Module 7

Market structure

Introduction

In the previous module, we examined the nature of industries and saw that industries differ with respect to their underlying structures, conduct, and performances. In this module, we characterise the optimal price, output, and advertising decisions of managers operating in environments of (1) perfect competition, (2) monopoly, (3) monopolistic competition, and (4) oligopoly.

It is logical to start with the simplest case: a situation where managerial decisions have no perceptible impact on the market price. Thus, in the first section of this module, we will analyse output decisions of managers operating in perfectly competitive markets. In subsequent sections, we will examine output decisions by firms that have market power: monopoly and monopolistic competition, and oligopoly.

There are two key assumptions used in the economic theory of firms you should review before looking at pricing and output decision-making in the four types of markets:

1. The firm's primary objective is the short-run maximisation of profit. This may not be, however, the case for oligopoly, where time horizons typically extend beyond the short run. High short-run profits may induce the entry of new competitors to cause a more competitive market for the firms later in the planning period.
2. The opportunity cost of producing a particular good or service is included in the cost of doing business – economic costs.

In analysing a firm's pursuit of short-run profit, the economic theory of the firm posits that its managers must address three basic questions:

1. Should our company be in this business? That is, should it be selling this particular product at all?
2. If so, how much should we produce?
3. And if we are able to set the price, what price should we charge?

Firms operating in perfectly competitive markets cannot set their own price. Therefore, this question does not apply to them.

Outcomes

Upon completion of this module you will be able to:

- *explain* different forms of market structure and their underlying assumptions.
- *analyse* the significance of barriers to entry and the relative size of the firms in an industry in shaping the structure of the industry.
- *explain* why monopolies may, in some circumstances, be undesirable from the perspective of the society.
- *compare* the short and long-run equilibrium situations under perfect and monopolistic competition.
- *outline* various models of oligopoly.
- *explain* why oligopolistic market structures cannot be explained via one single model.
- *explain* the nature of the game implicit in the theory of oligopoly.

Terminology

Consumer surplus:	The amount above the price paid that a consumer would willingly spend.
Efficiency:	Maximising welfare for any given distribution of income.
Homogeneous products:	Identical product.
Perfect information:	Buyers and sellers have all relevant information about the market.
Producer surplus:	Largest amount that can be subtracted from a supplier's revenues.

Perfect competition

Perfect competition provides a benchmark against which the behaviour of other markets is judged. In this module we stress five key points:

1. Competition has many desirable properties.
2. Free entry and exit is a crucial factor in determining whether a market is competitive and efficient.
3. Welfare is maximised under competition.
4. The desirability of competition is reduced in the presence of externalities such as pollution.

5. Even if some of the necessary conditions for perfect competition do not hold, markets can come close to achieving the desirable properties of perfect competition.

Even though perfect competition is rarely, if ever, encountered in the real world, we study the perfect competition model because it provides an ideal framework against which we compare other models and markets.

We define perfect competition as a market outcome in which all firms produce homogeneous, perfectly divisible output and face no barriers to entry or exit; producers and consumers have full information, incur no transaction costs and are price takers; and there are no externalities. That is, the main assumptions of perfect competition are:

1. *Homogeneous good.* All firms sell an identical product. Consumers view the products of various firms as the same and hence are indifferent between them.
2. *Perfect information.* Buyers and sellers have all relevant information about the market, including the price and quality of the product.
3. *Price taking.* Buyers and sellers cannot individually influence the price at which the product can be purchased or sold. Price is determined by the market, so each buyer and seller takes the price as given.
4. *No transaction costs.* Neither buyers nor sellers incur costs or fees to participate in the market.
5. *No externalities.* Each firm bears the full costs of its production process. That is, the firm does not impose externalities – uncompensated costs – on others. For example, pollution produced by a firm is an externality because the firm does not recompense the victims.
6. *Free entry and exit.* Firms can enter and exit the market quickly at any time without having to incur special expense. That is, firms do not face barriers to entry or exit.
7. *Perfect Divisibility of Output.* Firms can produce and consumers can buy a small fraction of a unit of output. As a result, the amount of output demanded or supplied varies continuously with price. This technical assumption avoids problems caused by large discrete changes in either supply or demand in response to small price changes.

Some economists also assume that a perfectly competitive market has a large number of buyers and sellers. If there are many firms, no one firm can charge a price above the market price without losing all its customers, so the firm views the price at which it can sell as beyond its control. Similarly, consumers cannot find a firm willing to sell below the market price, so consumers must view the market price as beyond their control.

However, even if there are relatively few firms in a market, no firm could raise its price above the market price without losing all its customers if another firm could quickly enter the market and underprice it. Thus, because we assume firms and consumers are price takers and that there is free entry and exit, we do not also have to assume that there are a large number of firms. Competitive markets typically have a large number of firms and consumers, but industries can have all the properties of perfect competition even though there are few firms in those industries.

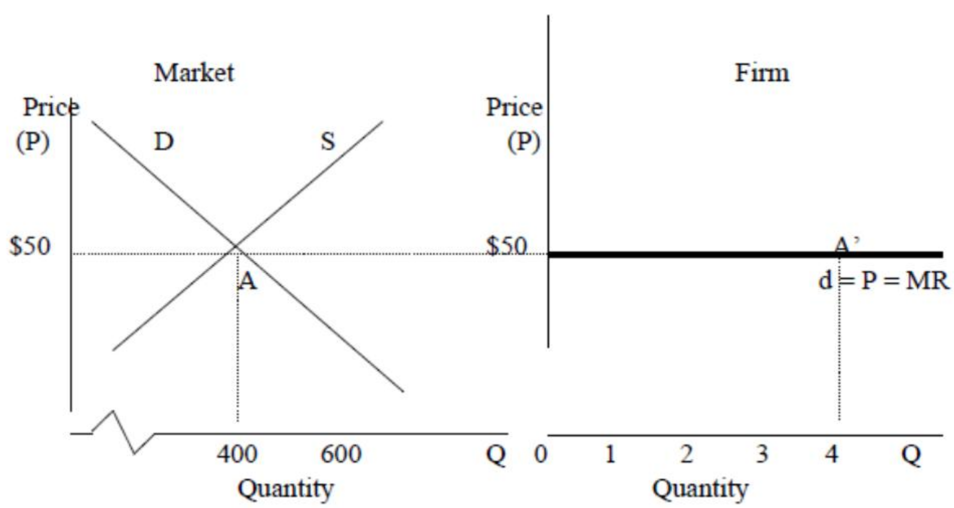
Single firm versus the market

Under perfect competition, the price is determined by interaction of many suppliers and demanders. The firm can sell its products only at this price, no less and no more. If the firm chooses to charge a higher price, given that its rivals are selling the same product, it will lose all its customers. The firm should not want to sell its product at a lower price, either; this strategy would have made sense, if the firm had some the capacity and the size to meet the needs of the customers lured from other firms, but it does not. These perfectly competitive firms are small; selling for less is not practical. Therefore, a perfectly competitive firm faces a demand curve that is horizontal at the market equilibrium price. Put differently, the demand is *perfectly elastic*.

Given that the market price is determined at the interaction of the market demand curve and the market supply curve, the perfectly competitive firm is a *price taker*. That is, the perfectly competitive firm takes the price of the product as given and has no perceptible effect on that price by varying its own level of output and sales product.

In Figure 7-1, D is the market demand curve, and S is the market supply curve of the product. Equilibrium price is P = $50 and is determined at point A, at the intersection of D and S. At this point, the quantity demanded equals quantity supplied, 400.

Figure 7-1



The equilibrium price and quantity can be determined algebraically by setting the demand and supply functions equal to each other and solving for the equilibrium price. Then substituting the result into the demand or supply functions and solving for Q, we get the equilibrium quantity.

Demand: $Q_D = 900 - 10P$ (1)

Supply: $Q_S = 150 + 5P$ (2)

Setting Q_D equal to Q_S, and solving for P, we have

$Q_D = Q_S$

$900 - 10P = 150 + 5P$

$750 = 15P$, $P = \$50$

Substituting into either function and solving for Q

$Q_D = 900 - 10(\$50) = 400$

$Q_S = 150 + 5(\$50) = 400$

Demonstration problem

Assume that in the example above, the industry (market) consists of 100 identical firms. How much would each firm produce? Depict the point of production for a representative firm.

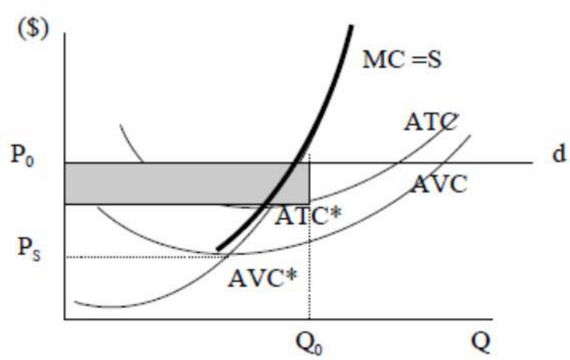
Answer:

It is clear that each firm will produce (1/100) of the industry's output. Since the industry as whole produces 400 units, the share of each firm is four units. The price charged by each firm is $50 along the horizontal line (d) and quantity produced is four, point A' in Figure 7-1.

Short-run supply decision

Let us first examine the incentives of a typical firm. Suppose a firm has the short-run cost curves in Figure 7-2 and faces a market price of P_0. How much should it produce? Indeed, should it produce anything at all?

Figure 7-2



The objective of any firm, including a competitive firm, is to maximise its profits (or, equivalently, minimise its losses). The competitive firm's profits, π, are

$$\pi = TR(PQ) - TC(Q) \qquad (3)$$

where P is price, Q is output, and TR and TC are total revenue and total costs, respectively.

A firm produces only if doing so is more profitable than not producing. It produces only if the revenues from producing exceed avoidable costs: the costs that are not incurred if a firm ceases production. The revenues earned in excess of avoidable cost are called *quasi-rents,* which are the payments above the minimum amount necessary to keep a firm operating in the short run. For simplicity, assume that all fixed costs are sunk. An example of a sunk cost in Module 6 is that a firm is not refunded its incorporation fee if it ceases operation. In this case, avoidable costs are the same as variable costs. Thus, the rule for deciding whether to remain in business is: produce and sell only if revenues are at least as great as total variable cost. Equivalently, the firm should produce and sell at price P only if it equals or exceeds average variable cost (AVC).

As shown in Figure 7-2, the minimum point of average cost (the lowest point on the ATC curve), ATC*, is greater than minimum AVC, AVC*, in the short run, because average costs are average variable costs plus average fixed costs. Thus a firm finds it more profitable to produce than to shut down if price is below minimum average cost, P < ATC*, but above minimum average variable cost, P > AVC*. It is more profitable to produce and earn some revenue in excess of variable cost than to shut down and earn no revenue (which can help offset the fixed costs). That is, the firm chooses to produce though it is losing money when all costs are considered.

Demonstration problem

Consider an example to clarify this apparent contradiction. Suppose a firm's fixed cost is $300 and sunk. Its marginal cost (MC) is constant at $20 at quantities less than 150 units, while at more than 150 units, MC rises drastically. If the price is $20, i.e., P = MC = $20, the firm will produce and sell 150 units. The firm just covers production cost and makes no contribution to the $300 fixed cost; it loses $300. What would be the effect of marginal costs of $19 and $21?

Answer:

If the price is $19, the firm is better off not producing at all, because it loses an additional $1 for every unit it produces and would lose $450 ($300 in fixed cost plus $150 in variable cost) if it produced 150 units. It is better to shut down and lose only $300 than to produce and suffer greater losses.

If the price is $21, by producing 150 units, the firm now more than covers variable cost: it earns $150 above variable cost. It still loses money overall (–300 + 150 = –150) because of the fixed cost of $300, but it is better to lose $150 than $300.

The price at which a firm ceases production is the *shutdown point*, which is P_S in Figure 7-2. That is, if price exceeds AVC*, the firm operates along its MC curve. The firm's *supply curve* reflects the quantity that a firm is willing to supply at any given price. The competitive firm's supply curve is the portion of the MC curve above AVC*, the shutdown point.

Demonstration problem

If a firm suffers losses in the short run (the period in which costs are sunk), should it continue to operate and remain unprofitable in the future?

Answer:

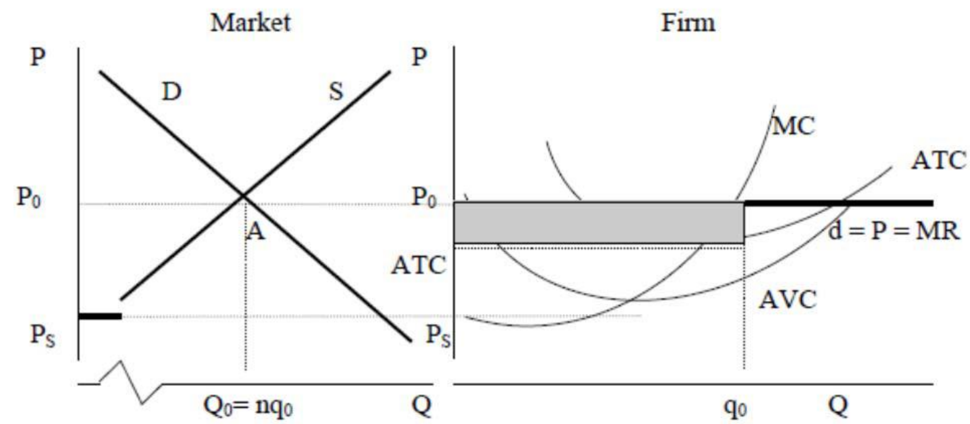
No. In the long run, a firm that is losing money will not reinvest – it will not continue to sink costs. Short-run losses are a signal that the firm should not invest further to replace plant and equipment. In the long run, a rational firm shuts down if it expects to have losses in each period forever. It prefers to cease production rather than invest in new facilities or maintenance and lose even more.

When a firm loses in the short run, its revenues are below the long-run opportunity cost of its resources. Because opportunity cost includes a normal profit, a firm that is making a loss may not literally be paying out more money than it receives; it is simply earning less than it could have earned had it invested its (already) sunk costs elsewhere.

As we have already seen, the short-run profit-maximisation is attained by P = MC. Suppose there are *n* identical firms and that all fixed costs are sunk in the short run. The short-run market supply curve, S in Figure 7-3, is the horizontal sum of the supply curves of each firm (the upper portion of the firm's marginal cost curve above the minimum of the AVC curve). The horizontal portion of the market supply curve reflects (1) that no output is forthcoming if price falls below the shutdown point and (2) that at a price slightly above the shutdown point, all firms produce.

The interaction of the market demand curve and the short-run market supply curve determines the *short-run equilibrium price*, P_0 and quantity, $Q_0 = nq_0$, where q is the volume of output produced by an individual firm, which produces 1/n of the market output.

Figure 7-3



The shaded rectangle in Figure 7-3 represents the maximum profits of the firm. To see this, note that the area of the shaded rectangle is given by its base (q_0) times the height [P_0 – ATC(q_0)]. Recall that ATC(q_0) = TC(q_0)/q_0; that is, average total cost is total cost divided by output. Intuitively, [P_0 – ATC(q_0)] represents the profits per unit produced. When this is multiplied by the profit-maximizing level of output (q_0), the result is the amount of total profits earned by the firm.

Demonstration problem

Suppose the cost function of for a firm is given by $TC(Q) = 10 + 2Q^2$

If the firm sells output in a perfectly competitive market and other firms in the industry sell output at a price of $40, what price should the manager of this firm put on the product? What level of output should be produced to maximise profits? How much profit will be earned?

Answer:

The derivate of the total cost function is the marginal cost function:

$$d(TC)/dQ = MC(Q) = 2(2Q) = 4Q$$

Since the firm competes in a perfectly competitive market, it must charge the same price other firms charge; thus, the manager should price the product at $40. To find the profit-maximising output, we must equate price with marginal cost 40 = 4Q, so the profit-maximising level of output is 10 units. The maximum profits are thus:

$$\text{Profit} = (40)(10) - [5 + 2(10)^2] = 400 - 205 = \$195$$

Long run

In the short run, a firm decides whether to produce or not and also if the decision is to produce, how much to produce. In the long run, the firm faces less constraint. They can, indeed, adjust their levels of capital so that they can enter this market. Remember, long run is a time frame in which an existing firm can change the size of its fixed input (plant) – there are no fixed inputs – or to decide to leave the industry to avoid losses. By a similar token, in the long run, new firms can enter the industry in pursuit of profits.

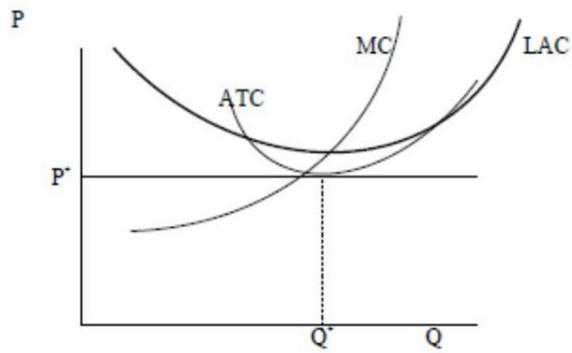
As indicated earlier, in the short run, a firm might face three different possibilities: making an economic profit, taking an economic loss, or breaking even. In the long run, however, a perfectly competitive firm, despite its short-run situation, cannot either run an economic profit or an economic loss. Indeed, the only outcome in the long run for a perfectly competitive firm is one in which the firm makes normal profit.

An industry in which firms are making an economic profit in the short run adjusts in two different ways. First, the number of firms in the industry increases. Second, the existing firms expand to take advantage of the profit. *Entry* by new firms is a rational decision by investors who respond to market incentives (signals) prompted by an economic profit. By the same token, economic profit also serves as the incentive (signal) to the existing firms to expand their existing operation.

The presence of short-run losses prompts a different set of rational responses. First, the number of firms in the industry decreases as some existing firms *exit*. Second, the existing firms contract the scale of their business.

The process just described continues until ultimately the market price is such that all firms in the market earn zero economic profits. Moreover, the best level of output is the one at which price equals the minimum point of ATC (short-run average cost curve) as well as the lowest point of the long-run average cost curve (LAC). This is shown in Figure 7-4. At the price of P^* each firm receives just enough to cover the average costs of production (ATC) because in the long run there is no distinction between fixed and variable costs, and economic profits are zero.

Figure 7-4



It is important to remember the distinction we made in Module 6 between economic profits and accounting profits. The fact that a firm in a perfectly competitive industry earns zero economic profits in the long run does not mean that accounting profits are zero; rather, zero economic profits implies that accounting profits are just high enough to offset any implicit costs of production. The firm earns no more, and no less, than it could earn by using the resources in some other capacity. This is why firms continue to produce in the long run even though their economic profits are zero.

Efficiency

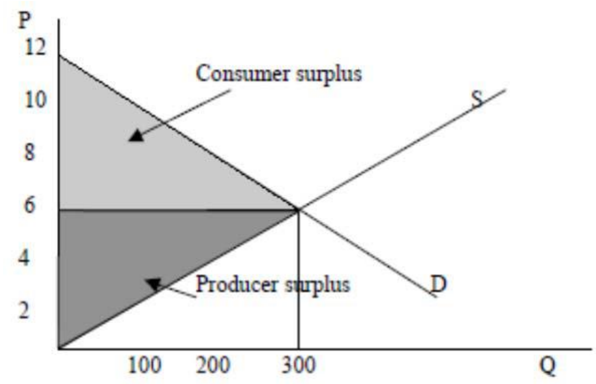
We now describe a common measure of welfare showing that competition maximises this measure of welfare for any given distribution of income, and illustrate that departures from competition lower welfare.

Consumer surplus

Typically, consumers value the goods they purchase above what they actually pay for them. *Consumer surplus* is the amount above the price paid that a consumer would willingly spend, if necessary, to consume the units purchased.

The demand curve reflects the value that consumers place on consuming alternative units of a good. For example, the demand curve in Figure 7-5 indicates that consumers would pay $10 for 100 units of the good, $8 for 200 units, and $6 for 300 units. In the competitive equilibrium, consumers pay $6 for 300 units. They would, however, be willing to pay $4 more for the first 100 units, $2 more for the first 200 units, and no extra amount for 300 units. The total consumer surplus is the area below the demand curve and above the equilibrium price of $6 up to the equilibrium quantity of 300 units. This area equals $900 (= [$12 – $6] x 300/2). The amount that consumers did actually pay is 300 x $6 = $1,800. Therefore the consumer surplus is 50 per cent of what is actually paid.

Figure 7-5



Producer surplus

Similarly, firms may receive more for the goods they sell than it costs them to produce those goods. *Producer surplus* is the largest amount that can be subtracted from a supplier's revenues and yet the supplier would still willingly produce the product.

We can use information from the supply curve to calculate firms' producer surplus. The marginal cost of producing output represents the firm's supply curve. For example in Figure 7-5, it costs firms $2 to produce 100 units, $4 to produce 200 units, and $6 to produce 300 units. The producer surplus is the area above the supply curve and below the price line. Therefore, the producer surplus is the area equal to $900. That is, the firm would be willing to depend on an extra $900 than going without any sale.

One common measure of welfare from a market is the sum of consumer and producer surplus. It is the amount that consumers and producers are willing to pay to exchange the equilibrium quantity of output.

Deadweight loss

The cost to society of a market not operating efficiently is called deadweight loss. It is the welfare loss – the sum of the consumer surplus and producer surplus lost – from a deviation from the competitive equilibrium. We discuss the application of this concept below.

Monopoly

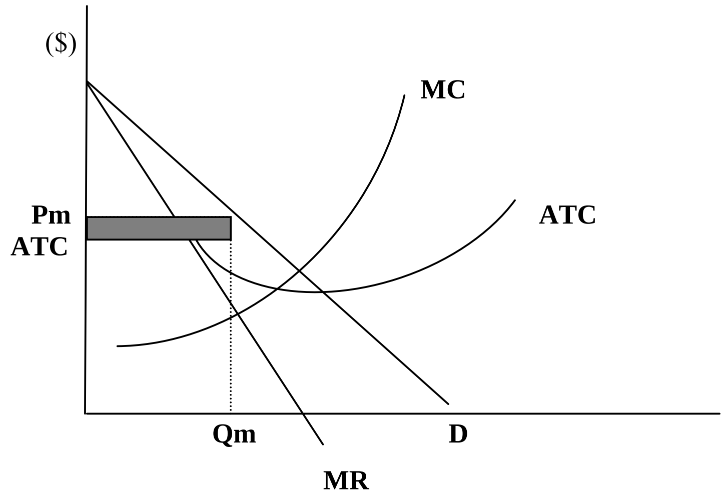
In the previous section, we characterised the optimal output decisions of firms that are small relative to the total market. In this context, small means the firms have no control over the prices they charge for the product. In this section, we consider the opposite extreme: monopoly. Monopoly refers to a situation where a single firm serves an entire market for a good for which there are no close substitutes. As such, monopolists can safely ignore the reaction of their rivals, because there are no close rivals.

Monopolies persist over time if the entry of new firms is prevented by *barriers to entry*. Barriers to entry are additional costs that a potential entrant must incur before gaining entry to a market. These costs may arise because of economies of scale, the best location, possession of the necessary information, the right to produce the product (such as a patent or a government mandate), the existing firms controlling an essential raw material, and so on. Consumer loyalty to the existing firm also poses a barrier to a potential entrant, since the new firm would have to spend substantial amounts on advertising to offset it. In some cases, the entrant cost is infinite (where it is impossible to acquire the necessary input or permission to produce).

When one thinks of a monopoly, one usually envisions a very large firm. This needn't be the case, however; the relevant consideration is whether there are other firms selling close substitutes for the good in a given market. For example, a petrol station located in a small town that is several hundred kilometres from another petrol station is a monopolist in that town. In a large town, there are usually many petrol stations, and the market for petrol is not characterised by monopoly.

The profit-maximising monopolist will wish to expand output until marginal costs rise to equal marginal revenues. Since this firm faces the entire market demand, the firm's demand curve and the market demand curve are one and the same. Thus, the market marginal revenue curve is the firm's marginal revenue curve. We saw in previous modules that the marginal revenue curve associated with a negatively sloping linear demand curve has the same vertical intercept on the graph and twice the slope of the demand curve. In Figure 7-6, we show the market demand curve (D) faced by the monopolist and the corresponding marginal revenue (MR) curve. Superimposed on these are the cost curves of the monopolist – the short-run average cost (ATC) and marginal cost (MC) curves. The profit-maximising monopolist produces up to the point where marginal cost per unit rises to meet the falling marginal revenues. This point occurs at output level Q_m. Notice that for every unit to the right of Q_m, MC > MR, it will therefore not be produced. Conversely, for every unit to the left of Q_m, MC < MR, it therefore will be produced and sold. The firm's profits can be visualised as the rectangle $(P_m – ATC) \times Q_m$.

Figure 7-6



Monopolists in the real world usually do have some peripheral competition from distant and partial substitutes. The post office experiences competition from the telephone company and from such delivery services as local or international courier companies for some of the services it provides. The electricity company competes with the gas company in some households. In all these cases, however, the extent of substitution of these products for the monopolist's product is quite small.

Demonstration problem

In the discussion above, what economic measure can determine the extent of substitution between products?

Answer:

The answer is the cross elasticity of demand between the monopolist's product and its distant substitutes.

Mathematically, the monopolist should produce the output, Q_m, such that marginal revenue equals marginal cost:

$$MR(Q_m) = MC(Q_m) \qquad (4)$$

Given the level of output, Q_m, that maximises profits, the monopoly price is the price on the demand curve corresponding to the Q_m units produced: $P_m = P$ (when $Q = Q_m$).

Demonstration problem

Suppose the inverse demand function for a monopolist's product is given by

$$P = 60 - Q$$

And the cost function is given by

$$TC(Q) = 20 + 2Q$$

Determine the profit-maximising price and quantity and the maximum profits.

Answer:

As we know, MR has the same intercept as the demand curve but a slope that is twice as large as that in the demand curve

$$MR = 60 - 2Q$$

and $MC = 2$

Next, we set MR = MC to find the profit-maximising level of output:

$$60 - 2Q = 2$$

$$2Q = 58$$

Solving for Q yields the profit-maximising output of $Q_m = 29$ units. We find the profit-maximizing price by plugging in for Q_m in the demand function:

$$P = 60 - (29) = \$31$$

Thus, the profit-maximising price is $31 per unit. Finally, profits are given by the difference between revenues and costs:

$$\text{Profits} = ((P_m)(Q_m)) - TC(Qm)$$

$$= (31)(29) - [20 + 2(29)]$$

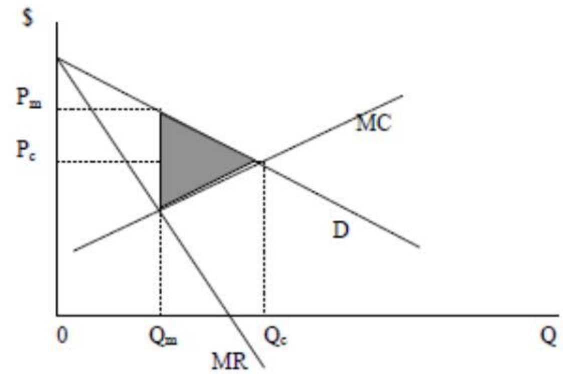
$$= \$821$$

Welfare loss of monopolies

Often, the flip side of the power that a monopolist enjoys is viewed as a cost to the society, *social cost*. As we discussed earlier, the cost to the society of a market not operating efficiently is called deadweight loss.

In comparison to perfectly competitive industries, monopolies tend to create a deadweight loss. This is the case since a monopolist charges too high a price and produces too little output, compared to the socially optimal level of price and output obtained under perfect competition. Under perfect competition, the price paid by consumers reflects the marginal cost – which in absence of externalities is the true cost to the society – while under monopoly, the price is marked up above marginal cost. Therefore monopolies, in comparison, operate on a higher point on the demand curve, where the price is higher and output is lower. As illustrated in Figure 7-7, P_m and Q_m correspond to the monopoly price and quantity, i.e., where MR = MC, whereas P_c and Q_c are the price and quantity under perfect competition where P = MC.

Figure 7-7



The deadweight loss, or the loss to the society, is shown by the shaded area, which is partly the loss to consumers and partly to producers.

The multi-plant monopoly

Until this point, we have assumed that the monopolist produces output at a single location. In many instances, however, many firms operate more than one plant. They may have built two or more smaller plants to avoid diseconomies of plant size that would occur if they tried to serve their market from a single, much larger, plant. A second reason for multi-plant operation is relatively high transportation costs for the finished goods. If the market is spread over a wide geographical area, the firm will find it more economical to operate two or more plants in two or more locations, if the savings in transportation costs more than outweigh the economies of plant size foregone. Third, the firm may operate two or more plants as a result of a merger or takeover, and the costs of scrapping both plants and building another larger one more than offset the economies of plant size foregone.

The multi-plant monopolist, unlike a simple monopolist, has to do two things:

1. It must determine its profit-maximizing price and total output level.
2. At the same time it must determine the cost-minimizing allocation of the total output among its two or more plants.

The standard profit-maximising rule, that marginal costs should equal marginal revenue, remains applicable, but our interpretation of the marginal cost curve must reflect the fact that marginal costs now derive from two or more production sources. The relevant marginal cost curve must show the marginal cost for each incremental unit produced when the firm is free to choose the plant in which that incremental unit should be produced. Clearly, the firm will always nominate the plant that can produce the incremental unit at the lowest additional (or marginal) cost.

For simplicity, suppose the firm operates just two plants, plant A with the total cost function $TC_A(Q_A)$ and plant B represented by the cost function $TC_B(Q_B)$, where ($Q_A + Q_B = Q$ = total output of the monopolist). The demand for the monopolist's product is typically given by $P = f(Q) = f(Q_A + Q_B)$. Note that consumers do not care which plant their purchased products come from.

It follows that, at any total output level (Q), the marginal cost from each plant should be equal, since if this were not true, the last unit might be taken away from the plant with the higher marginal cost and be produced instead by the plant with the lower marginal cost, and thus reduce the cost to the firm as a whole. That is,

$$MC_A(Q_A) = MC_B(Q_B)$$

The firm's profits will be maximised when

$$MR(Q) = MC_A(Q_A)$$

$$MR(Q) = MC_B(Q_B) \qquad (5)$$

Demonstration problem

Suppose a monopolist faces the following demand and cost curves.

Demand: $P = 100 - (Q)$, hence

$$MR = 100 - 2Q = 100 - 2\,(Q_A + Q_B)$$

and costs:

$$TC_A = 2Q_A^2, hence$$
$$MC_A = 4Q_A$$
$$TC_B = Q_B^2, hence$$
$$MC_B = 2Q_B$$

Determine (a) the level of output produced by each plant, (b) the total level of output, and (c) the price charged.

Answer:

$MR(Q) = MC_A$

$MR(Q) = MC_B$

Plugging in

$100 - (Q_A + Q_B) = 4Q_A$

$100 - (Q_A + Q_B) = 2Q_B$

From the first equation:

$Q_B = 100 - 5Q_A$

Substituting this into the second equation:

$100 – (Q_A + 100 – 5Q_A) = 2(100 – 5Q_A)$

$Q_A = 18.25$

$Q_B = 100 – 5(18.25) = 9.75$

$P = 100 – (28) = \$72.$

Monopolistic competition

In monopolistic markets, the firms must choose a price knowing that the consumer has many close substitutes to choose from. If the price is too high, in view of the consumer's perception of the value of the differentiating features of the firm's products, the consumer will purchase a competing firm's product instead. Thus, the monopolistic competitor must expect a relatively elastic demand response to changes in its price level. Yet at the same time, it expects to change price without causing any other firm to retaliate and, consequently, without causing a change in the general price level in the market. This is possible because the firm is one of many firms, and it expects the impact of its actions to be spread imperceptibly over all the other firms, giving no one firm any sufficient reason to react to the initial firm's price change.

Monopolistic competition is so called because it has elements of both monopoly and pure competition. The firm has a significant amount of monopolistic pricing and pure competition. The firm has a significant amount of the monopolist's pricing power by virtue of the differentiation of its product. It can change price up or down without experiencing the extreme response of pure competition. For price increases it will suffer a loss of sales, but this loss in not total, as it would be for the pure competitor. Like a monopoly, the monopolistic competitor can adjust the price upward or downward to the level which maximises its profits. But like the pure competitor, the monopolistic competitor has many rivals in the short run, compounded by the free entry of new firms in the long run.

The following sums up the conditions that prevail in a monopolistically competitive industry: (a) Many buyers and sellers, (b) differentiated products, and (c) rather easy entry to and exit from the industry by firms in the long run.

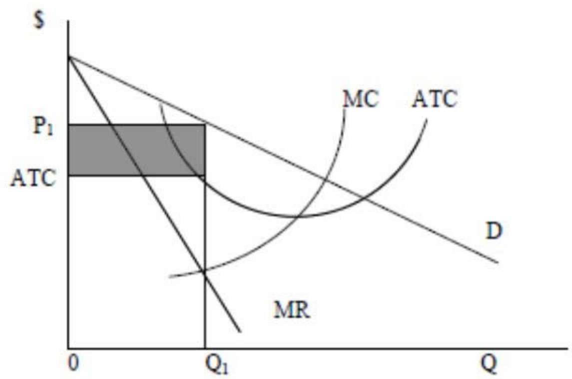
In reality, monopolistically competitive markets are found where a large number of vendors gather to sell similar products to a gathering of potential buyers. The weekly fruit and vegetable market in some communities may be characterised as monopolistic competition.

Short-run price and output determination

Figure 8-8 shows the equilibrium situation for a monopolistically competitive firm. The demand curve faced by this firm is negatively sloping because firms in this industry are price makers selling differentiated products. The monopolistically competitive firm maximises its profits at the price and output level where marginal revenue equals marginal costs. Since the firm produces a differentiated product, the demand curve it faces is negatively sloped. That is, the firm is a price maker to an extent. However, the demand is highly price elastic since there are many close substitutes for the product.

The best level of output and price is found when the firm sets its MR = MC, where the short-run economic profit is shown by the shaded are.

Figure 7-8



Note that a monopolistically competitive firm can make a positive economic profit, or a negative economic profit (loss), or zero economic profit in the short run. In the above case in Figure 7-8, the firm makes a positive economic profit since P > ATC at the production point, Q_1.

Long-run price and output determination

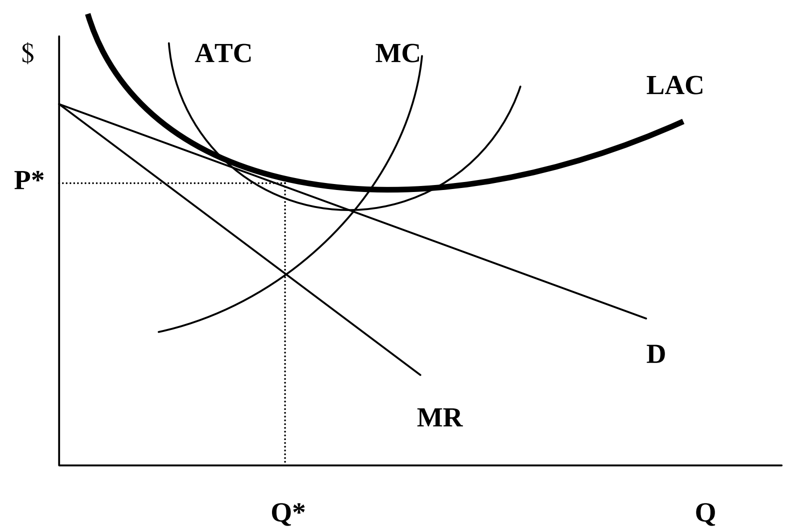
Because there is free entry, if firms earn short-run profits in a monopolistically competitive industry, additional firms will enter the industry in the long run to capture some of those profits. Similarly, if existing firms incur losses, in the long run firms will exit the industry.

An industry in which monopolistically competitive firms are making an economic profit in the short run adjusts in two different ways. First, the number of firms in the industry increases. Second, the existing firms expand to take advantage of the profit. Entry by new firms is a rational decision by investors who respond to market incentives (signals) prompted by an economic profit. By the same token, economic profit also serves as the incentive (signal) to the existing firms to expand their existing operation. On the other hand, the presence of short-run losses prompts a different set of rational responses. In this case, on the one hand, the number of firms in the industry decreases as some existing firms exit, and on the other hand, the existing firms contract the scale of their business.

The process just described continues until ultimately the market price is such that all firms in the market earn zero economic profits. The best level of output in the long run is, therefore, the one at which price equals

ATC (short-run average cost curve) as well as LAC (the long-run average cost curve). This is shown in Figure 7-9. At the price of P^* each firm receives just enough to cover the average costs of production (ATC) because in the long run there is no distinction between fixed and variable costs, and economic profits are zero.

Figure 7-9



In the long run, monopolistically competitive firms produce at Q*, where two conditions are satisfied: (1) P > MC = MR, and (2) P = ATC > minimum of average costs. The first condition is the requirement for profit-maximisation that is the objective of the firm in the short run as well as in the long run. However, unlike perfect competition, the point of optimality occurs to the left of the minimum of ATC. Therefore, P > MC implying that monopolistically competitive firms produce less output than is socially desirable. The second condition ensures that firms earn zero economic profits just as firms in perfectly competitive markets do. Even though the firms have some control over price, competition among them leads to a situation where no firm earns more than its opportunity cost of producing.

Demonstration problem

You are the manager of a monopolistically competitive firm, and your demand and cost functions are given by $P = 10 – 1/2\ Q$ and $TC(Q) = 100 – 20Q + Q^2$.

a. Find the profit-maximising price and output, and the maximum profit.
b. What are the adjustments in the long run?

Answer:

a. Setting MR = MC to obtain Q

MR (= 10 – Q) = MC (= –20 + 2Q), hence, Q = 10 and P = \$5. Profit = TR – TC = 10(\$5) – (100 –20(10) + 10^2) = \$50.

b. In the long run, new firms enter causing the existing firms' market share to diminish; the demand curve shifts to the left, shifting the MR curve with it. Economic profit disappears and each firm will make only normal profit, where MR = MC coincides with P = ATC.

Oligopoly

Oligopolies are markets in which there are only a few sellers of a homogenous or differentiated product. In the real world, the great majority of market situations are oligopolies. Prominent examples are the automobile, steel, aluminium, chemical, breakfast cereals, cigarettes and many other industries. The homogenous products include steel, whereas differentiated products include breakfast cereals and cars.

Oligopolies are mutually dependent because there are only a few of them sharing a particular market, and any one firm's sales gain, resulting from a price reduction, for example, will be accompanied by sales losses for its rivals. The rival firms must be expected to react to their loss of sales, probably by also reducing price to win back their lost customers. Clearly, such myopic price-cutting could precipitate a 'price war' which could inflict heavy financial losses on all firms. Conversely, a price increase that is ignored by rivals may lead to a substantial loss of market share and profitability, since at least some of its customers will switch to a rival firm's product.

When General Motors, for example, introduces price rebates in the sale of its cars, Ford and Daimler Chrysler are likely to follow with their own rebates. Or when Honda makes an aggressive move to increase production of its Accord cars, Toyota and Ford might react by cutting their production of Camry and Taurus, respectively. Therefore, oligopolists should attempt to predict the probable reaction of rivals to its strategic actions and decide whether or not an action is likely to be worthwhile in the final analysis before taking that action.

As a general rule, oligopolists can compete on the basis of price, or non-price, such as product differentiation, quantity, advertising, service, etc. However, since price competition can be destructive, there is a tendency for oligopolists not to engage in price competition.

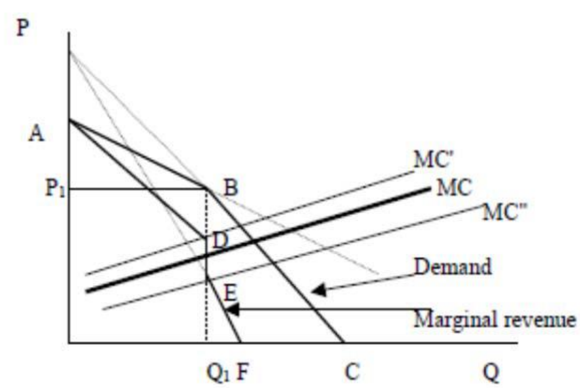
The kinked demand curve model of oligopoly

We shall first examine the *kinked demand curve model.* Also known as Sweezy Oligopoly, this model is characterised by (a) few firms serving the market, (b) differentiated products, and (c) presence of barriers to entry. Furthermore, this model assumes that the firm's actions in regard to a price change may invite an asymmetrical reaction by other firms. For price increases, the firm will very likely lose most of its customers as there will be no reaction from rivals, since the rival firms will be content to sit back and receive the extra customers who switch away from the firm raising its price. However, price reductions by the firm will not increase its market share since its rivals will likely match the price reduction to maintain their own share of the market.

In conclusion, other firms do not react to this firm's price increases, the firm's demand curve above the current price level will be relatively elastic, and while below the current price level, the demand curve will be relatively inelastic since the firm's market share does not change as other firms match its price reduction. Therefore the demand curve faced by the firm has a kink at the current level of price.

In Figure 7-10, we show a firm's current price and output levels as P_1 and Q_1. For prices above P_1, the firm envisages the relative elastic demand curve shown by the line AB. For prices below P_1, it envisages the relatively inelastic demand curve shown by the line BC. The demand curve facing the firm is, therefore, ABC, being kinked at the current price level. The marginal revenue curve corresponding to this demand curve will have two separate sections. The upper section of the marginal revenue curve, shown as AD, relates to the upper section of the demand curve and therefore shares the same intercept and has twice the slope of the line AB. The lower section, EF, relates to the lower section of the demand curve and is positioned such that it has twice the slope of the line BC, and if extended up to the price axis would share its intercept point with the line BC similarly extended. Note that the kink in the demand curve, B, causes the DE discontinuity in the marginal revenue. The best level of output of the oligopolist with marginal cost curve MC is Q_1, found at the intersection of MC with the vertical section of MR. The oligopolist then charges the price of $P_{1,}$ given by point B (at the kink on the demand curve).

Figure 7-10



An important implication of the Sweezy model is that there is a range (DE) over which changes in marginal cost do not affect the profit-maximising level of output. That is, the marginal cost curve can rise to MC' or fall to MC" within this range without inducing the oligopolist to change the prevailing price of P_1 and sales of Q_1 units (as long as P >

AVC). Only when the marginal cost curve shifts above the MC' or below MC" will the oligopolist be induced to change its optimum combination of price and quantity.

Demonstration problem

Safe Ride Products markets its products in an oligopoly in which all makers of similar products are keenly aware of what each other is doing. Safe Ride Products perceives the demand function for its new road-emergency kit to be a kinked line with two different slopes.

Above the kink, $D_1 : Q_1 = 85 – P_1$

while below the kink, $D_2 : Q_2 = 32.5 – 0.25P_2$

Where, Q = Output in thousands of units, P = Price in dollars.

The firm's total cost, TC, is

$TC = 375 + 25Q + O.6Q^2$

a. Using the kinked-demand-curve model, what is the firm's output and price at the kink?
b. Are this output, price and profit optimal?
c. Graph this problem.

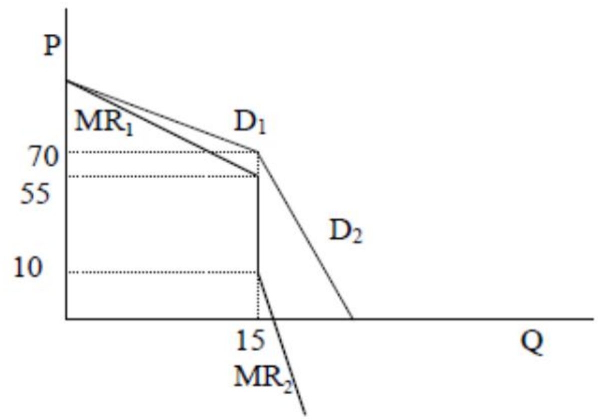
Answer:

a. The kink occurs at the intersection of the two differently sloped demand curves. But we first must invert the demand equations: $P_1 = 85 – Q_1$, and
$P_2 = 130 – 4Q_2$. Now setting $P_1 = P_2$, and treating Q_1 and Q_2 as the same quantity: 85 – Q = 130 – 4Q, Q = 15, and hence $P_1 = P_2 = \$70$.

Profit = $[(70(15)] – [375 – 25(15) – .6(15)^2] = \$165(000)$

b. Optimality requires that MR = MC. The upper point on the discontinued vertical MR curve is obtained by first plugging into MR_1, $MR_1 = 85 – 2Q = 85 – 2(15) = \$55$, whereas the lower point on this discontinued segment of the MR curve is found by plugging into the $MR_2 = 130 – 8Q = 130 – 8(15) = \$10$. Since at the current level of output (15), MC = 25 + 1.2Q = 43 falls between 10 and 55, the price, and output found above are those of the optimal situation.

c.



Non-cooperative oligopoly

Most work on oligopoly theory has concentrated on single-period. Such models are appropriate for markets that last for only brief periods, so that rival firms compete once, but never again. In such models, complex, long-run strategies and reputations for hard-nosed competition are irrelevant.

The three best-known single-period oligopoly models that use the concept of a Nash equilibrium, Cournot, Bertrand and Stackelberg models are discussed below. Cournot and Stackelberg are models of quantity competition, whereas Bertrand is a model of price competition.

Nash Equilibrium

John F. Nash (1951) defined the most widely used equilibrium concept. A set of strategies is called a **Nash equilibrium** if, holding the strategies of all other firms constant, no firm can obtain a higher payoff (profit) by choosing a different strategy. Thus, in a Nash equilibrium, no firm *wants* to change its strategy.

In the Cournot and Stackelberg models, firms' strategies concern setting quantities. In the Bertrand model, firms set prices. The Nash equilibrium concept is useful when strategies include setting advertising or other variables in addition to output or price.

Quantity competition

The Cournot model

The French mathematician Augustin Cournot presented the first – and probably still the most widely used – model of non-co-operative oligopoly in 1838. Cournot assumed that each firm acts independently and attempts to maximise its profits by choosing its output. The discussion focuses on the *duopoly*, or two-firm case.

Consider a Cournot duopoly for microprocessors characterised by the following conditions:

- *No entry*: There are two firms and no entry by other firms is possible (these firms own the only available technology in the market).
- *Homogeneity*: The firms produce identical (homogenous) microprocessors, so the sum of their outputs equals industry output: $Q = Q_1 + Q_2$, where Firm 1 produces Q_1 and Firm 2 produces Q_2.
- *Single period*: This market and the two firms only exist for one period.
- There are *a few buyers* in their market.
- Each firm believes rivals *will hold their output* constant.

To highlight the implications of Cournot oligopoly, suppose each duopoly must make an output decision, and each firm believes that its rival will hold output constant as it changes its own output. To determine its own output level, Firm 1 will equate marginal revenue with its marginal cost. Notice that since this is a duopoly, Firm 1's marginal revenue is affected by Firm 2's output level. In particular, the greater the output of Firm 2, the lower the market price and thus the lower is Firm 1's marginal revenue. This means that the profit-maximising level of output for Firm 1 depends on Firm 2's output level and the profit-maximising level of output for Firm 2 depends on Firm 1's output. These interrelationships are referred to as reaction functions.

A *reaction function* defines the profit-maximising level of output for a firm for given (expected) output levels of the other firm. It tells us a firm's best response to the output level of a rival firm.

What strategy should Firm 1 use to choose its output level? The answer depends on its belief about Firm 2's behaviour. If Firm 1 believes that Firm 2 will sell Q_2 processors, it can determine Q_1 that will maximise its profit. Firm 1 can sell all but Q_2 units of the amount demanded by the market; that is, it faces the *residual demand curve*, Q_1 = market demand – Q_2, which is the market demand curve minus the expected output of Firm 2, Q_2.

Note that Firm 1 has a monopoly over those consumers whose demands are not met by Firm 2. We can summarise the relationship between Firm 1's profit-maximising quantity and Firm 2's quantity in an equation,

$$Q_1 = R_1(Q_2) \qquad (7)$$

which is the *best-response function* (or reaction function) showing the best (highest profit) action (output) by a firm given its beliefs about the action its rival takes.

Similarly, Firm 2's best-response function is derived in a similar way. Since the firms are identical (same costs, identical products), Firm 2's reaction function is the mirror image of Firm 1's:

$$Q_2 = R_2(Q_1) \quad (8)$$

Accordingly, Firm 2's choice of output depends on the output it expects Firm 1 to produce.

Suppose the market demand in a Cournot model is represented by

$$P = 100 - Q \quad (9)$$

where $Q = Q_1 + Q_2$. Each firm has a constant marginal cost, $MC_1 = MC_2 =$ \$10 and no fixed costs. Each firm can produce enough output to meet the entire market's demand. Producers set their output with an eye on the market price. But, since the market price depends on total output produced by both firms, how much Firm 1 produces depends on how much it expects Firm 2 to produce. Put differently, Cournot equilibrium is the situation where neither firms has an incentive to change its output given the output of the other firm.

We can determine the reaction function for each firm as follows. To maximise profit, each firm sets marginal revenue equal to marginal cost.

$$\begin{aligned} &TR_1 = (100 - Q_1 - Q_2)xQ_1 = 100Q_1 - Q_1^2 - Q_1Q_2 \\ &and \\ &MR_1 = 100 - 2Q_1 - Q_2 \end{aligned} \quad (10)$$

Now setting MR_1 equal to MC_1 (=10) and solving for Q_1:

$$100 - 2Q_1 - Q_2 = 10$$

Firm 1's reaction function (R_1):

$$Q_1 = 45 - 0.5Q_2 \quad (11)$$

The same calculation applies to Firm 2:

$$\begin{aligned} &TR_2 = (100 - Q_1 - Q_2)xQ_2 = 100Q_2 - Q_2^2 - Q_1Q_2 \\ &and \\ &MR_2 = 100 - 2Q_2 - Q_1 \end{aligned} \quad (12)$$

Setting MR_2 equal to MC_2 (=10) and solving for Q_2:

$$100 - 2Q_2 - Q_1 = 10$$

Firm 2's reaction function (R_2):

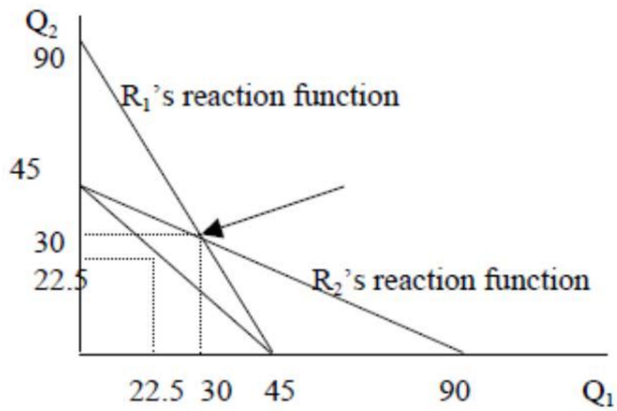
$$Q_2 = 45 - 0.5Q_1 \quad (13)$$

The equilibrium output levels are the values for Q_1 and Q_2 that are at the intersection of the reactions functions.

$$Q_1 = Q_2 = 30$$
$$P = \$40,$$
$$\pi_1 = \pi_2 = \$900$$

If each firm believes the other will produce 30 units and if each firm produces 30 units, neither firm wants to change its output. A firm is unwilling to produce at a point not on its reaction function because doing so would result in a lower profit. The only point where both firms are on their best-response functions is at the intersection of the best-response functions. A non-intersection point cannot be an equilibrium; an equilibrium point is one in which neither firm wants to change its behaviour. In the Cournot equilibrium, total market output is 30 + 30 = 60 processors and the price is $40.

Figure 7-11



To understand why reaction functions are shaped as they are, let us highlight a few points in Figure 7-11. First, it is clear from Firm's 1 reaction function, equation (11), that if Firm 2 produced zero units of output, the profit-maximising level of output for Firm 1 would be 45 (on horizontal axis). At this point (Q_1 = 45 and Q_2= 0), Firm 1 is a monopolist. Similarly, it is clear from Firm's 2 reaction function, equation (13), that if Firm 1 produced zero units of output, the profit-maximising level of output for Firm 2 would be 45 (on vertical axis). At this point (Q_2 = 45 and Q_1 = 0), Firm 1 is a monopolist.

In a model in which firms only choose output levels, any output levels at which no firm believes it can increase its profits by increasing or decreasing its output are, by definition, a Cournot equilibrium, and no combination of outputs could be an equilibrium except a Cournot equilibrium. Thus, where firms must choose output levels independently, the Cournot equilibrium is not only realistic, it is the only plausible equilibrium.

Because the Cournot equilibrium is a special case of the Nash equilibrium where firms have strategies over quantities, it is often referred to as a *Cournot-Nash equilibrium* or a *Nash-in-quantities equilibrium*.

Collusion

The firms are worse off and the consumers are better off at the Cournot equilibrium than if firms act collusively as a cartel (monopoly). Firms can benefit at the expense of consumers by agreeing to restrict output or, equivalently, charge higher prices. Such an act by firms is known as *collusion.*

If the two firms decide to collude and antitrust laws do not prevent them from doing so, they would set their output to maximise *total* profit, behaving like a monopolist and presumably split the profit evenly. This is done by choosing total output Q so that marginal revenue equals marginal cost, which equals 10 in this example.

$$TR = P \times Q = (100 – Q) \times Q = 100Q – Q^2$$

Marginal revenue is therefore

$$MR = 100 – 2Q = (MC = \$10)$$

$$Q = 45, \text{ and hence } Q_1 = Q_2 = 22.5$$

$$P = \$55$$

Each firm earns profit of $1,012.50.

As expected, under a collusive mechanism, which is a co-operative scenario, both firms produce less, charge a higher price and naturally earn more profit than in the Cournot equilibrium.

The Stackelberg model

So far, we have assumed that our two duopolists make their output decisions at the same time. In the Stackelberg oligopoly, firms may set their decisions in sequence. Specifically, one firm is assumed to make an output decision before the other firm does. The former is referred to as the *leader* and the latter as the *follower.* The implication is that the follower takes the leader's output as given, and chooses its own output that maximises profit. That is, the follower behaves in a Cournot fashion. The leader, however, observes the follower's output in setting a level of output that maximises its own profit. Other conditions required for the Stackelberg Oligopoly are similar to those of Cournot's.

Let's start with Firm 2. Since Firm 2 is the follower and sets it output after the leader, its profit maximising level of output is determined by its reaction function:

$$R_{2:}\ Q_2 = 45 - 0.5Q_1$$

Firm 1 is the leader and goes first, *first mover,* anticipating Firm 2's move. That is, the leader will choose a point on Firms 2's reaction function that maximises its own profit.

$$TR_1 = (100 - Q_1 - Q_2)xQ_1 = 100Q_1 - Q_1^2 - Q_1Q_2$$
$$and$$
$$TR_1 = 100Q_1 - Q_1^2 - Q_1(45 - 0.5Q_1) = 55Q_1 - 0.5Q_1^2$$
$$hence$$
$$MR_1 = 55 - Q_1 = MC_1 = 10, therefore$$
$$Q_1 = 45, and Q_2 = 22.5.$$

Therefore, the leader produces twice as much as the follower. Given that both charge the same price for their homogenous products, we can conclude that it pays to move first, *first mover advantage*.

P = 100 – (45 + 22.5) = $32.5

Profit earned by Firm 1 is $1,012.50 and by Firm 2 is $506.25.

The Bertrand model (price competition)

Cournot's work was well ahead of its time. The first major challenge to his book came in 1883, 45 years after it was published. In this critique, Joseph Bertrand argued that it is hard to see who sets prices in oligopolistic markets if the firms do not set them. Cournot, by having firms choose output rather than price, fails to explain explicitly the mechanism by which prices are determined (but, for that matter, so does a competitive model).

In Bertrand's model, firms set prices rather than output. If consumers have complete information and realise that firms produce identical products, they buy the one with the lowest price. In a Bertrand model, since each firm believes its rival's price is fixed by a slight price cut, the firm is able to capture all its rival's business. In the Bertrand equilibrium discussed below, firms make zero profits and no firm can increase its profits by raising or lowering its price, which, when it exists, is equivalent to the social optimum (competitive equilibrium) discussed above.

To illustrate the Bertrand equilibrium, let us make the same assumptions as in the Cournot example: no entry, homogenous products, and single period. We also assume the same demand and cost relationships as above. The only important change is that firms now set prices rather than quantities. Each firm is willing to sell as much quantity as is demanded at the price it sets.

To explain more precisely, because the products are identical, all consumers will purchase from the firm charging the lowest price. Suppose Firm 1 charges the profit-maximising price. However, by slightly undercutting this price, Firm 2 would capture the entire market and make positive profits, while Firm 1 would sell nothing. Therefore Firm 1 would retaliate against Firm 2 by undercutting Firm 2's lower price, thus recapturing the entire market.

When would this 'price war' end? When each firm charged a price that equals marginal cost, $P_1 = P_2 = MC$. Given the price of the other firm, neither firm would choose to lower its price, for then its price would be below marginal cost and would make a loss. Also, no firm would want to raise its price, for then it would earn nothing. In short, Bertrand oligopoly and homogeneous products lead to a situation where each firm charges marginal cost and economic profits are zero. Note that the duapolists in this case would be acting as perfectly competitive firms.

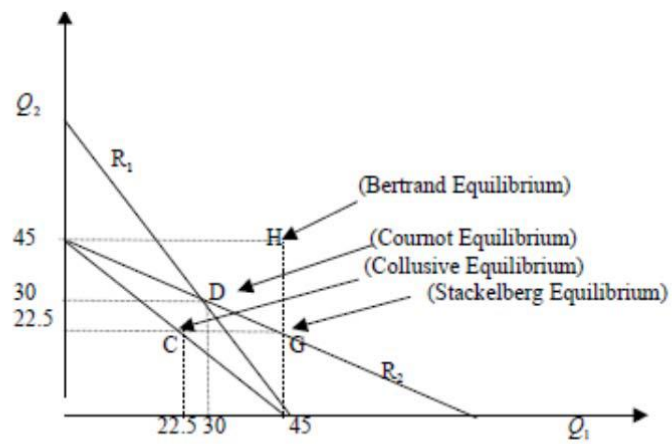
Therefore, with the given demand and cost functions,

$$P_1 = P_2 = MC = \$10$$
$$100 - (Q_1 + Q_2) = 10,$$
$$therefore,$$
$$Q_1 + Q_2 = 90, and$$
$$Q_1 = Q_2 = 45$$

Each firm will earn zero economic profit.

The following Figure captures all these oligopoly models.

Figure 7-12 Alternative models of oligopoly equilibrium



Points D, C, G, and H are, respectively, representative of the Cournot, Collusion, Stackelberg, and Bertrand equilibrium. Note that in all four cases, we have assumed homogenous products.

Module summary

Summary

The process by which price and quantity are determined in the real world is a function of the market structure within which firms compete against each other. Four different market structures are identified: perfect competition, monopolistic competition, monopoly, and oligopoly. The key factors that differentiate these markets are the type of product, number and the nature of buyers and sellers, conditions of entry and exit to and from the industry, and the presence of economies of scale.

Under perfect and monopolistic market conditions, there are numerous firms competing in the industry selling products that are homogenous, in the former, or somewhat differentiated, in the latter. Furthermore, market entry and exit are free from all barriers. Under pure monopoly, there is only one seller of a product that has no substitute. Monopolies arise from patents, control of raw materials, and so on. Since barriers to entry are so high, the monopolies can maintain their profit in the long run.

Oligopolies are characterised by a few sellers selling either differentiated or homogenous products. The main feature of oligopolistic market structure is interdependency amongst the firms.

Assignment

Assignment

1. Suppose a manager of a firm is risk neutral. Explain how the pricing strategy by the manager will differ from the perfectly competitive situation, where the price is set on the basis of equating marginal cost and marginal revenue (note: marginal revenue for a firm in competitive setting is the price itself).

2. A cellular phone provider estimates the following pricing situation for the coming year:

   a. Boom (30 per cent probability) – price per set $40.00

   b. Unchanged (50 per cent probability) – price per set $30.00

   c. Recession (20 per cent probability) – price per set $20.00

   The cost function for the firm is $C(Q) = 10 – 5Q^2$. What should be the optimal output decision if the firm maximises expected profit? Calculate the expected profit of the firm.

Assessment

Assessment

1. How does a monopolistically competitive firm use the measure of elasticity in pricing decisions? If a firm measures the elasticity of demand to be –2.5 and has a cost function C(Q) = 50 + 4Q2, then how much should the firm charge the consumers for its products?
2. In a Cournot duopoly situation, the firms have the same cost structure of C(Q) = 48 + 2.5Q. If the elasticity of demand is –1.8, then calculate the optimum price in this situation.
3. For a firm maximising its profits in a perfectly competitive situation, find the conditions of profit-maximisation in terms of price and marginal cost. Why will the firm not sell a quantity where the price is greater or less than the marginal cost?
4. If a firm has a cost function C(Q) = 100 + 4Q2 – 2Q and faces a price of $150 on a perfectly competitive world, then what is the level of output that it should produce? Find the profit at this level of output.

Assessment answers

1. $MR = P[1+1/E_f] = MC$

   $MC = 4, E_f = 2.5$

   Therefore, P = 6.67.

2. $P = [\ nE_m/(1+nE_m)\ ]\ MC$

   $MC = 2.5\ E_m = -1.8, n = 2, P = 3.46.$

3. To maximise profit, the firm sets MR = MC. However, since in perfect competition, the firm faces a horizontal demand curve, MR = P, therefore, P = MR = MC. When P > MC, the firm is in a position to increase its total profit by producing yet additional units of output, which otherwise would remain unexploited. Similarly, when P < MC, the firms has produced too much. By cutting back on its production, the firm can cut its loss, or increase its profit.

4. P = MC. Plugging in: \$150 = 8Q – 2, and hence Q = 9. Profit = TR (19 x \$150) – TC (100 + 4 x 19^2 – 2 x 19) = \$2850 – \$1506 = \$1344.

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