12 Monopolistic Competition and Oligopoly

Read Pindyck and Rubinfeld (2012), Chapter 12
CHAPTER 12 OUTLINE

12.1 Monopolistic Competition
12.2 Oligopoly
12.3 Price Competition
12.4 Competition versus Collusion: The Prisoners’ Dilemma
12.5 Implications of the Prisoners’ Dilemma for Oligopolistic Pricing
12.6 Cartels
monopolistic competition  Market in which firms can enter freely, each producing its own brand or version of a differentiated product.

oligopoly  Market in which only a few firms compete with one another, and entry by new firms is impeded.

cartel  Market in which some or all firms explicitly collude, coordinating prices and output levels to maximize joint profits.
The Makings of Monopolistic Competition

A monopolistically competitive market has two key characteristics:

1. Firms compete by selling differentiated products that are highly substitutable for one another but not perfect substitutes. In other words, the cross-price elasticities of demand are large but not infinite.

2. There is free entry and exit: it is relatively easy for new firms to enter the market with their own brands and for existing firms to leave if their products become unprofitable.
Equilibrium in the Short Run and the Long Run

Because the firm is the only producer of its brand, it faces a downward-sloping demand curve. Price exceeds marginal cost and the firm has monopoly power.

In the short run, described in part (a), price also exceeds average cost, and the firm earns profits shown by the yellow-shaded rectangle.
Equilibrium in the Short Run and the Long Run

In the long run, these profits attract new firms with competing brands. The firm’s market share falls, and its demand curve shifts downward.

In long-run equilibrium, described in part (b), price equals average cost, so the firm earns zero profit even though it has monopoly power.
Under perfect competition, price equals marginal cost.

The demand curve facing the firm is horizontal, so the zero-profit point occurs at the point of minimum average cost.
Under monopolistic competition, price exceeds marginal cost. Thus there is a **deadweight loss**, as shown by the yellow-shaded area. The demand curve is downward-sloping, so the zero profit point is to the left of the point of minimum average cost.

In both types of markets, entry occurs until profits are driven to zero.
Is monopolistic competition then a socially undesirable market structure that should be regulated? The answer—for two reasons—is probably no:

1. In most monopolistically competitive markets, monopoly power is small. Usually enough firms compete, with brands that are sufficiently substitutable, so that no single firm has much monopoly power. Any resulting deadweight loss will therefore be small. And because firms’ demand curves will be fairly elastic, average cost will be close to the minimum.

2. Any inefficiency must be balanced against an important benefit from monopolistic competition: product diversity. Most consumers value the ability to choose among a wide variety of competing products and brands that differ in various ways. The gains from product diversity can be large and may easily outweigh the inefficiency costs resulting from downward-sloping demand curves.
EXAMPLE 12.1 MONOPOLISTIC COMPETITION IN THE MARKETS FOR COLAS AND COFFEE

The markets for soft drinks and coffee illustrate the characteristics of monopolistic competition. Each market has a variety of brands that differ slightly but are close substitutes for one another.

**TABLE 12.1 ELASTICITIES OF DEMAND FOR COLAS AND COFFEE**

<table>
<thead>
<tr>
<th>BRAND</th>
<th>ELASTICITY OF DEMAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colas</td>
<td></td>
</tr>
<tr>
<td>RC Cola</td>
<td>–2.4</td>
</tr>
<tr>
<td>Coke</td>
<td>–5.2 to –5.7</td>
</tr>
<tr>
<td>Ground coffee</td>
<td></td>
</tr>
<tr>
<td>Folgers</td>
<td>–6.4</td>
</tr>
<tr>
<td>Maxwell House</td>
<td>–8.2</td>
</tr>
<tr>
<td>Chock Full o’ Nuts</td>
<td>–3.6</td>
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</table>

With the exception of RC Cola and Chock Full o’ Nuts, all the colas and coffees are quite price elastic. With elasticities on the order of –4 to –8, each brand has only limited monopoly power. This is typical of monopolistic competition.
1. Suppose all firms in a monopolistically competitive industry were merged into one large firm. Would that new firm produce as many different brands? Would it produce only a single brand? Explain.
1. Suppose all firms in a monopolistically competitive industry were merged into one large firm. Would that new firm produce as many different brands? Would it produce only a single brand? Explain.

ANS. • Monopolistic competition is defined by product differentiation. Each firm earns economic profit by distinguishing its brand from all other brands. This distinction can arise from underlying differences in the product or from differences in advertising.
• If these competitors merge into a single firm, the resulting monopolist would not produce as many brands, since too much brand competition is internecine (mutually destructive). However, it is unlikely that only one brand would be produced after the merger.
• Producing several brands with different prices and characteristics is one method of splitting the market into sets of customers with different price elasticities. The monopolist can sell to more consumers and maximize overall profit by producing multiple brands and practicing a form of price discrimination.
12.2 Oligopoly

In oligopolistic markets, the products may or may not be differentiated.

What matters is that only a few firms account for most or all of total production.

- In some oligopolistic markets, some or all firms earn substantial profits over the long run because barriers to entry make it difficult or impossible for new firms to enter.
- Examples of oligopolistic industries include automobiles, steel, aluminum, petrochemicals, electrical equipment, and computers.

Oligopoly is a prevalent form of market structure.

- Scale economies may make it unprofitable for more than a few firms to coexist in the market;
- patents or access to a technology may exclude potential competitors; and
- the need to spend money for name recognition and market reputation may discourage entry by new firms. These are “natural” entry barriers—they are basic to the structure of the particular market. In addition, incumbent firms may take strategic actions to deter entry.

Managing an oligopolistic firm is complicated because pricing, output, advertising, and investment decisions involve important strategic considerations, which can be highly complex.
Equilibrium in an Oligopolistic Market

In an oligopolistic market, however, a firm sets price or output based partly on strategic considerations regarding the behavior of its competitors. With some modification, the underlying principle to describe an equilibrium when firms make decisions that explicitly take each other’s behavior into account is the same as the equilibrium in competitive and monopolistic markets: *When a market is in equilibrium, firms are doing the best they can and have no reason to change their price or output.*

**NASH EQUILIBRIUM**

- **Nash equilibrium** Set of strategies or actions in which each firm does the best it can given its competitors’ actions.

  *Nash Equilibrium:* Each firm is doing the best it can given what its competitors are doing.

- **duopoly** Market in which two firms compete with each other.
The Cournot Model

- Cournot model  Oligopoly model in which firms produce a homogeneous good, each firm treats the output of its competitors as fixed, and all firms decide simultaneously how much to produce.

**Figure 12.3**

**FIRM 1’S OUTPUT DECISION**

Firm 1’s profit-maximizing output depends on how much it thinks that Firm 2 will produce.

If it thinks Firm 2 will produce nothing, its demand curve, labeled $D_1(0)$, is the market demand curve. The corresponding marginal revenue curve, labeled $MR_1(0)$, intersects Firm 1’s marginal cost curve $MC_1$ at an output of 50 units.

If Firm 1 thinks that Firm 2 will produce 50 units, its demand curve, $D_1(50)$, is shifted to the left by this amount. Profit maximization now implies an output of 25 units.

Finally, if Firm 1 thinks that Firm 2 will produce 75 units, Firm 1 will produce only 12.5 units.
REACTION CURVES

- **reaction curve**  Relationship between a firm’s profit-maximizing output and the amount it thinks its competitor will produce.

**FIGURE 12.4**

REACTION CURVES AND COURNOT EQUILIBRIUM

Firm 1’s reaction curve shows how much it will produce as a function of how much it thinks Firm 2 will produce. (The xs at Q2 = 0, 50, and 75 correspond to the examples shown in Figure 12.3.)

Firm 2’s reaction curve shows its output as a function of how much it thinks Firm 1 will produce.

In Cournot equilibrium, each firm correctly assumes the amount that its competitor will produce and thereby maximizes its own profits. Therefore, neither firm will move from this equilibrium.
COURNOT EQUILIBRIUM

- **Cournot equilibrium**  
  Equilibrium in the Cournot model in which each firm correctly assumes how much its competitor will produce and sets its own production level accordingly.

Cournot equilibrium is an example of a Nash equilibrium (and thus it is sometimes called a Cournot-Nash equilibrium).

In a Nash equilibrium, each firm is doing the best it can given what its competitors are doing.

As a result, no firm would individually want to change its behavior. In the Cournot equilibrium, each firm is producing an amount that maximizes its profit given what its competitor is producing, so neither would want to change its output.
The Linear Demand Curve—An Example

Two identical firms face the following market demand curve \( P = 30 - Q \)
Also, \( MC_1 = MC_2 = 0 \)

Total revenue for firm 1:
\[
R_1 = PQ_1 = (30 - Q)Q_1 = 30Q_1 - Q_1^2 - Q_2Q_1
\]
then \( MR_1 = \frac{\Delta R_1}{\Delta Q_1} = 30 - 2Q_1 - Q_2 \)

Setting \( MR_1 = 0 \) (the firm’s marginal cost) and solving for \( Q_1 \), we find

Firm 1’s reaction curve:
\[
Q_1 = 15 - \frac{1}{2}Q_2 \quad (12.1)
\]

By the same calculation, Firm 2’s reaction curve:
\[
Q_2 = 15 - \frac{1}{2}Q_2 \quad (12.2)
\]

Cournot equilibrium:
\[
Q_1 = Q_2 = 10
\]

Total quantity produced:
\[
Q = Q_1 + Q_2 = 20
\]

If the two firms collude, then the total profit-maximizing quantity is:

Total revenue for the two firms:
\[
R = PQ = (30 - Q)Q = 30Q - Q^2
\]
then \( MR_1 = \frac{\Delta R}{\Delta Q} = 30 - 2Q \)

Setting \( MR = 0 \) (the firm’s marginal cost) we find that total profit is maximized at \( Q = 15 \).
Then, \( Q_1 + Q_2 = 15 \) is the collusion curve.

If the firms agree to share profits equally, each will produce half of the total output:
\[
Q_1 = Q_2 = 7.5
\]
**Figure 12.5**

**DUOPOLY EXAMPLE**

The demand curve is $P = 30 - Q$, and both firms have zero marginal cost. In Cournot equilibrium, each firm produces 10.

The collusion curve shows combinations of $Q_1$ and $Q_2$ that maximize total profits.

If the firms collude and share profits equally, each will produce 7.5.

Also shown is the competitive equilibrium, in which price equals marginal cost and profit is zero.
First Mover Advantage—The Stackelberg Model

- **Stackelberg model** Oligopoly model in which one firm sets its output before other firms do.

Suppose Firm 1 sets its output first and then Firm 2, after observing Firm 1’s output, makes its output decision. In setting output, Firm 1 must therefore consider how Firm 2 will react.

\[ P = 30 - Q \]

Also, \( MC_1 = MC_2 = 0 \)

**Firm 2’s reaction curve:**

\[ Q_2 = 15 - \frac{1}{2} Q_1 \]  \hspace{1cm} (12.2)

**Firm 1’s revenue:**

\[ R_1 = PQ_1 = 30Q_1 - Q_1^2 - Q_2 Q_1 \]  \hspace{1cm} (12.3)

\[
R_1 = 30Q_1 - Q_1^2 - Q_1 \left( 15 - \frac{1}{2} Q_1 \right) = 15Q_1 - \frac{1}{2} Q_1^2
\]

\[
MR_1 = \frac{\Delta R_1}{\Delta Q_1} = 15 - Q_1
\]  \hspace{1cm} (12.4)

Setting \( MR_1 = 0 \) gives \( Q_1 = 15 \), and \( Q_2 = 7.5 \)

We conclude that Firm 1 produces twice as much as Firm 2 and makes twice as much profit. **Going first gives Firm 1 an advantage.**
3. A monopolist can produce at a constant average (and marginal) cost of $AC = MC = \$5$. It faces a market demand curve given by $Q = 53 - P$.

a) Calculate the profit-maximizing price and quantity for this monopolist. Also calculate its profits.

b) Suppose a second firm enters the market. Let $Q_1$ be the output of the first firm and $Q_2$ be the output of the second. Market demand is now given by $Q_1 + Q_2 = 53 - P$.

Assuming that this second firm has the same costs as the first, write the profits of each firm as functions of $Q_1$ and $Q_2$.

c) Suppose (as in the Cournot model) that each firm chooses its profit-maximizing level of output on the assumption that its competitor’s output is fixed. Find each firm’s “reaction curve” (i.e., the rule that gives its desired output in terms of its competitor’s output).

d) Calculate the Cournot equilibrium (i.e., the values of $Q_1$ and $Q_2$ for which each firm is doing as well as it can given its competitor’s output). What are the resulting market price and profits of each firm?

e) Suppose there are $N$ firms in the industry, all with the same constant marginal cost, $MC = \$5$. Find the Cournot equilibrium. How much will each firm produce, what will be the market price, and how much profit will each firm earn? Also, show that as $N$ becomes large, the market price approaches the price that would prevail under perfect competition.
3. a. Calculate the profit-maximizing price and quantity for this monopolist. Also calculate its profits.

**ANS.** First solve for the inverse demand curve, \( P = 53 - Q \). Then the marginal revenue curve has the same intercept and twice the slope:

\[ MR = 53 - 2Q. \]

Marginal cost is a constant $5. Setting \( MR = MC \), find the optimal quantity:

\[ 53 - 2Q = 5, \text{ or } Q = 24. \]

Substitute \( Q = 24 \) into the demand function to find price:

\[ P = 53 - 24 = $29. \]

Assuming fixed costs are zero, profits are equal to

\[ \pi = TR - TC = (29)(24) - (5)(24) = $576. \]

b. Suppose a second firm enters the market. Let \( Q_1 \) be the output of the first firm and \( Q_2 \) be the output of the second. Market demand is now given by

\[ Q_1 + Q_2 = 53 - P. \]

Assuming that this second firm has the same costs as the first, write the profits of each firm as functions of \( Q_1 \) and \( Q_2 \).

**ANS.** When the second firm enters, price can be written as a function of the output of both firms: \( P = 53 - Q_1 - Q_2 \). We may write the profit functions for the two firms:

\[ \pi_1 = P Q_1 - C(Q_1) = (53 - Q_1 - Q_2)Q_1 - 5Q_1, \text{ or } \pi_1 = 48Q_1 - Q_1^2 - Q_1Q_2 \]

and

\[ \pi_2 = P Q_2 - C(Q_2) = (53 - Q_1 - Q_2)Q_2 - 5Q_2, \text{ or } \pi_2 = 48Q_2 - Q_2^2 - Q_1Q_2. \]
3. Suppose (as in the Cournot model) that each firm chooses its profit-maximizing level of output on the assumption that its competitor’s output is fixed. Find each firm’s “reaction curve” (i.e., the rule that gives its desired output in terms of its competitor’s output).

ANS. Under the Cournot assumption, each firm treats the output of the other firm as a constant in its maximization calculations. Therefore, Firm 1 chooses $Q_1$ to maximize $\pi_1$ in part (b) with $Q_2$ being treated as a constant. The change in $\pi_1$ with respect to a change in $Q_1$ is

$$\frac{\partial \pi_1}{\partial Q_1} = 48 - 2Q_1 - Q_2 = 0,$$

or $Q_1 = 24 - \frac{Q_2}{2}$.

This equation is the reaction function for Firm 1, which generates the profit-maximizing level of output, given the output of Firm 2. Because the problem is symmetric, the reaction function for Firm 2 is

$$Q_2 = 24 - \frac{Q_1}{2}.$$

d. Calculate the Cournot equilibrium (i.e., the values of $Q_1$ and $Q_2$ for which each firm is doing as well as it can given its competitor’s output). What are the resulting market price and profits of each firm?

ANS. Solve for the values of $Q_1$ and $Q_2$ that satisfy both reaction functions by substituting Firm 2’s reaction function into the function for Firm 1:

$$Q_1 = 24 - \left(\frac{1}{2}\right)\left(24 - \frac{Q_1}{2}\right),$$

or $Q_1 = 16$.

By symmetry, $Q_2 = 16$.

To determine the price, substitute $Q_1$ and $Q_2$ into the demand equation:

$$P = 53 - 16 - 16 = 21.$$

Profit for Firm 1 is therefore

$$\pi_1 = PQ_1 - C(Q_1) = \pi_1 = (21)(16) - (5)(16) = 256.$$

Firm 2’s profit is the same, so total industry profit is $\pi_1 + \pi_2 = 256 + 256 = 512$. 
If there are $N$ identical firms, then the price in the market will be
\[ P = 53 - \left( Q_1 + Q_2 + \cdots + Q_N \right). \]

Profits for the $i^{th}$ firm are given by
\[ \pi_i = P Q_i - C(Q_i), \]
\[ \pi_i = 53Q_i - Q_i^2 - Q_i^2 - \cdots - Q_i^2 = 5Q_i. \]

Differentiating to obtain the necessary first-order condition for profit maximization,
\[ \frac{\partial \pi_i}{\partial Q_i} = 53 - Q_i - Q_i - \cdots - Q_i - 5 = 0. \]

Solving for $Q_i$,
\[ Q_i = 24 - \frac{1}{2} \left( Q_1 + \cdots + Q_{i-1} + Q_{i+1} + \cdots + Q_N \right). \]

If all firms face the same costs, they will all produce the same level of output, i.e., $Q_i = Q^*$. Therefore,
\[ Q^* = 24 - \frac{1}{2} (N-1)Q^*, \]
\[ 2Q^* = 48 - (N-1)Q^*, \]
\[ (N+1)Q^* = 48, \quad \text{or} \quad Q^* = \frac{48}{N+1}. \]

Now substitute $Q = NQ^*$ for total output in the demand function:
\[ P = 53 - N \left( \frac{48}{N+1} \right). \]

Total profits are
\[ \pi_T = PQ - C(Q) = P(NQ^*) - 5(NQ^*) \]
\[ \pi_T = \left[ 53 - N \left( \frac{48}{N+1} \right) \right] \left( N \left( \frac{48}{N+1} \right) \right) - 5N \left( \frac{48}{N+1} \right) \]
\[ \pi_T = \left[ 48 - \left( N \left( \frac{48}{N+1} \right) \right) \right] \left( N \left( \frac{48}{N+1} \right) \right) = \left( 2,304 \right) \left( \frac{N}{(N+1)} \right). \]

Notice that with $N$ firms
\[ Q = 48 \left( \frac{N}{N+1} \right) \]
and that, as $N$ increases ($N \to \infty$)
\[ Q = 48. \]

Similarly, with
\[ P = 53 - 48 \left( \frac{N}{N+1} \right), \]
as $N \to \infty$,
\[ P = 53 - 48 = 5. \]

Finally,
\[ \pi_T = 2,304 \left( \frac{N}{(N+1)} \right), \]
so as $N \to \infty$,
\[ \pi_T = 0. \]

In perfect competition, we know that profits are zero and price equals marginal cost. Here, $\pi_T = 0$ and $P = MC = 5$. Thus, when $N$ approaches infinity, this market approaches a perfectly competitive one.
5. Two firms compete in selling identical widgets. They choose their output levels $Q_1$ and $Q_2$ simultaneously and face the demand curve

$$P = 30 - Q$$

where $Q = Q_1 + Q_2$. Until recently, both firms had zero marginal costs. Recent environmental regulations have increased Firm 2’s marginal cost to $15. Firm 1’s marginal cost remains constant at zero. True or false: As a result, the market price will rise to the monopoly level.
12.3 Price Competition

Price Competition with Homogeneous Products—The Bertrand Model

- Bertrand model  Oligopoly model in which firms produce a homogeneous good, each firm treats the price of its competitors as fixed, and all firms decide simultaneously what price to charge.

Let’s return to the duopoly example of the last section.

\[ P = 30 - Q \]

\[ MC_1 = MC_2 = 3 \]

\[ Q_1 = Q_2 = 9, \text{ and in Cournot equilibrium, the market price is } 12, \text{ so that each firm makes a profit of } 81. \]

Now suppose that these two duopolists compete by simultaneously choosing a price instead of a quantity.

Nash equilibrium in the Bertrand model results in both firms setting price equal to marginal cost: \[ P_1 = P_2 = 3. \] Then industry output is 27 units, of which each firm produces 13.5 units, and both firms earn zero profit.

In the Cournot model, because each firm produces only 9 units, the market price is $12. Now the market price is $3. In the Cournot model, each firm made a profit; in the Bertrand model, the firms price at marginal cost and make no profit.
Price Competition with Differentiated Products

Suppose each of two duopolists has fixed costs of $20 but zero variable costs, and that they face the same demand curves:

**Firm 1’s demand:** \( Q_1 = 12 - 2P_1 + P_2 \)

**Firm 2’s demand:** \( Q_2 = 12 - 2P_2 + P_1 \)

**CHOOSING PRICES**

Firm 1’s profit:

\[ \pi_1 = P_1 Q_1 - 20 = 12P_1 - 2P_1^2 - 20 \]

Firm 1’s profit maximizing price:

\[ \Delta \pi_1 / \Delta P_1 = 12 - 4P_1 + P_2 = 0 \]

Firm 1’s reaction curve:

\[ P_1 = 3 + \frac{1}{4} P_2 \]

Firm 2’s reaction curve:

\[ P_2 = 3 + \frac{1}{4} P_1 \]
**NASH EQUILIBRIUM IN PRICES**

Here two firms sell a differentiated product, and each firm’s demand depends both on its own price and on its competitor’s price. The two firms choose their prices at the same time, each taking its competitor’s price as given.

Firm 1’s reaction curve gives its profit-maximizing price as a function of the price that Firm 2 sets, and similarly for Firm 2.

The Nash equilibrium is at the intersection of the two reaction curves: When each firm charges a price of $4, it is doing the best it can given its competitor’s price and has no incentive to change price.

Also shown is the collusive equilibrium: If the firms cooperatively set price, they will choose $6.

The firms have the same costs, so they will charge the same price $P$. Total profit is given by

\[ \pi_T = \pi_1 + \pi_2 = 24P - 4P_2 + 2P_2 - 40 = 24P - 2P_2 - 40. \]

This is maximized when \( \frac{\partial \pi_T}{\partial P} = 0 \). \( \frac{\partial \pi_T}{\partial P} = 24 - 4P \), so the joint profit-maximizing price is $P = $6. Each firm’s profit is therefore

\[ \pi_1 = \pi_2 = 12P - P^2 - 20 = 72 - 36 - 20 = $16 \]
EXAMPLE 12.2   A PRICING PROBLEM FOR PROCTER & GAMBLE

P&G’s demand curve for monthly sales:

\[ Q = 3375P^{-3.5}(P_U)^{.25}(P_K)^{.25} \]

Assuming that P&G’s competitors face the same demand conditions, with what price should you enter the market, and how much profit should you expect to earn?

<table>
<thead>
<tr>
<th>P&amp; G’s Price ($)</th>
<th>1.10</th>
<th>1.20</th>
<th>1.30</th>
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</table>

$1.40 is the price at which your competitors are doing the best they can, so it is a Nash equilibrium. As the table shows, in this equilibrium you and your competitors each make a profit of $12,000 per month. If you could collude with your competitors, you could make a larger profit. You would all agree to charge $1.50, and each of you would earn $20,000.
11. Two firms compete by choosing price. Their demand functions are

\[ Q_1 = 20 - P_1 + P_2 \]
\[ Q_2 = 20 + P_1 - P_2 \]

where \( P_1 \) and \( P_2 \) are the prices charged by each firm, respectively, and \( Q_1 \) and \( Q_2 \) are the resulting demands. Note that the demand for each good depends only on the difference in prices; if the two firms colluded and set the same price, they could make that price as high as they wanted, and earn infinite profits. Marginal costs are zero.

a) Suppose the two firms set their prices at the same time. Find the resulting Nash equilibrium. What price will each firm charge, how much will it sell, and what will its profit be? (Hint: Maximize the profit of each firm with respect to its price.)

b) Suppose Firm 1 sets its price first and then Firm 2 sets its price. What price will each firm charge, how much will it sell, and what will its profit be?

c) Suppose you are one of these firms and that there are three ways you could play the game: (i) Both firms set price at the same time; (ii) You set price first; or (iii) Your competitor sets price first. If you could choose among these options, which would you prefer? Explain why.
11. Two firms compete by choosing price. Their demand functions are
\[ Q_1 = 20 - P_1 + P_2 \quad \text{and} \quad Q_2 = 20 + P_1 - P_2 \]
where \( P_1 \) and \( P_2 \) are the prices charged by each firm, respectively, and \( Q_1 \) and \( Q_2 \) are the resulting demands. Note that the demand for each good depends only on the difference in prices; if the two firms colluded and set the same price, they could make that price as high as they wanted, and earn infinite profits. Marginal costs are zero.

a. Suppose the two firms set their prices at the same time. Find the resulting Nash equilibrium. What price will each firm charge, how much will it sell, and what will its profit be? (Hint: Maximize the profit of each firm with respect to its price.)

To determine the Nash equilibrium in prices, first calculate the reaction function for each firm, then solve for price. With zero marginal cost, profit for Firm 1 is:
\[ \pi = P_1 Q_1 = P_1 (20 - P_1 + P_2) = 20P_1 - P_1^2 + P_2P_1. \]
Marginal revenue is the slope of the total revenue function (here it is the derivative of the profit function with respect to \( P_1 \) because total cost is zero):
\[ MR_1 = 20 - 2P_1 + P_2. \]
At the profit-maximizing price, \( MR_1 = 0 \). Therefore,
\[ P_1 = \frac{20 + P_2}{2}. \]
This is Firm 1's reaction function. Because Firm 2 is symmetric to Firm 1, its reaction function is \( P_2 = \frac{20 + P_1}{2} \). Substituting Firm 2's reaction function into that of Firm 1:
\[ P_1 = \frac{20 + \frac{20 + P_1}{2}}{2} = 10 + 5 + \frac{P_1}{4}, \]
so \( P_1 = $20 \).
By symmetry, \( P_2 = $20 \).

To determine the quantity produced by each firm, substitute \( P_1 \) and \( P_2 \) into the demand functions:
\[ Q_1 = 20 - 20 + 20 = 20 \quad \text{and} \]
\[ Q_2 = 20 + 20 - 20 = 20. \]
Profits for Firm 1 are \( P_1 Q_1 = $400 \), and, by symmetry, profits for Firm 2 are also $400.
Suppose Firm 1 sets its price *first* and then Firm 2 sets its price. What price will each firm charge, how much will it sell, and what will its profit be?

If Firm 1 sets its price first, it takes Firm 2’s reaction function into account. Firm 1’s profit function is:

\[ \pi_1 = P_1 \left( 20 - P_1 + \frac{20 + P_1}{2} \right) = 30P_1 - \frac{P_1^2}{2}. \]

To determine the profit-maximizing price, find the change in profit with respect to a change in price:

\[ \frac{d\pi_1}{dP_1} = 30 - P_1. \]

Set this expression equal to zero to find the profit-maximizing price:

\[ 30 - P_1 = 0, \text{ or } P_1 = $30. \]

Substitute \( P_1 \) in Firm 2’s reaction function to find \( P_2 \):

\[ P_2 = \frac{20 + 30}{2} = $25. \]

At these prices,

\[ Q_1 = 20 - 30 + 25 = 15 \quad \text{and} \quad Q_2 = 20 + 30 - 25 = 25. \]

Profits are

\[ \pi_1 = (30)(15) = $450 \quad \text{and} \quad \pi_2 = (25)(25) = $625. \]

If Firm 1 must set its price first, Firm 2 is able to undercut Firm 1 and gain a larger market share. However, both firms make greater profits than they did in part (a), where they chose prices simultaneously.
Suppose you are one of these firms and that there are three ways you could play the game: (i) Both firms set price at the same time; (ii) You set price first; or (iii) Your competitor sets price first. If you could choose among these options, which would you prefer? Explain why.

**ANS.** Your first choice should be (iii), and your second choice should be (ii). (Compare the Nash profits in part (a), $400, with profits in part (b), $450 and $625.) From the reaction functions, we know that the price leader provokes a price increase in the follower. By being able to move second, however, the follower increases price by less than the leader, and hence undercuts the leader. Both firms enjoy increased profits, but the follower does better.
7. Suppose that two competing firms, A and B, produce a homogeneous good. Both firms have a marginal cost of $MC = 50. Describe what would happen to output and price in each of the following situations if the firms are at (i) Cournot equilibrium, (ii) collusive equilibrium, and (iii) Bertrand equilibrium.

1. Because Firm A must increase wages, its MC increases to $80.
2. The marginal cost of both firms increases.
3. The demand curve shifts to the right.
7. Suppose that two competing firms, \( A \) and \( B \), produce a homogeneous good. Both firms have a marginal cost of \( MC = $50 \). Describe what would happen to output and price in each of the following situations if the firms are at (i) Cournot equilibrium, (ii) collusive equilibrium, and (iii) Bertrand equilibrium.

a. Because Firm \( A \) must increase wages, its \( MC \) increases to $80.

ANS. (i) In a Cournot equilibrium you must think about the effect on the reaction functions, as illustrated in Figure 12.5 of the text. When Firm \( A \) experiences an increase in marginal cost, its reaction function will shift inward. The quantity produced by Firm \( A \) will decrease and the quantity produced by Firm \( B \) will increase. Total quantity produced will decrease and price will increase.

(ii) In a collusive equilibrium, the two firms will collectively act like a monopolist. When the marginal cost of Firm \( A \) increases, Firm \( A \) will reduce its production to zero, because Firm \( B \) can produce at a lower marginal cost. Because Firm \( B \) can produce the entire industry output at a marginal cost of $50, there will be no change in output or price. However, the firms will have to come to some agreement on how to share the profit earned by \( B \).

(iii) Before the increase in Firm \( A \)’s costs, both firms would charge a price equal to marginal cost \( (P = $50) \) because the good is homogeneous. After Firm \( A \)’s marginal cost increases, Firm \( B \) will raise its price to $79.99 (or some price just below $80) and take all sales away from Firm \( A \). Firm \( A \) would lose money on each unit sold at any price below its marginal cost of $80, so it will produce nothing.
b. The marginal cost of both firms increases.

ANS. 
(i) Again refer to Figure 12.5. The increase in the marginal cost of both firms will shift both reaction functions inward. Both firms will decrease quantity produced and price will increase.

(ii) When marginal cost increases, both firms will produce less and price will increase, as in the monopoly case.

(iii) Price will increase to the new level of marginal cost and quantity will decrease.

c. The demand curve shifts to the right.

ANS. 
(i) This is the opposite of the case in part b. In this situation, both reaction functions will shift outward and both will produce a higher quantity. Price will tend to increase.

(ii) Both firms will increase the quantity produced as demand and marginal revenue increase. Price will also tend to increase.

(iii) Both firms will supply more output. Given that marginal cost remains the same, the price will not change.
12.4 Competition versus Collusion: The Prisoners’ Dilemma

In our example, there are two firms, each of which has fixed costs of $20 and zero variable costs. They face the same demand curves:

**Firm 1’s demand:** \( Q_1 = 12 - 2P_1 + P_2 \)

**Firm 2’s demand:** \( Q_2 = 12 - 2P_2 + P_1 \)

We found that in Nash equilibrium each firm will charge a price of $4 and earn a profit of $12, whereas if the firms collude, they will charge a price of $6 and earn a profit of $16.

\[
\pi_2 = P_2 Q_2 - 20 = (4)[(12 - (2)(4) + 6] - 20 = $20 \\
\pi_1 = P_1 Q_1 - 20 = (6)[12 - (2)(6) + 4] - 20 = $4
\]

So if Firm 1 charges $6 and Firm 2 charges only $4, Firm 2’s profit will increase to $20. And it will do so at the expense of Firm 1’s profit, which will fall to $4.

**PAYOFF MATRIX**

- **noncooperative game** Game in which negotiation and enforcement of binding contracts are not possible.
- **payoff matrix** Table showing profit (or payoff) to each firm given its decision and the decision of its competitor.

<table>
<thead>
<tr>
<th>FIRM 2</th>
<th>CHARGE $4</th>
<th>CHARGE $6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRM 1</strong></td>
<td>Charge $4</td>
<td>$12, $12</td>
</tr>
<tr>
<td></td>
<td>Charge $6</td>
<td>$4, $20</td>
</tr>
</tbody>
</table>

**TABLE 12.3** PAYOFF MATRIX FOR PRICING GAME
THE PRISONERS’ DILEMMA

- prisoners’ dilemma  
  Game theory example in which two prisoners must decide separately whether to confess to a crime; if a prisoner confesses, he will receive a lighter sentence and his accomplice will receive a heavier one, but if neither confesses, sentences will be lighter than if both confess.

<table>
<thead>
<tr>
<th></th>
<th>PRISONER B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pray to A</td>
<td>CONFESS</td>
</tr>
<tr>
<td>Confess</td>
<td>–5, –5</td>
</tr>
<tr>
<td>Don’t confess</td>
<td>–10, –1</td>
</tr>
</tbody>
</table>

If Prisoner A does not confess, he risks being taken advantage of by his former accomplice. After all, no matter what Prisoner A does, Prisoner B comes out ahead by confessing. Likewise, Prisoner A always comes out ahead by confessing, so Prisoner B must worry that by not confessing, she will be taken advantage of. Therefore, both prisoners will probably confess and go to jail for five years. Oligopolistic firms often find themselves in a prisoners’ dilemma.
EXAMPLE 12.3 PROCTER & GAMBLE IN A PRISONERS’ DILEMMA

We argued that P&G should expect its competitors to charge a price of $1.40 and should do the same. But P&G would be better off if it and its competitors all charged a price of $1.50.

<table>
<thead>
<tr>
<th>TABLE 12.5 PAYOFF MATRIX FOR PRICING PROBLEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNILEVER AND Kao</td>
</tr>
<tr>
<td>CHARGE $1.40                   CHARGE $1.50</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>P&amp;G Charge $1.40                 $12, $12     $29, $11</td>
</tr>
<tr>
<td>P&amp;G Charge $1.50                 $3, $21       $20, $20</td>
</tr>
</tbody>
</table>

Since these firms are in a prisoners’ dilemma, it doesn’t matter what Unilever and Kao do. P&G makes more money by charging $1.40.
12.5 Implications of the Prisoners’ Dilemma for Oligopolistic Pricing

Does the prisoners’ dilemma doom oligopolistic firms to aggressive competition and low profits? Not necessarily. Although our imaginary prisoners have only one opportunity to confess, most firms set output and price over and over again, continually observing their competitors’ behavior and adjusting their own accordingly. This allows firms to develop reputations from which trust can arise. As a result, oligopolistic coordination and cooperation can sometimes prevail.

Price Rigidity

- **price rigidity** Characteristic of oligopolistic markets by which firms are reluctant to change prices even if costs or demands change.

- **kinked demand curve model** Oligopoly model in which each firm faces a demand curve kinked at the currently prevailing price: at higher prices demand is very elastic, whereas at lower prices it is inelastic.
**Figure 12.7**

**The Kinked Demand Curve**

Each firm believes that if it raises its price above the current price $P^*$, none of its competitors will follow suit, so it will lose most of its sales.

Each firm also believes that if it lowers price, everyone will follow suit, and its sales will increase only to the extent that market demand increases.

As a result, the firm’s demand curve $D$ is kinked at price $P^*$, and its marginal revenue curve $MR$ is discontinuous at that point.

If marginal cost increases from $MC$ to $MC'$, the firm will still produce the same output level $Q^*$ and charge the same price $P^*$.
Price Signaling and Price Leadership

- **price signaling**  Form of implicit collusion in which a firm announces a price increase in the hope that other firms will follow suit.

- **price leadership**  Pattern of pricing in which one firm regularly announces price changes that other firms then match.

In some industries, a large firm might naturally emerge as a leader, with the other firms deciding that they are best off just matching the leader’s prices, rather than trying to undercut the leader or each other.

Price leadership can also serve as a way for oligopolistic firms to deal with the reluctance to change prices, a reluctance that arises out of the fear of being undercut or “rocking the boat.”
Most textbooks sold in the United States have retail prices in the $200 range. In fact even other microeconomics textbooks—which are clearly inferior to this one—sell for around $200. Publishing companies set the prices of their textbooks, so should we expect competition among publishers to drive down prices? Partly because of mergers and acquisitions over the last decade or so, college textbook publishing is an oligopoly.

These publishers have an incentive to avoid a price war that could drive prices down. The best way to avoid a price war is to avoid discounting and to increase prices in lockstep on a regular basis. The retail bookstore industry is also highly concentrated, and the retail markup on textbooks is around 30 percent. Thus a $200 retail price implies that the publisher is receiving a net (wholesale) price of about $150. The elasticity of demand is low, because the instructor chooses the textbook, often disregarding the price. On the other hand, if the price is too high, some students will buy a used book or decide not to buy the book at all. In fact, it might be the case that publishers could earn more money by lowering textbook prices. So why don’t they do that? First, that might lead to a dreaded price war. Second, publishers might not have read this book!
The Dominant Firm Model

**Price Setting by a Dominant Firm**

\( D \) is the market demand curve, and \( S_F \) is the supply curve (i.e., the aggregate marginal cost curve) of the smaller fringe firms.

The dominant firm must determine its demand curve \( D_D \). As the figure shows, this curve is just the difference between market demand and the supply of fringe firms.

At price \( P_1 \), the supply of fringe firms is just equal to market demand; thus the dominant firm can sell nothing. At a price \( P_2 \) or less, fringe firms will not supply any of the good, so the dominant firm faces the market demand curve.

At prices between \( P_1 \) and \( P_2 \), the dominant firm faces the demand curve \( D_D \).
The Dominant Firm Model

- **dominant firm** Firm with a large share of total sales that sets price to maximize profits, taking into account the supply response of smaller firms.

**Figure 12.9**

PRICE SETTING BY A DOMINANT FIRM

The dominant firm sets price, and the other firms sell all they want at that price. The dominant firm’s demand curve, $D_D$, is the difference between market demand $D$ and the supply of fringe firms $S_F$.

The dominant firm produces a quantity $Q_D$ at the point where its marginal revenue $MR_D$ is equal to its marginal cost $MC_D$.

The corresponding price is $P^*$. At this price, fringe firms sell $Q_F$ so that total sales equal $Q_T$. 
12.6 Cartels

Producers in a *cartel* explicitly agree to cooperate in setting prices and output levels.

- If enough producers adhere to the cartel’s agreements, and if market demand is sufficiently *inelastic*, the cartel may drive prices well above competitive levels.

**Cartels are often international.**

- While U.S. antitrust laws prohibit American companies from colluding, those of other countries are much weaker and are sometimes poorly enforced.
- Furthermore, nothing prevents countries, or companies owned or controlled by foreign governments, from forming cartels.
- For example, the OPEC cartel is an *international agreement among oil-producing countries* which has succeeded in raising world oil prices above competitive levels.
CONDITIONS FOR CARTEL SUCCESS

First, a stable cartel organization must be formed whose members agree on price and production levels and then adhere to that agreement.

The second condition, and may be the most important, is the potential for monopoly power. Even if a cartel can solve its organizational problems, there will be little room to raise price if it faces a highly elastic demand curve.

Analysis of Cartel Pricing

Cartel pricing can be analyzed by using the dominant firm model discussed earlier. We will apply this model to two cartels, the OPEC oil cartel and the CIPEC copper cartel. This will help us understand why OPEC was successful in raising price while CIPEC was not.
ANALYZING OPEC

Figure 12.10

THE OPEC OIL CARTEL

TD is the total world demand curve for oil, and $S_C$ is the competitive (non-OPEC) supply curve.

OPEC’s demand $D_{OPEC}$ is the difference between the two.

Because both total demand and competitive supply are inelastic, OPEC’s demand is inelastic.

OPEC’s profit-maximizing quantity $Q_{OPEC}$ is found at the intersection of its marginal revenue and marginal cost curves; at this quantity, OPEC charges price $P^*$. If OPEC producers had not cartelized, price would be $P_c$, where OPEC’s demand and marginal cost curves intersect.
ANALYZING CIPEC

**Figure 12.11**

**THE CIPEC COPPER CARTEL**

TD is the total demand for copper and $S_c$ is the competitive (non-CIPEC) supply.

CIPEC’s demand $D_{CIPEC}$ is the difference between the two.

Both total demand and competitive supply are relatively elastic, so CIPEC’s demand curve is elastic, and CIPEC has very little monopoly power.

Note that CIPEC’s optimal price $P^*$ is close to the competitive price $P_c$. 
As the examples of OPEC and CIPEC illustrate, **successful cartelization requires two things:**

First, the total demand for the good must **not be very price elastic.**

Second, either the **cartel must control nearly all the world’s supply** or, if it does not, the **supply of noncartel producers must not be price elastic.**

**Most international commodity cartels have failed** because few world markets meet both conditions.
EXAMPLE 12.7 THE MILK CARTEL

The U.S. government has supported the price of milk since the Great Depression and continues to do so today. The government, however, scaled back price supports during the 1990s, and as a result, wholesale prices of milk have fluctuated more widely. Not surprisingly, farmers have been complaining.

In response to these complaints, in 1996 the federal government allowed milk producers in the six New England states to cartelize. The cartel—called the Northeast Interstate Dairy Compact—set minimum wholesale prices for milk, and was exempt from the antitrust laws. The result was that consumers in New England paid more for a gallon of milk than consumers elsewhere in the nation.

Studies have suggested that the cartel in the New England states has caused retail prices of milk to rise by only a few cents a gallon. Why so little? The reason is that the New England cartel is surrounded by a fringe of noncartel producers.

Congress ended the Northeast Interstate Dairy Compact in October 2001. Although proponents of the Compact attempted to revive the cartel, opposition in Congress has been strong. Nonetheless, milk production continues to benefit from federal price supports.
5. Two firms compete in selling identical widgets. They choose their output levels $Q_1$ and $Q_2$ simultaneously and face the demand curve

\[ P = 30 - Q \]

where $Q = Q_1 + Q_2$. Until recently, both firms had zero marginal costs. Recent environmental regulations have increased Firm 2’s marginal cost to $15. Firm 1’s marginal cost remains constant at zero. True or false: As a result, the market price will rise to the monopoly level.
Surprisingly, this is true. However, it occurs only because the marginal cost for Firm 2 is $15 or more. If the market were monopolized before the environmental regulations, the marginal revenue for the monopolist would be

\[ MR = 30 - 2Q. \]

Profit maximization implies \( MR = MC \), or \( 30 - 2Q = 0 \). Therefore, \( Q = 15 \), and (using the demand curve) \( P = 15 \).

The situation after the environmental regulations is a Cournot game where Firm 1's marginal costs are zero and Firm 2's marginal costs are $15. We need to find the best response functions:

Firm 1’s revenue is

\[ PQ_1 = (30 - Q_1 - Q_2)Q_1 = 30Q_1 - Q_1^2 - Q_1Q_2, \]

and its marginal revenue is given by:

\[ MR_1 = 30 - 2Q_1 - Q_2. \]

Profit maximization implies \( MR_1 = MC_1 \) or

\[ 30 - 2Q_1 - Q_2 = 0 \Rightarrow Q_1 = 15 - \frac{Q_2}{2}, \]

which is Firm 1’s best response function.

Firm 2’s revenue function is symmetric to that of Firm 1 and hence

\[ MR_2 = 30 - Q_1 - 2Q_2. \]

Profit maximization implies \( MR_2 = MC_2 \), or

\[ 30 - 2Q_2 - Q_1 = 15 \Rightarrow Q_2 = 7.5 - \frac{Q_1}{2}, \]

which is Firm 2’s best response function.

Cournot equilibrium occurs at the intersection of the best response functions. Substituting for \( Q_1 \) in the response function for Firm 2 yields:

\[ Q_2 = 7.5 - 0.5(15 - \frac{Q_1}{2}). \]

Thus \( Q_2 = 0 \) and \( Q_1 = 15 \). \( P = 30 - Q_1 - Q_2 = 15 \), which is the monopoly price.
Recap: Chapter 12

- Monopolistic Competition
- Oligopoly
- Price Competition
- Competition versus Collusion:
  - The Prisoners’ Dilemma
  - Implications of the Prisoners’ Dilemma for Oligopolistic Pricing
- Cartels