entry barriers, high levels of concentration (high four-firm concentration ratios and low number of competitors), relatively homogeneous goods, and fairly steady growth rates in demand.

[19] Eckbo (1976) also finds that cartel success is more likely when demand is sufficiently inelastic. This implies few close substitutes for the cartelized product and a greater gain in profits when moving from a competitive to a cartel outcome.

[20] Alternatively, Rotemberg and Saloner (1986) argue that price cuts are more likely during boom periods, because the benefit from price cutting is greater during a boom.

9.4 Case Studies of Cartels

Three case studies illuminate the complexity of maintaining a real-world cartel. These examples are designed to show how firms attempt to form price or output agreements and how cheating, entry, and politics can affect cartel success. We consider a classic, historical case, the US steel industry in the early 1900s; the OPEC cartel, established in 1960 and continuing through today; and the international vitamin cartel of the 1990s.

9.4.1 The Steel Industry[21]

One of the most famous examples of collusion occurred in the US steel industry in the early 1900s. This is a case where the ability to collude was enhanced by a major merger in 1901 that substantially bolstered industry concentration. Before that time, the industry was fragmented, consisting of hundreds of small steel producers. Although there were frequent attempts to fix price, cheating was common. To maintain high capacity utilization rates, price competition was frequently cutthroat. Concerned with growing excess capacity, Charles Schwab, president of Carnegie Steel, worked with the leading banker at the time, J. P. Morgan, to consolidate the major US steel companies.

In February of 1901, over ten major steel producers were merged, creating the US Steel Company.[22] This merger substantially raised concentration, as US Steel controlled over 65% of the nation's steel producing capacity. When the new company was formed, an intense debate ensued among the board of directors over its pricing strategy. On the one side was Charles Schwab, who supported former Carnegie Steel's policy of pricing as aggressively as needed to keep mills operating at full capacity. On the other side was Judge Ebert H. Gary, former president of Federal Steel, who wanted to avoid price competition, as it tended to lower profits. Gary's position was ultimately accepted, and he became president of US Steel.

Although it is always difficult to uncover the details of illegal collusive activity, there is general agreement that US Steel cooperated with its competitors through trade associations and private meetings. The most famous of these are called "Gary Dinners," where Judge Gary invited the leaders of competing steel producers to dinner for the purpose of fixing prices at noncompetitive levels during periods of both "stress" and "industrial calm." These meetings continued from 1907 until

[21] This discussion borrows from Adams and Mueller (1990) and Scherer (1996).

[22] These include Carnegie Steel, Federal Steel, American Steel and Wire, American Plate, American Steel Hoop, American Bridge Company, and Lake Superior Consolidated Iron Mines.

1911, ending 9 months before an antitrust suit was filed.[23] In this industry, both a merger that substantially raised concentration and Gary's ability to persuade the board of directors of the benefits of cooperation were significant contributors to collusion in the steel industry. Ultimately, enforcement of the antitrust laws led to the demise of cartel behavior.

9.4.2 The OPEC Cartel[24]

Although the Organization of Petroleum Exporting Countries (OPEC) is frequently considered a classic example of a cartel, it does not meet the criteria of a perfect cartel. OPEC is unable to consistently control world oil production. Further, OPEC members have not always pursued purely economic goals. In some cases, both political and economic factors come into play. Thus, at best, OPEC is an imperfect cartel. We summarize OPEC's behavior since its inception, paying particular attention to the causes of the three oil shocks that occurred in 1973–1974, in 1979–1980, and in 2004–2007.

OPEC was established in 1960 when the USA imposed oil quotas that favored imported oil from Canada and Mexico over oil from Venezuela and the Persian Gulf. In response, the minister of Venezuelan Energy and Mining called a meeting in September of 1960 with the major oil producing nations to discuss ways to increase oil prices. OPEC was established at this meeting; founding members were Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. Since then, several countries have joined OPEC: Qatar (in 1961), Libya (1962), UAE (1967), Algeria (1969), Nigeria (1971), and Angola (2007).[25] In spite of OPEC's efforts, real oil prices did not rise from 1960 through 1972. In fact, real prices (in 2009 dollars) averaged $23.35 (ranging from $21.24 to $24.84) from 1950 to 1959 and averaged $20.21 (ranging from $18.84 to $20.84) from 1960 to 1972.

One reason for its ineffectiveness is that the oil within OPEC nations was extracted and sold by foreign corporations, primarily British Petroleum, Shell, Exxon, Standard Oil of California, Texaco, Gulf Oil, and Mobil. OPEC consists of a group of countries, not producers, making it difficult for OPEC to set price or production quotas. Initially, OPEC countries imposed high excise taxes on oil that was extracted and exported from their countries, but beginning in 1971 each

[23] United States v. United States Steel Corporation et al., 251 US 417 (1920). Although this behavior would be considered illegal today, the Supreme Court acquitted US Steel because the government challenged the monopoly status of the company (under Section 2 of the Sherman Act) rather than its collusive behavior (under Section 1). The government could not make a strong enough case that US Steel had monopolized the market because its market share had fallen from 65% to 52% from 1907 to 1915.

[24] This discussion borrows from Scherer (1996), Martin (2005), Mufson (2007), Perry (2007), El-Tablawy (2008), Samuelson (2008), and Jahn (2009).

[25] Ecuador, Gabon, and Indonesia also joined OPEC but later left.

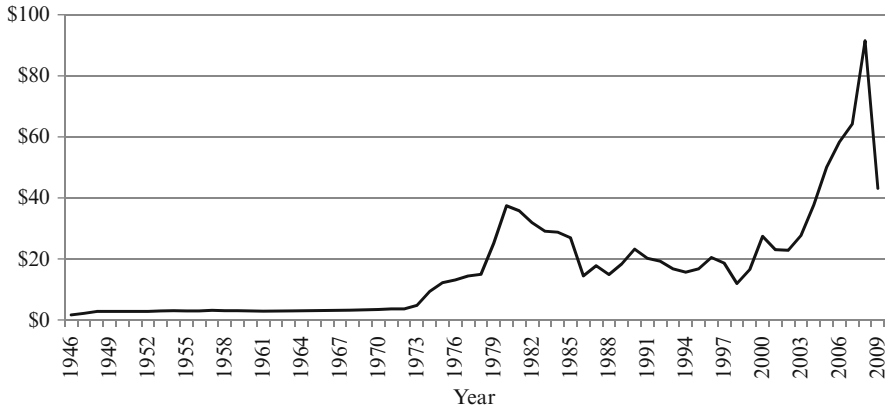

Fig. 9.8 Nominal price of oil in the USA, 1946–2009

country began to nationalize or take over majority ownership of petroleum operations within its borders. Most international oil companies became tenants of their oil operations, receiving a straight fee per barrel for services. Further, OPEC nations gained greater control over oil production.

The first oil shock occurred in 1973. Due to an economic boom of industrial nations, OPEC called a meeting to raise oil prices. Before an agreement was reached, on October 6, 1973 Egypt and Syria invaded the disputed regions that were occupied by Israel, actions that were opposed by many oil importing nations. This opposition led OPEC delegates to agree to a substantial price increase. In addition, Arab OPEC members imposed an oil embargo on shipments to two nations that supported Israel, the USA and the Netherlands. The result was an unprecedented increase in the average (nominal) price of oil per barrel in the USA, rising from $3.60 in 1972 to $9.35 in 1974 (see Fig. 9.8), and an economic recession. The political tension between the West and OPEC countries may be just as important as economic considerations in explaining the oil shock of 1973.

The second oil shock began with the political unrest in Iran at the end of 1978. In response to continued conflict with oil consumers from Western nations, Iranian oil exports ceased for 69 days in early 1979. Unfortunately, Iran accounted for 15% of OPEC oil production in 1978. With insufficient capacity to pick up the slack in the short run, oil prices rose sharply (see Fig. 9.8). In the USA, the average price of oil rose from $15 to $37 per barrel from 1978 to 1980. This embargo triggered another major recession in the USA.

The final oil shock occurred in the 2000s, a period when oil prices rose to record highs (see Fig. 9.8). For example, the nominal price of a barrel of oil rose from about $16 in 1999 to a peak of $147 in July of 2008. There are two main reasons for this steep rise in price. First, the war in Iraq and the political unrest in Nigeria, Iran, and Venezuela caused supply to diminish by an estimated 5% to 8%. Second, a booming world economy and the rapid development of China and India caused world oil demand to increase 13% from 1999 to 2007. In this period, China's demand almost doubled, compared to US demand which grew by 7%. The effect of

the world economy on oil prices became even more apparent with the major recession that began in early 2008. By December of 2008 when the recession hit its peak, oil prices declined to just $43 per barrel.

The multitude of factors and events in the market for oil makes it difficult to judge the effectiveness of OPEC in coordinating output and price levels in the world oil market. Although OPEC does not call itself a cartel, it has endeavored to collude. Its Web page indicates that OPEC sets production quotas for member nations and was established to acquire "a major say in the pricing of crude oil on world markets."[26] OPEC has also encouraged non-member nations to coordinate with OPEC in setting production quotas worldwide. If US companies behaved this way, they would be in clear violation of the Sherman Act.

In any case, the evidence indicates that OPEC has not been a perfect cartel. First, coordination is a problem because member nations do not have a single goal. Saudi Arabia and other sparsely populated nations along the Persian Gulf prefer to emphasize the economic interests of OPEC nations (i.e., to act as a profit-maximizing cartel). On the other hand, leaders of other nations have frequently said that OPEC should also be an "active political agent" and pursue the political, frequently anti-American, interests of member nations (Mouawad 2007). This sentiment is consistent with the political motivation of the first two oil shocks.

A second problem that limits OPEC's success is that production costs vary widely among member nations, making coordination more difficult. As an example, oil development and operating costs are less than $2 per barrel for Saudi Arabia but are $7 for Venezuela (*The Economist*, March 6, 1999, 23). Disparate costs can create a difference of opinion concerning how output restrictions should be distributed among member nations.

Third, OPEC nations appear to face a difficult cartel dilemma. One issue is that OPEC controls part but not all of world oil production, ranging from 40 to 41% from 2004 to 2009. Thus, non-OPEC suppliers may encourage production cuts by OPEC nations and then increase their own production. Even among OPEC nations, cheating on production quotas has been a frequent problem, especially in the 1980s when the real price of oil fell dramatically (see Fig. 9.9). Cheating has also been a problem in the last decade. For example, Saudi Arabia was reported to be producing about 5% above its quota in early 2009 (*Petroleum Economist* 2009).

Finally, entry and energy conservation have weakened OPEC's power. Steep oil prices in the early 1980s and in the last decade led to rigorous exploration and the discovery of new oil fields in Alaska, Brazil, Canada, and Russia. New energy conserving technologies have also reduced energy demand. For instance, US per capita oil consumption was 28.5 barrels in 1972 and just 23.4 barrels in 2008.

[26] OPEC's stated objective "is to co-ordinate and unify petroleum policies among Member Countries, in order to secure fair and stable prices for petroleum producers; an efficient, economic and regular supply of petroleum to consuming nations; and a fair return on capital to those investing in the industry." Available at http://www.opec.org, accessed May 15, 2010.

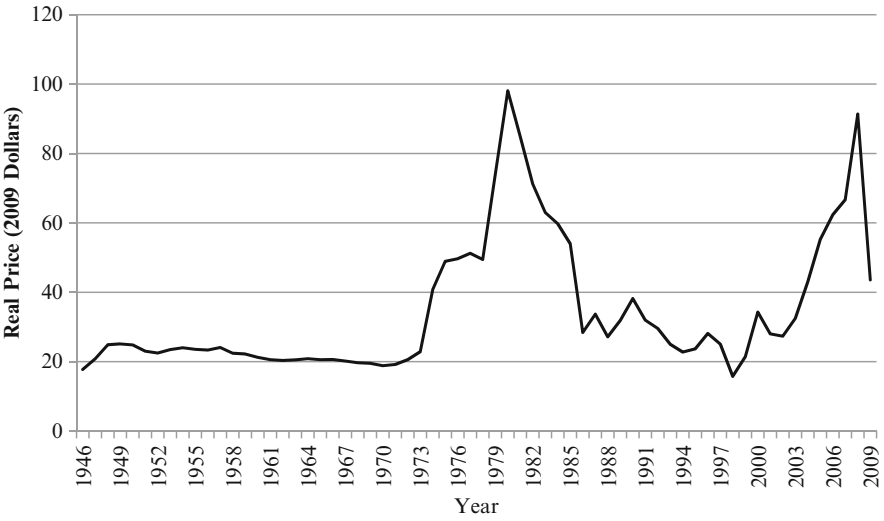

Fig. 9.9 The real price of oil in the USA (2009 dollars), 1946–2009

We can conclude that OPEC is an imperfect cartel that suffers from many of the problems associated with maintaining collusive agreements between independent suppliers. Not only must OPEC deal with coordinating an agreement among countries with different cost structures, address the cartel dilemma, and cope with entry of new suppliers, but it must also operate in the presence of volatile political issues. Given these difficulties, it is not surprising that the real price of oil has fluctuated so dramatically since OPEC gained power in the early 1970s as Fig. 9.9 indicates.

9.4.3 The International Vitamin Cartel[27]

According to a statement from the US Attorney General's office (*Federal News Service* 1999), "the vitamin cartel is the most pervasive and harmful criminal antitrust conspiracy ever uncovered." The vitamin cartel was international in scope, lasted for 10 years, and operated as a near perfect cartel.

The international vitamin cartel was formed in 1989 when F. Hoffmann-La Roche (of Switzerland), BASF (of Germany), and Rhone-Poulenc (now Aventis, of France) met in Switzerland and agreed to raise the prices of vitamins A and E. Soon afterwards, the Japanese chemical company Eisai joined in the price-fixing agreement. By the end of 1991, at least 20 worldwide vitamin producers participated in the conspiracy. Sixteen different vitamin products were involved, which were sold as supplements and added to such products as milk, breakfast cereal, cosmetics, and animal feed.

[27] This discussion borrows from the Department of Justice (May 21, 1999), Europa (2001), and Bush et al. (2004).

The cartel was stable and highly successful for three main reasons. First, participants agreed to set prices and allocate volume so that market shares remained stable and revenues were fairly distributed. Second, adherence to cartel agreements were closely monitored and strictly enforced. Participants met quarterly and sometimes monthly to share price and sales information. Finally, entry was thwarted by high entry barriers due to substantial start-up costs and scale economies (Connor and Lande 2006).

The vitamin cartel was exceptionally large in scale. Total affected sales are estimated to be $8.3 billion in the European economic area, $7.4 billion in the USA, and $0.55 billion in Canada. Globally, sales affected by price-fixing agreements are estimated to be $34.3 billion.

The vitamin cartel was able to raise prices and adversely affect consumers throughout the world. After reviewing the evidence, Bush et al. (2004) conclude that the cartel was able to raise average vitamin prices by 20% to 35% in the USA and by 30% to 40% in Canada and Europe. These estimates imply that the dollar value of global injuries were between $9 to $13 billion, with 15% accruing to the USA, 26% to the European economic area, 1% to Canada, and 58% to the rest of the world.

The cartel's only weakness was that collusion is illegal in developed countries. World antitrust authorities were able to crack the cartel by obtaining insider cooperation. Rhone-Poulenc voluntarily reported details of the cartel in exchange for full immunity from the US Department of Justice and the European Commission. Amnesty policies exist in the USA and the European Union, giving immunity to the first company to cooperate with authorities. According to Pate (2004) of the Antitrust Division of the US Department of Justice, "Because cartel activities are hatched and carried out in secret, obtaining the cooperation of insiders is the best and often the only way to crack a cartel." This first to come forward policy adds to cartel instability.

Fines imposed on cartel participants were the highest in history for an antitrust violation. Leading producers and instigators of the cartel received stiff fines in the USA in 1999 and in Europe in 2001. F. Hoffmann-La Roche received fines of $500 million in the USA and $407 million in Europe, BASF received fines of $225 million in the USA and $261 million in Europe, and Eisai received fines of $40 million in the USA and $11.7 million in Europe. Total fines on all cartel participants are estimated to be between $4.4 and $5.6 billion.

Despite the impressive magnitude of the fines, Bush et al. (2004) point out the total fine was considerably less than the estimated gain from cartel activity, of between $9 and $13 billion. Thus, this case raises an important policy concern. Because the probability of being caught is less than 100%, for a fine to be an effective deterrent it must exceed the expected gain in profits that results from cartel activity. In the case of the vitamin cartel, fines should have been well over double their actual amounts.[28] Issues involving the effectiveness of antitrust policy will be taken up in Chap. 20.

[28] To illustrate, consider a cartel that increases profits by $10 billion and has a probability of being successfully caught and convicted of 50%. In this case, the expected gain from forming a cartel is $10 billion minus $0.5 \cdot f$, where f is the amount of the fine. For the fine to successfully deter a cartel, the expected gain must be negative. For this to be true, f must exceed $20 billion.

In any case, we can conclude that if it were not for antitrust enforcement, the international vitamin cartel would have continued as a near perfect cartel.

9.5 Summary

1. There are two types of oligopoly models, those that assume cooperation or collusion and those that assume noncooperative behavior. Collusion can be explicit or tacit. **Explicit collusion** occurs when firms make a formal agreement to coordinate on one or more strategic variables. **Tacit collusion** occurs when firms coordinate without a formal agreement.
2. A **cartel** is a group of firms that have made an explicit collusive agreement. In a **perfect cartel**, all firms in the industry are members of the cartel and their goal is to maximize industry profits. This leads to the monopoly price and total output level. Like a monopoly, a cartel outcome is allocatively inefficient.
3. Cartels face a **coordination problem**, because the output levels or market shares of each firm in the cartel are indeterminate. With two firms, the coordination problem is described by the **output-distribution line**, which identifies all combinations of firm output from cartel participants who will produce the total cartel (monopoly) level of output.
4. In a duopoly setting, firm i's **isoprofit equation** describes all possible levels of q_i and q_j that are consistent with a constant level of profit for firm i. The isoprofit curves are tangent at points along the output-distribution line.
5. The **cartel dilemma** is a type of prisoners' dilemma. Action that is most profitable from the cartel's perspective is not what is most profitable from the individual firm's perspective. Individual firms have an incentive to cheat on the cartel agreement by increasing output (or lowering price).
6. Collusion is more likely when the following conditions hold.
   - Cartels are legal or the expected cost of antitrust litigation is low.
   - There are few firms in the market.
   - Firms have similar costs and produce homogeneous goods.
   - Demand and cost conditions are stable.
   - Entry barriers are high.
7. There are several ways firms can facilitate collusion.
   - **Market Division:** The market is divided up so that each firm serves a different set of customers. This avoids direct competition among firms.
   - **Most-Favored-Customer Clause:** If a customer purchases a product today that is discounted in the near future, the customer will receive a rebate for the difference in price. This guarantee reduces a firm's benefit from cutting price.
   - **Meet-the-Competition Clause:** A store will meet the low price of any competitor. This eliminates a firm's benefit from cutting price.

- **Trigger Strategy:** In a duopoly setting, this involves two components: (1) firm *i* cooperates today if firm *j* cooperated in the previous period and (2) firm *i* behaves competitively for an extended period if firm *j* failed to cooperate in the previous period. The **fundamental principle of collusion** states that a trigger strategy is more likely to support collusion when there are fewer firms and when future profits are not too heavily discounted.

8. The empirical evidence regarding cartels is generally consistent with economic theory. Collusion typically leads to higher prices and profits, but the monopoly outcome is rarely reached because not all firms in the market are cartel members in most real-world cartels. Cheating and the entry of new competitors are prominent causes of cartel failure. Cartels are more successful when concentration is high, products are relatively homogeneous, entry barriers are high, and demand growth is steady.
9. The US steel industry provides an excellent example where company leaders met socially to form price-fixing agreements, as Adam Smith predicted. At best, OPEC is an imperfect cartel because cartel members frequently disagree on economic versus political goals, OPEC nations produce only about 40% of the world supply of oil, and entry and cheating on production quotas have diminished OPEC's economic power to control price. The international vitamin cartel provides an example of the most sophisticated and elaborate conspiracy to fix prices. If it had not been for the antitrust laws in Europe and the USA, it would have continued to this day.

9.6 Review Questions

1. Define collusion and a perfect cartel. Compare and contrast cartel and monopoly outcomes.
2. Assume a duopoly market (firms 1 and 2) with the following inverse market demand: $p = 120 - Q$, where $Q = q_1 + q_2$. Firms face the same costs, and firm i's total cost equation is $TC_i = 20q_i$.

   A. Determine the cartel price and market level of output.
   B. Without additional information about the cartel, explain why you cannot calculate the output and profit levels for each firm.

3. Discuss the efficiency implications of a perfect cartel. Does your answer justify antitrust laws that make collusion illegal?
4. For each pair of industries listed below, which of the two would you expect collusion to be easier to maintain. Explain.

   A. Steel and automobiles.
   B. Cement and wheat.
   C. Fast food and airline service between two cities.

5. Regarding the Cartel Dilemma:
   A. Briefly explain the cartel dilemma.
   B. In the duopoly problem described in question 2 above, calculate the optimal levels of output and profits for each firm if you assume symmetry (i.e., equilibrium output and profits are the same for each firm).
   C. (Advanced) Show that firm 1 will prefer to cheat on the cartel agreement by increasing output.
6. In problem 2 above, assume that firms are able to divide the market in half, so that each firm's inverse demand becomes $p_i = 120 - 2q_i$. Would this be an effective way to facilitate collusion?
7. Office Depot, Office Max, and Staples compete in the office supply market by offering low-price guarantees (i.e., a meet-the-competition clause). Are such guarantees beneficial or harmful to consumers? Explain.
8. Assume that a market consists of three firms (1, 2, and 3) which form a cartel. Firm 3 is a rogue firm that frequently undercuts the price of its competitors. Could such behavior lead to even lower prices than would be found in competitive markets? Explain.
9. Suppose you were looking for an industry in which to form a cartel. Given the empirical evidence, what would be the ideal set of conditions that would maximize the likelihood of cartel success?
10. Provide a behavioral reason why it could be more difficult to establish and maintain an effective cartel among firms in different nations, such as the OPEC cartel, than among firms within a single nation, such as the steel cartel in the USA during the early twentieth century.