

These notes essentially correspond to chapter 8 of the text.

# 1 Perfectly Competitive Markets

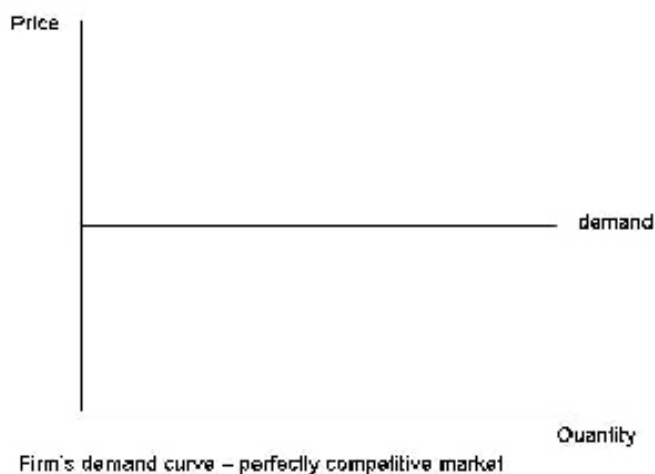
The first market structure that we will discuss is perfect competition (also called price-taker markets – I will use the terms interchangeably throughout the notes). We study this theoretical market for two main reasons. First, there are actual markets that meet the assumptions (listed below) necessary for perfect competition to apply. Many agricultural and retailing industries meet these assumptions, as well as stock exchanges. Second, the perfectly competitive market can be used as a benchmark model, as there are many desirable properties of this model. We will compare the perfectly competitive model (discussed in this chapter) with the monopoly model (chapter 10) after we have completed the monopoly model.

## 1.1 Assumptions of perfectly competitive markets

We will list 4 assumptions in order for a market to be perfectly competitive.

1. Consumers believe all firms produce identical products.
2. Firms can enter and exit the market freely (no barriers to entry).
3. Perfect information on prices exists (all firms and all consumers know the price being charged by each firm, and this knowledge is common knowledge).
4. Transactions costs are low. Transactions costs are the costs associated with making a transaction, such as finding a trading partner, negotiating a trade, and enforcing the trade.

If these 4 assumptions are met then each firm in the market will face a perfectly elastic demand curve. Recall that a perfectly elastic demand curve is a perfectly horizontal line, like:

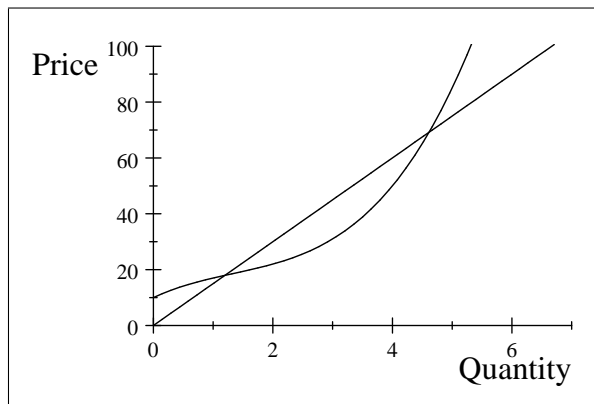


We will return to the firm's demand curve shortly.

## 2 Profit Maximization

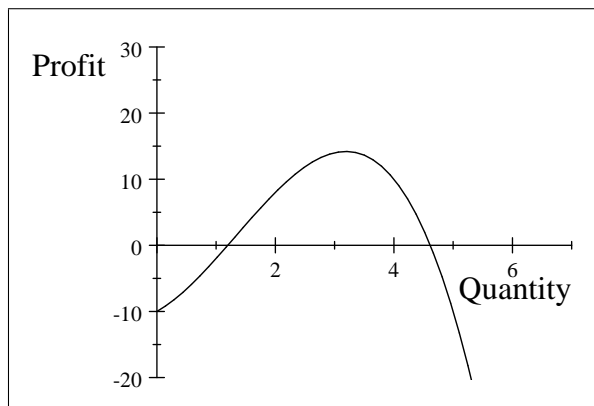
The goal of the firm is to maximize its profit (economic profit). Recall that economic profit equals total revenue minus explicit costs minus implicit costs, or  $\Pi = TR - TC$  (we will use  $\Pi$  as the symbol for profit). Now, we know that  $TR = P * q$  and that  $TC$  is some function of  $q$ . So we can rewrite profit as:  $\Pi(q) = Pq - TC(q)$ . Price is a function of  $Q$ , so  $\Pi(q) = P(Q) * q - TC(q)$ . Now, profit is solely a function of quantity. There is a subtle difference between  $Q$  and  $q$ . When  $Q$  is used, this refers to the market quantity. When  $q$  is used, this refers to a specific firm's quantity. We will typically consider the market quantity as the sum of all of the individual firm quantities. Assuming there are  $n$  firms in the market, the market quantity,  $Q$ , would then equal  $q_1 + q_2 + \dots + q_{n-1} + q_n$  or  $Q = \sum_{i=1}^n q_i$ , where  $\sum$  is the summation operator. Thus,  $Q$  is implicitly a function of  $q$ , so that price is implicitly also a function of  $q$ . While a firm's total cost depends only on how much it produces,  $q$ , the market price depends on how much all of the firm's produce,  $Q$ , which depends on  $q$ .

We can "derive" the profit function from the firm's total revenue function and total cost function. We know that the firm's demand curve in a price-taker market is perfectly elastic – this means that it will charge the same price regardless of how many units it sells. The firm's total revenue function,  $TR(q)$ , is then  $TR(q) = Pq$ , where  $P$  is a constant at the level of the firm's demand curve. Suppose that  $P = 15$ , then  $TR(q) = 15q$ . Plotting this will yield a straight line through the origin with a slope of 15. We know that the firm's total cost curve,  $TC(q)$ , is a function that is typically a cubic function. Let's assume that  $TC(q) = 10 + 10q - 4q^2 + q^3$ . If we plot the two functions below we get (where the TR is the straight line and the TC is the curved line):



Plot of  $TR(q)$  and  $TC(q)$ .

Since  $\Pi(q) = TR(q) - TC(q)$ , then  $\Pi(q) = 15q - (10 + 10q - 4q^2 + q^3)$ . If we plot this relationship, we get:



Plot of  $\Pi(q)$

Notice that  $\Pi(q) = 0$  where  $TR(q)$  intersects  $TC(q)$ . Also,  $\Pi(q) < 0$  when  $TC(q) > TR(q)$ . The peak of the profit graph occurs at the quantity where the distance between  $TR(q)$  and  $TC(q)$  is the greatest. In this example, the maximum profit occurs at a quantity of about 3.19. The profit at that level is about 14.19. Thus, one way to find the profit-maximizing quantity is to plot the profit function and then find the quantity that corresponds to the peak of the profit function (it should be noted that you want to find the peak of the function over the range of positive quantities, as the profit function actually reaches a higher level but that is on the left side of the y-axis).

## 2.1 Profit-maximizing rules

We have already discussed one rule:

1. Plot the profit function and then find the quantity that corresponds to the peak of the profit function as well as its associated profit level.
2. Another rule that can be used is to find the quantity that corresponds to the point where the marginal profit is zero. We can write marginal profit as  $\frac{\partial \Pi}{\partial q}$ . If the marginal profit equals zero, we are at the peak of the profit function. So  $\frac{\partial \Pi}{\partial q} = 0$  is another rule.
3. The most useful rule will be to find the quantity that corresponds to the point where  $MR(q) = MC(q)$ . Since marginal profit is just the additional revenue we gain from producing an extra unit ( $MR(q)$ ) minus the additional cost of producing that unit ( $MC(q)$ ), we can rewrite marginal profit as  $\frac{\partial \Pi}{\partial q} = MR(q) - MC(q)$ . Since marginal profit must equal zero at the profit-maximizing quantity,  $0 = MR(q) - MC(q)$ , which implies that  $MR(q) = MC(q)$  at the profit-maximizing quantity.

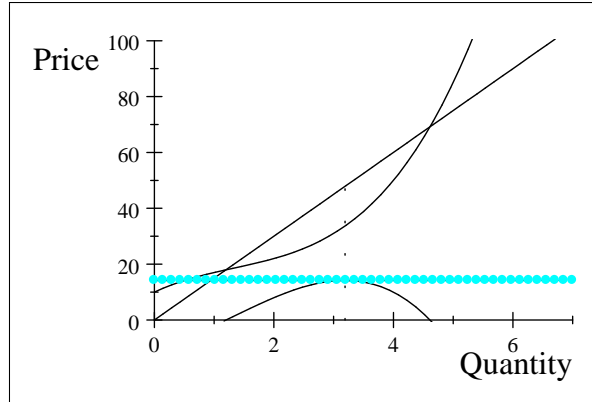
Although all 3 rules give the same profit-maximizing quantity and level of profit at the profit-maximizing quantity, we will frequently use rule #3.

### 2.1.1 Deriving the price-taker's MR curve

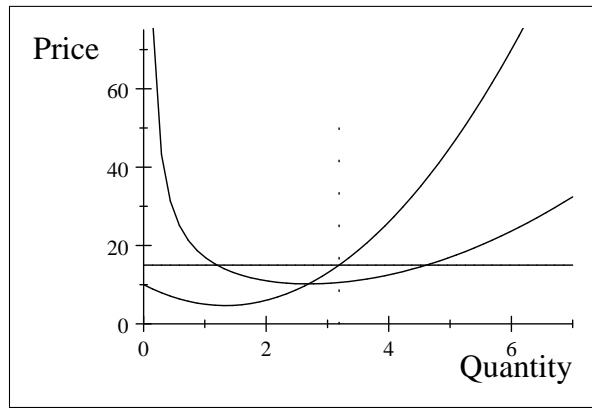
If we are to use rule #3 to find the profit-maximizing quantity, we must find the firm's  $MR$  curve. We "know" the firm's  $MC$  curve (or at least we have already discussed it). We know that  $MR = \frac{\partial TR}{\partial q}$ . For the price-taking firm,  $TR = Pq$ , where  $P$  is some constant that does NOT depend on how much the firm produces (If we were to write down an inverse demand function for a price-taking firm, it would be  $P(Q) = a$ , which means that the price does NOT depend on the quantity produced). If we differentiate  $TR$  with respect to  $q$  we get  $\frac{\partial TR}{\partial q} = P$ , so that the firm's  $MR$  is simply  $MR = P$ ; each time the firm produces another unit it receives additional revenue of  $P$ .

## 2.2 The firm's picture and profit-maximization

Typically we will use the firm's picture when we try to find the profit maximizing quantity and the maximum profits. I have reproduced the TR and TC picture from above, and I have also included the corresponding profit curve. The dashed (vertical) line is at a quantity of 3.19, which is approximately the profit-maximizing quantity. The second picture shows the firm's ATC, MC, and MR curves. Notice that  $MC = MR$  at approximately 3.19, which corresponds to the profit-maximizing quantity in the first picture.



Plot of  $TR(q)$ ,  $TC(q)$ , and  $\Pi(q)$ .



Plot of  $ATC$ ,  $MC$ , and  $d = MR$  for a representative price-taking firm.

To find the firm's maximum profit using the graph, follow these steps:

1. Find the quantity level that corresponds to the point where  $MR = MC$ . In this example it is 3.19.
2. Find the total revenue at the profit-maximizing quantity. In this example,  $TR = 15 * 3.19 = 47.85$ .
3. Find the total cost at the profit-maximizing quantity. To find the TC, simply find the ATC that corresponds to the profit-maximizing quantity. Then, since  $ATC = \frac{TC}{q}$ , we know that  $ATC * q = TC$ . In this example, the  $ATC$  of 3.19 units is approximately 10.55. This means that  $TC = 10.55 * 3.19 \approx 33.65$ .
4. Now, find the profit, which is  $TR - TC$ . In this example, we have  $47.85 - 33.65 = 14.2$ . Alternatively, since  $TR = P * Q$  and  $TC = ATC * Q$ , we can find profit as  $(P - ATC) * Q$ . The horizontal dashed line (it may not be dashed, but just horizontal, when this prints) in the first picture is at 14.2, which is approximately the peak of the profit curve.

To find the firm's profit maximizing quantity and maximum profit mathematically, simply differentiate the profit function with respect to  $q$  and set the resulting first-order condition equal to zero. Thus,  $\frac{\partial \Pi}{\partial q} = 0$ .

As an example, consider  $\Pi(q) = 15q - (10 + 10q - 4q^2 + q^3)$ . We have:

$$\begin{aligned} \frac{\partial \Pi}{\partial q} &= 15 - 10 + 8q - 3q^2 = 0 \\ -3q^2 + 8q + 5 &= 0 \\ \frac{-8 \pm \sqrt{8^2 - 4 * (-3) * 5}}{2 * (-3)} &= q \\ \frac{-8 \pm \sqrt{64 + 60}}{-6} &= q \\ \frac{-8 \pm 2\sqrt{31}}{-6} &= q \\ \frac{-4 \pm \sqrt{31}}{-3} &= q \\ \frac{-4 \pm 5.57}{-3} &= q \end{aligned}$$

So the solution is either  $q = -0.52$  or  $q = 3.19$ .

### 3 Shutdown Rule

In the short-run, the price-taking firm has a decision to make regarding its quantity choice. If the firm can earn a positive profit at some quantity level, then it will obviously produce the profit-maximizing quantity. If the firm is earning zero profit (again, this is economic profit), it will still produce because a zero economic profit means that the firm is earning as much as it could if it shifted its resources to their second best use. So, if the maximum profit a firm could earn is zero, then the firm would produce the quantity that corresponds to zero economic profit. However, should the firm make a loss in the short-run the firm has 3 choices that it could make. I will describe them first and then discuss the conditions under which the firm would make each decision.

1. Continue to produce – this is just what it sounds like; even though the firm is making a loss, it still continues to produce at the profit-maximizing (or in this case, loss-minimizing) quantity
2. Shutdown – the term shutdown has a very specific meaning in economics; it means that the firm produces a quantity of zero (stop production), but it still stays in the industry. Technically, the firm continues to pay its fixed costs (like rent) but pays zero variable costs (because it produces zero quantity).
3. Go out of business – in this case the firm decides to leave the industry altogether; not only does it stop producing, but it breaks all of its contracts (leases, wage contracts, supply contracts) and completely leaves the industry.

#### 3.1 Going out of business

A firm will choose to go out of business if it is currently making a loss (recall that this is an economic loss, so the firm could actually be earning positive accounting profit) and it does not ever expect to make a profit again. Firms do not want to go out of business if they have a bad day or a bad week, so it may be the case that the firm is making a loss and still stays in business because it believes it will make a profit again in the future. Thus, in order to know whether or not a firm will go out of business we need to know (1) whether or not it is currently making a loss and (2) whether or not the firm expects to earn a profit some time in the future. Assuming that the firm is currently making a loss and that it does expect to make a profit in the future, the firm now has two choices: to continue to produce or shutdown.

### 3.2 Continue to produce vs. shutdown

The decision to continue to produce or shutdown comes down to whether or not the firm's total revenue from producing is greater than its total variable costs of production. We already know that  $TR < TC$  because the firm is making a loss; thus, the key decision is whether the firm can pay its variable costs. The shutdown rule is then:

**Shutdown rule:** Assume that the firm is making a loss and that it expects to make profits in the future. The firm will shutdown if the total revenue at the profit-maximizing (or loss-minimizing in this case) quantity is less than the profit-maximizing total variable cost, or  $TR < TVC$ . If  $TR > TVC$ , then the firm will continue to produce. Alternatively, the shutdown rule can be written as: the firm will shutdown if  $P < AVC$ , since  $TR = P * Q$  and  $TVC = AVC * Q$ .

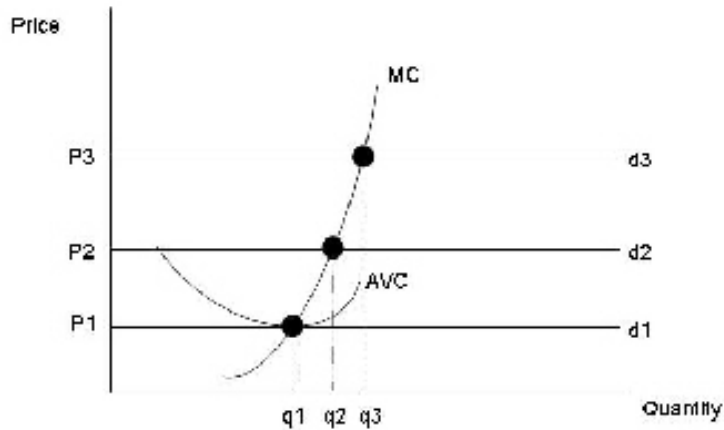
Why does the firm only consider variable costs, and not fixed costs, when making its shutdown decision? If the firm has decided to stay in the industry, it must pay its fixed costs regardless of whether or not it produces. Thus, these costs should not enter into the decision to either produce or shutdown (but they would enter into the going out of business decision). The following table shows a chart of a Dairy Queen which makes a loss during the winter months.

	Operate	Shutdown
TR	\$250	\$0
TFC	\$300	\$300
TVC	\$200	\$0
Profit	-\$250	-\$300

In this example, the Dairy Queen would decide to operate (assuming that it has decided NOT to go out of business) because it only loses \$250 if it operates as opposed to \$300 if it shuts down. Notice that if we change the amount of TFC (and hold TVC and TR constant), that the amount of TFC does not affect the firm's decision – it will always lose \$50 less when it operates than when it shuts down. Now, if we change TVC (and hold TR and TFC constant), notice that the firm's decision may change. If  $TVC < \$250$ , then the firm will decide to continue to operate because the profit to operating is greater than the profit to shutting down. If  $TVC > \$250$ , the firm will decide to shutdown because the profit to shutting down is greater than the profit from operating.

### 3.3 Firm's supply curve

Recall that a supply curve is a price and quantity supplied pair. What we want to see is if we can find the firm's supply curve. We will use the firm's picture. The picture below has the firm's MC and AVC, as well as 3 demand curves, d1, d2, and d3. Notice that when the demand curve shifts upward it intersects the MC curve at a new quantity level. Since the demand curves shift parallel to one another, each quantity level corresponds to only one price (which is the definition of a function). Thus, the firm's supply curve in a perfectly competitive market is simply the firm's MC above the minimum of AVC.

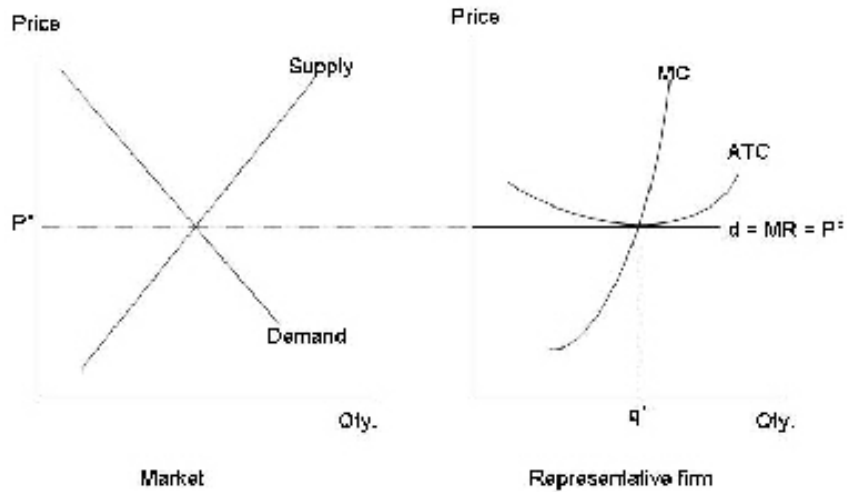


**Market Supply Curve** The market supply curve can be found by fixing a price and determining the quantity that each firm will supply at that price. When we add the quantities each firm will supply at a given price together, we get the total market quantity that will be supplied at that price. Notice that the market supply curve will be more elastic than the individual firm supply curves.

#### 4 LR vs. SR equilibrium in perfectly competitive markets

In the short-run (SR), perfectly competitive firms may make an economic profit or loss. The SR equilibrium simply requires firms to produce their profit-maximizing quantity, which is described in detail in the preceding sections. However, long-run equilibrium in perfectly competitive markets requires firms to earn zero economic profit when they produce their profit-maximizing quantity. Recall that the term equilibrium means “to be balanced” or “to be at rest”. If firms in a perfectly competitive market are earning positive economic profits, then other firms with similar resources will enter that market. If firms in a perfectly competitive market are making losses, then some of those firms will exit the market. Clearly, firms entering and exiting the market is not a situation where all things are “at rest”. While an individual firm may be at rest (since it can do no better than to produce its profit-maximizing quantity), the market itself is not at rest. However, when all firms in the perfectly competitive market are earning zero economic profits at their profit-maximizing quantities, then the market is in LR equilibrium because there is no incentive for any of the firms to exit, nor is there any incentive for other firms to enter the market.

A picture of LR-equilibrium looks like the following picture. You should note that in the firm’s picture the MC, ATC, and MR all intersect at the firm’s profit-maximizing quantity. Since  $P = ATC$  at  $q^*$ , the firm is earning zero-economic profit.



## 5 Monopoly

A monopolist is defined as a single seller of a well-defined product for which there are no close substitutes. In reality, there are very few “true” monopolists; however, people sometimes consider firms with a large market share (such as Microsoft) a monopolist. We will focus on the implications of the “true” monopolist.

In the perfectly competitive market, the market demand curve is downward sloping, and the firm’s demand curve is horizontal (perfectly elastic). In a monopoly, the market demand curve is also downward-sloping – however, since there is only a single seller in the market, the market demand curve is also the monopolist’s demand curve. The monopolist’s downward-sloping demand curve has some implications for the monopolist’s  $MR$ .

### 5.1 Deriving $MR$ for monopolist

We will derive the monopolist’s  $MR$  by example first, and then through a formal mathematical derivation.

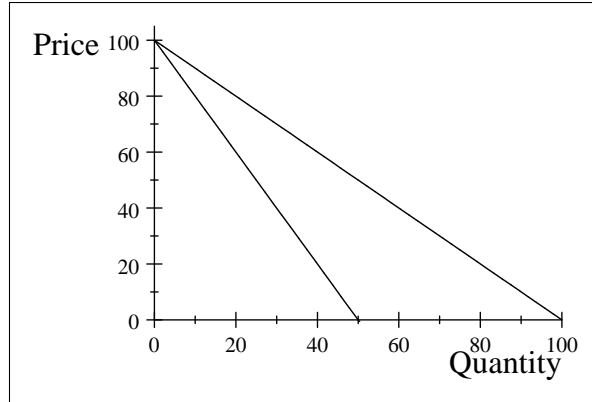
#### 5.1.1 Deriving $MR$ by example

Suppose that the monopolist faces the following inverse demand function,  $P(Q) = 100 - Q$ . The monopolist’s  $TR$  function is found by multiplying price and quantity, so that  $TR = P(Q) * Q = (100 - Q) * Q$  in this example. We can now fill out the table below for the given quantities. The price is found by plugging the different quantity levels into the inverse demand function. Total revenue is found by multiplying price and quantity. Recall that  $MR$  is just the increase in  $TR$  from one unit to the next (which is how we found  $MC$  in chapter 7, except we looked at the increase in  $TC$  from one unit to the next).

Quantity	Price	TR	MR
0	100	0	–
1	99	99	99
2	98	196	97
3	97	291	95
4	96	384	93
5	95	475	91

If we were to plot the price and quantity pairs, we would get the firm’s demand curve. If we were to plot the  $MR$  and quantity pairs, we would get the firm’s  $MR$ . Plotting the two relationships gives us:





The  $MR$  is the steeper of the two lines, and lies inside the demand curve. Notice that the  $MR$  of the 2<sup>nd</sup> unit is \$97 even though the price is \$98. The reason that  $MR < P$  is because if the monopolist wishes to sell an additional unit, it needs to lower the price on EVERY unit sold. Thus, the first unit that was initially sold for \$99 brought in additional revenue of \$99. To sell 2 units, the monopolist must lower the price to \$98. The second unit brings in additional revenue of \$98, but the 1<sup>st</sup> unit must now also be sold for \$98, which is a loss of \$1 in revenue. Thus, the total additional revenue generated by the second unit is  $\$98 - \$1 = \$97$ . So, the  $MR$  for a monopolist will fall faster than the demand curve. Recall that in a perfectly competitive market the  $MR$  and demand curves were the same curves.

### 5.1.2 Deriving a $MR$ function

We can also derive a monopolist's  $MR$  as a function of quantity. We will derive this using a linear inverse demand function.

Recall that  $TR = P(Q) * Q$  which equals  $(a - bQ) * Q$  for a general linear inverse demand function with intercept  $a$  and slope  $(-b)$ . Simply differentiate  $TR$  with respect to  $Q$  to find  $MR(Q)$ . This yields:

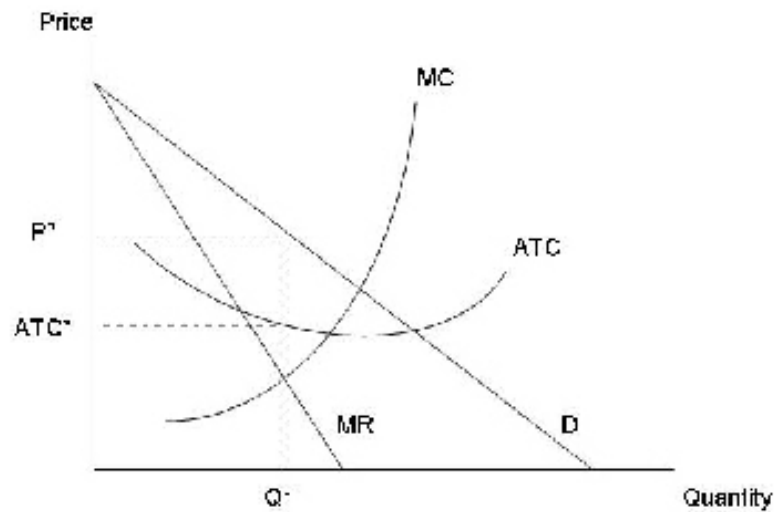
$$\frac{\partial TR}{\partial Q} = a - 2bQ$$

## 5.2 Profit maximization for a monopolist

We will use two methods to find the monopolist's maximum profit. The first is a graphical method and the second is a mathematical method.

### 5.2.1 Profit maximization – graphically

The steps to finding the monopolist's profit-maximizing price and quantity are similar to those for the perfectly competitive firm. A picture is shown below and the steps are described following the picture.



1. The first step is to find the quantity that corresponds to the point where  $MR = MC$ . This is  $Q^*$  in the picture.
2. The second step is to find the price that corresponds to the quantity that corresponds to the point where  $MR = MC$ . The firm finds this price by finding the price on the DEMAND curve that corresponds to its profit-maximizing quantity. This is shown in the picture as  $P^*$ .
3. Find the firm's total revenue at the profit-maximizing price and quantity. Since this is just the price times the quantity it is  $(P^*) * (Q^*)$ .
4. Now, find the  $ATC$  that corresponds to the profit-maximizing quantity. This is shown as  $ATC^*$  in the picture.
5. Find the firm's total cost at the profit-maximizing price and quantity. This is  $TC = (ATC^*) * (Q^*)$ .
6. The firm's profit is then  $TR - TC$ . Alternatively, the firm's profit can be written as  $\Pi = (P^*) * (Q^*) - (ATC^*) * (Q^*) = (P^* - ATC^*) * (Q^*)$ . When written this way, it is easy to see that the profit the firm earns is simply the rectangle outlined by the dotted lines in the picture from  $P^*$  to  $ATC^*$  and over to  $Q^*$ . So profit is simply the area outlined by that rectangle.

### 5.2.2 Profit maximization – mathematically

We will follow the same basic steps to determine the profit-maximizing price and quantity mathematically. We will need a few pieces of information: the monopolist's inverse demand function and the total cost function. Assume that the inverse demand function is:  $P(Q) = 24 - Q$ . Suppose the monopolist's total cost function is  $TC(Q) = Q^2 + 12$ . Simply set up the monopolist's profit function, differentiate with respect to  $Q$ , set the first order condition equal to zero, and solve for  $Q$ :

$$\begin{aligned} \Pi &= (24 - Q)Q - (Q^2 + 12) \\ \frac{\partial \Pi}{\partial Q} &= 24 - 2Q - 2Q \\ 0 &= 24 - 4Q \\ Q &= 6 \end{aligned}$$

So the monopolist's profit maximizing quantity is 6. The price in the market is then:

$$P(Q) = 24 - Q$$

$$P(6) = 18$$

The monopolist's profit is then:

$$\Pi = 6 * 18 - (36 + 12)$$

$$\Pi = 108 - 48$$

$$\Pi = 60$$

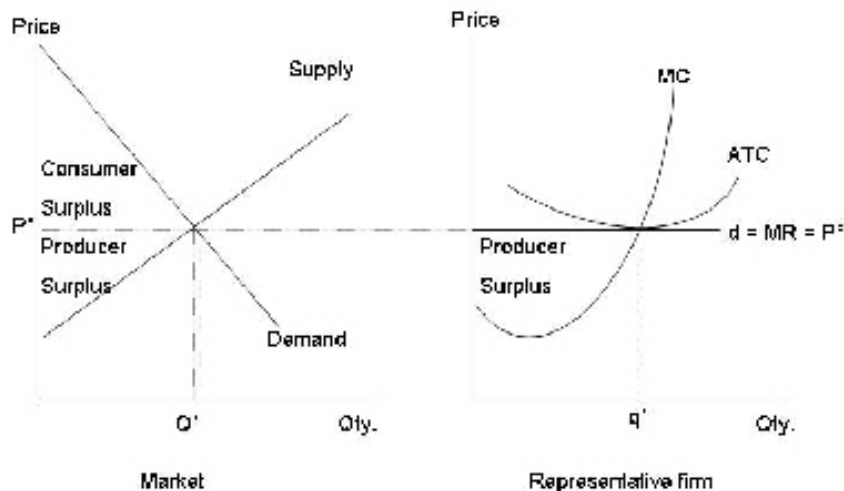
## 6 Monopolies and Social Welfare

It was suggested that one reason to use the perfectly competitive market was that it provided a benchmark model for markets to reach. We can now compare the welfare properties of the monopoly with those of the perfectly competitive market.

There are quite possibly more definitions for the term “efficient” in economics than there are for any other term. We can define efficiency as a market situation where all the gains from trade are captured. Recall the partial equilibrium analysis of a tax from chapter 3. When a price control was imposed on the market there were some trades that were previously made that were no longer possible. This loss to society from trades that were not made is called deadweight loss. What we will show is that the perfectly competitive market contains no deadweight loss, while the monopoly market does.

### 6.1 Welfare and Perfect Competition

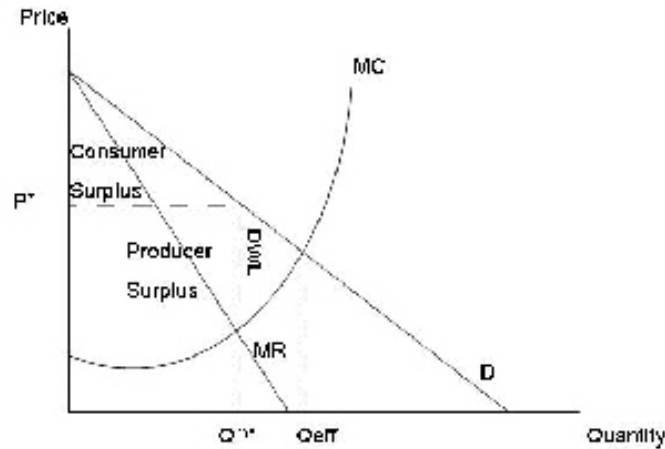
The picture below shows a perfectly competitive market in LR equilibrium.



In the competitive market, there is no deadweight loss. The market is perfectly efficient, as all the gains from trade in both the market and the firm pictures have been captured.

### 6.2 Welfare and monopoly

The picture below shows the welfare effects of a monopoly.



Notice that in the monopoly market the efficient quantity ( $Q_{eff}$ ) is not the same as the monopolist's profit-maximizing quantity ( $Q^{m*}$ ). This is because the efficient quantity is found at the point where society's marginal benefit (the demand curve) equals society's marginal cost (the monopolist's MC), while the monopolist looks at its own marginal benefit (which is the MR curve) and finds the quantity that sets its own marginal benefit equal to MC. Since the monopolist's marginal benefit curve is not the same as society's marginal benefit curve, the market is inefficient, and deadweight loss (DWL) results.

The fact that deadweight loss results in a monopoly is the reason that monopolies are considered bad (well, at least that's why economists consider monopolies bad). Of course, since monopolies are so bad, why then do they exist?

### 6.3 Reasons monopolies exist

There are two major reasons why monopolies exist, which can be broken into a few subcategories. Those reasons are cost advantages and government actions

#### 6.3.1 Cost Advantages

1. Control a key input

One reason that a monopoly may exist is that a firm may control a key input needed in the production of a product. In the diamond market, DeBeers owned 80% of the world's diamond supply at one point in time. Thus, if someone wanted diamonds, they had to go through DeBeers.

2. Superior technology/production technique

It can also be the case that one firm has a better production technology or technique than other firms. If this is the case, that firm will be able to charge a lower price than the other firms and, if it can charge a low enough price while still maintaining profits, it should be able to drive the other firms from the market, creating a monopoly or at least a near-monopoly.

3. Natural monopoly

A natural monopoly exists when the LRATC for a representative firm in an industry is decreasing throughout the entire range of relevant demand. In this case, the larger a firm becomes the the lower the per-unit costs it experiences (there are no diseconomies of scale). Thus, a single firm will have lower production costs than 2 or more firms.

### 6.3.2 Government Actions

1. Government monopolies

There are some industries, such as the post office, that are run by the government and protected from competition. These industries are monopolies because the government has deemed them as monopolies.

2. Licensing

In most cases the government does not license monopolies, but it does require licenses (liquor licenses, medallions for New York City taxicabs) that protect firms from competition.

3. Patents

Patents are used to protect “inventors” from having their creative work stolen/copied by others. The government grants the inventor a patent that gives him monopoly power over his product for a specified time period.

### 6.4 Government actions that reduce market power

The government attempts to reduce market power because firms with more market power tend to cause larger deadweight loss in the market. The government can reduce market power through a few methods.

1. Remove artificial restrictions in the market

Any government action that creates market power could be removed in order to reduce market power.

2. Increase competition through antitrust laws

The antitrust laws were created to reduce market power. The government prosecutes firms for various forms of anti-competitive behavior in an effort to reduce market power.

3. Price or profit regulation

If we look at the monopolist’s picture, we can see what the price should be that will allow the efficient quantity to be traded in the market. Thus, the government could force the monopolist to price at this level, increasing efficiency. Of course, finding this price in a theoretical model is much easier than it is in the real-world.

## 7 The monopolist’s LR equilibrium

Recall that positive economic profits attract other firms to enter the market when the market is perfectly competitive. However, when the market is a monopoly, the monopolist is protected by some entry barrier. Since the monopolist is protected by an entry barrier other firms cannot enter into the industry – thus they cannot take away the monopolist’s economic profit. This means that the monopolist’s LR equilibrium, if its entry barriers stay intact, will look exactly like its short-run equilibrium, even if positive economic profits are being made. The primary difference between the monopolist and the perfectly competitive market in the LR is that the monopolist can sustain economic profits in the LR while the perfectly competitive firm cannot.