

These notes essentially correspond to chapter 10 of the text.

1 Perfectly Competitive Markets

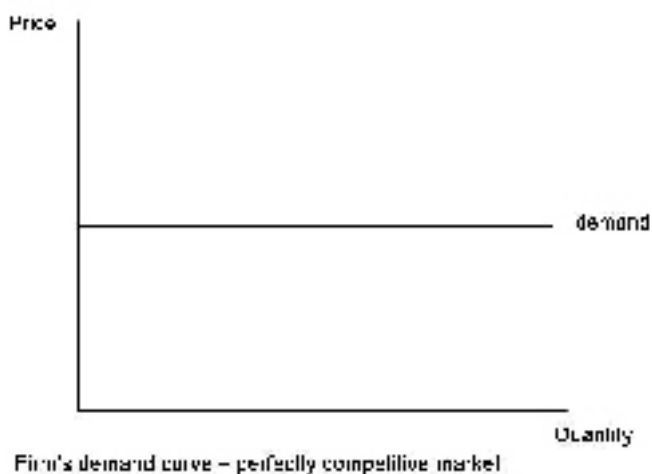
The first market structure that we will discuss is perfect competition (also called price-taker markets – I will use the terms interchangeably throughout the notes). We study this theoretical market for two main reasons. First, there are actual markets that meet the assumptions (listed below) necessary 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 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. Large numbers of buyers and sellers (so that each buyer and seller is small relative to the market)
5. Opportunity for normal profits (or zero economic profit) in long run equilibrium.

If these 5 assumptions are met (note that textbooks differ in both the number of assumptions, as well as the precise wording of the assumptions, but the underlying idea is the same across textbooks), 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:

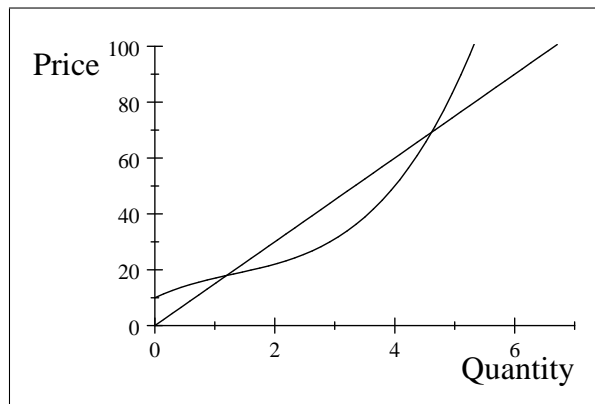


We will return to the firm's demand curve shortly.

2 Profit Maximization

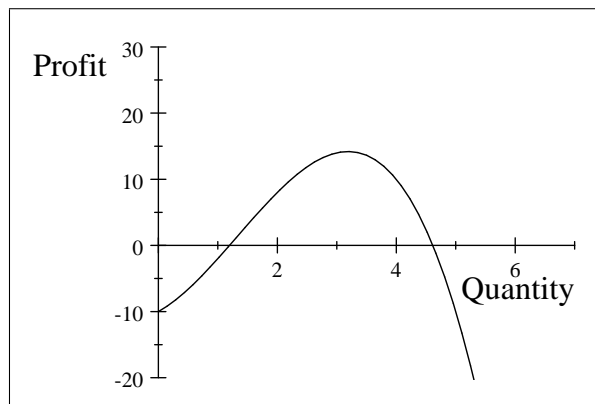
The goal of the firm is to maximize its profit (economic profit). Recall that economic profit equals total revenue minus explicit costs minus implicit costs, or $\Pi = TR - TC$ (we will use Π as the symbol for profit). Now, we know that $TR = P * q$ and that TC is some function of q . So we can rewrite 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 firms 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 “looks like 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 $TC(q)$.

Because $\Pi(q) = TR(q) - TC(q)$, 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 $\frac{\Delta\Pi}{\Delta q}$. If the marginal profit equals zero, we are at the peak of the profit function. So $\frac{\Delta\Pi}{\Delta q} = 0$ is another rule.
3. The most useful rule will be to find the quantity that corresponds to the point where $MR(q) = MC(q)$. Because 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 $\frac{\Delta\Pi}{\Delta q} = MR(q) - MC(q)$. Because 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.

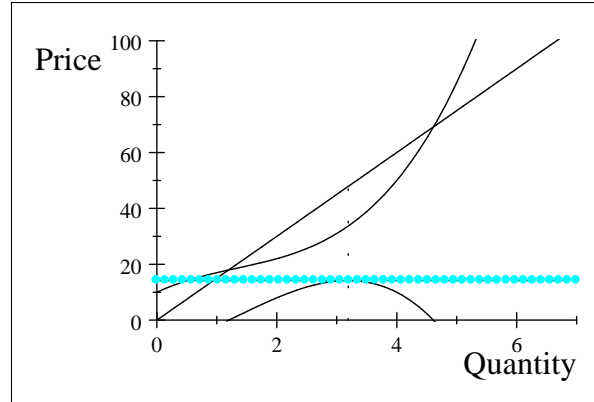
Although all 3 rules give the same profit-maximizing quantity and level of profit at the profit-maximizing quantity, we will frequently use rule #3.

2.1.1 “Deriving” the price-taker’s MR curve

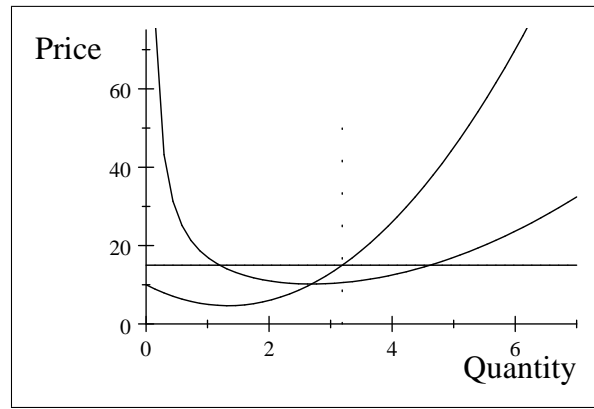
If we are to use rule #3 to find the profit-maximizing quantity, we must find the firm’s MR curve. We “know” the firm’s MC curve (or at least we have already discussed it). We know that $MR = \frac{\Delta TR}{\Delta q}$. For the price-taking firm, $TR = Pq$, where P is some constant that does NOT depend 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 the firm increases production from 1 unit to 2 units, then TR increases from P to $2P$, so $MR = 2P - P = P$. If the firm increases production from 2 units to 3 units, then TR increases from $2P$ to $3P$, so $MR = 3P - 2P = P$. If the firm increases production from 3 units to 4 units, then TR increases from $3P$ to $4P$, so $MR = 4P - 3P = P$. Hopefully the pattern is clear, as the $MR = P$; 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.

Of course, while pictures are helpful to develop intuition, we can use calculus to find the optimal profit:

$$\begin{aligned} \Pi(q) &= 15q - (10 + 10q - 4q^2 + q^3) \\ \frac{\partial \Pi(q)}{\partial q} &= 15 - 10 + 8q - 3q^2 \\ 0 &= 5 + 8q - 3q^2 \end{aligned}$$

For this particular problem the math does not work out so nicely – we would need to use the quadratic formula to find q :

$$\begin{aligned} q &= \frac{-8 \pm \sqrt{64 - 4(-3)(5)}}{2(-3)} \\ q &= \frac{-8 \pm \sqrt{124}}{-6} \\ q &= \frac{-8 \pm 2\sqrt{31}}{-6} \\ q &= \frac{-8 + 2\sqrt{31}}{-6}, \frac{-8 - 2\sqrt{31}}{-6} \end{aligned}$$

The first possible answer, $\frac{-8+2\sqrt{31}}{-6}$, is ≈ -0.52 , which is not a realistic quantity. The second possible answer, $\frac{-8-2\sqrt{31}}{-6} \approx 3.19$. So the only viable solution is $q = \frac{4+\sqrt{31}}{3}$. From here we can find the firm's maximum profit by substituting our solution, $q = \frac{4+\sqrt{31}}{3}$, into the profit function, $\Pi(q) = 15q - (10 + 10q - 4q^2 + q^3)$, and directly calculating the profit.

While the general rule for profit maximization is $MR = MC$, recall that in perfectly competitive markets that $MR = P$. Thus, in perfectly competitive markets, $P = MC$ is an equivalent profit-maximization rule.

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 $TVC = AVC * Q$.

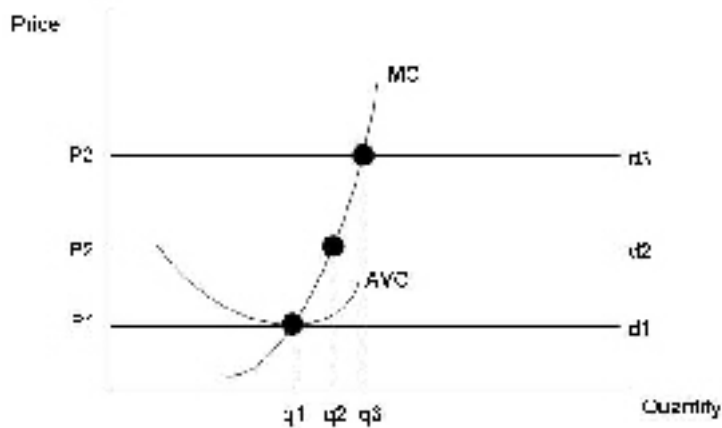
Why does the firm only consider variable costs, and not fixed costs, when making its shutdown decision? If the firm has decided to stay in the industry, it must pay its fixed costs regardless of whether or not it produces. Thus, these costs should not enter into the decision to either produce or shutdown (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 short run 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.



3.4 Firm's long run supply curve

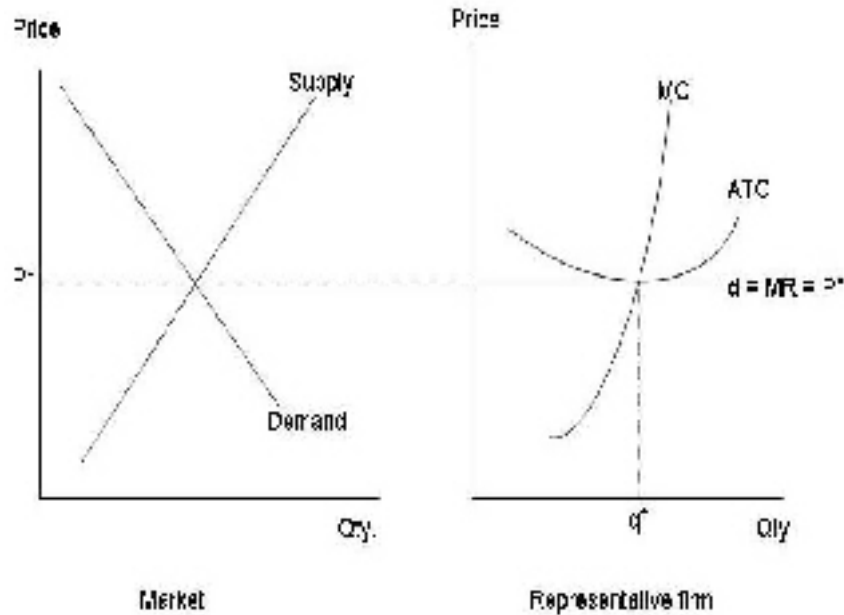
In the long run the firm will need to make at least zero economic profit. In this case, the analysis is similar to that for the firm's short run supply curve, only now we must have price above the minimum of ATC.

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.



4.1 LR Market Supply Curve

The firm's long-run market supply curve may be increasing (like a typical supply curve), constant (perfectly elastic), or decreasing (like a demand curve). The shape of the LR-supply curve depends upon the type of industry in which the firm operates. If the firm operates in an increasing cost industry, the LR market supply curve will be increasing. If the firm operates in a constant cost industry, the LR market supply curve will be constant. If the firm operates in a decreasing cost industry, the LR market supply curve will be decreasing.

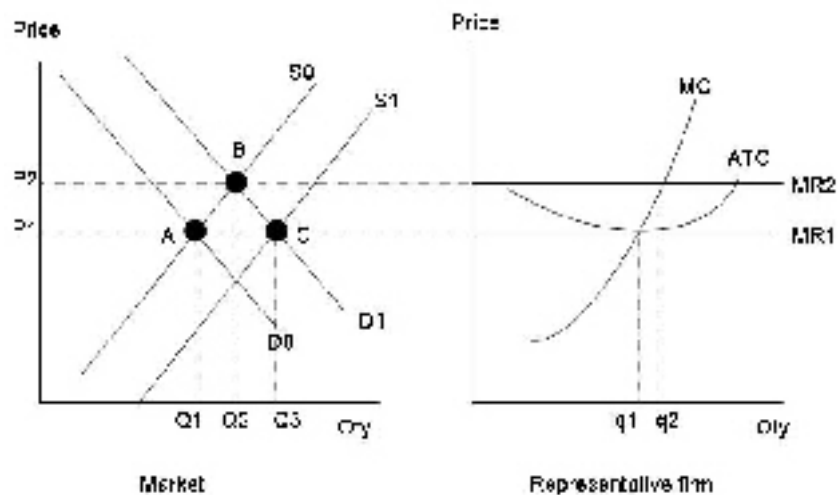
4.1.1 Constant cost industry

A constant cost industry is an industry in which input prices stay constant regardless of the quantity produced in the market. Constant cost industries are industries where the resources used only comprise a small fraction of the total use of the resource. Consider the matchbook industry. The resources used in making matchbooks are basically some wood and some chemicals. The amount of those resources used in the production of matchbooks is insignificant when compared to the total use of the resource (think about the amount of wood that goes into matchbooks, and how many matchbooks a single house could make). So, expansions and contractions in the matchbook industry are unlikely to affect the demand for the resources in that industry. Thus, firm costs will stay the same regardless of how industry output changes.

The following picture illustrates how the long-run market supply curve can be found. Suppose that the market is initially in LR equilibrium, corresponding to point A in the market picture (with price P_1 and quantity Q_1). Notice that the firm is earning zero economic profit at P_1 . Demand then shifts from D_0 to D_1 , moving the equilibrium in the market from point A to point B. The price rises to P_2 , causing the firm's MR to shift from MR_1 to MR_2 . Since the firm is now earning economic profits, point B is NOT a long-run equilibrium point. The profits will cause new firms to enter, which will cause the market supply to increase from S_0 to S_1 . The market equilibrium is now point C. The price then returns to P_1 , causing the firm's MR to return to MR_1 . The firm is again earning zero economic profit, so point C is a long-run equilibrium point.

We will only consider linear LR market supply curves. Since we are only considering linear curves, all we need is two points to draw the line. In this case, points A and C are both LR equilibrium points, and we can obtain the LR market supply curve by drawing the line that connects these two points. This line is the perfectly horizontal line at P_1 . Thus, the industry is a constant cost industry because the LR supply curve is perfectly elastic. Also notice that as the market output expands (from Q_1 to Q_2 to Q_3), the firm's

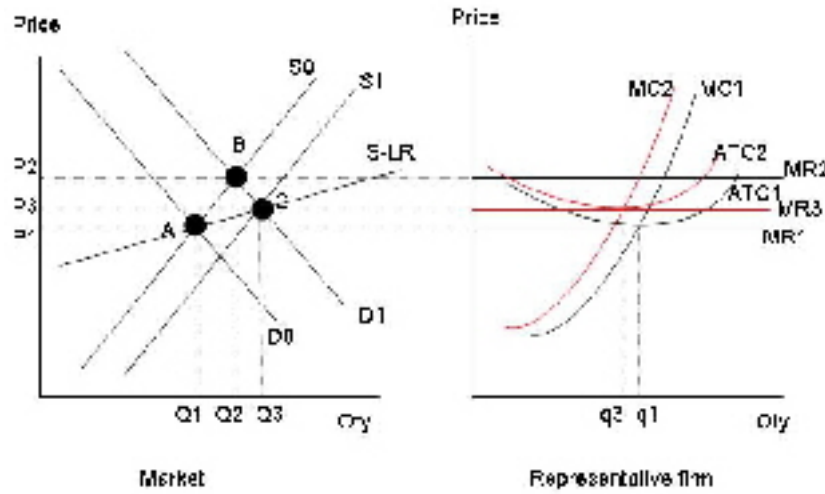
costs do not change.



4.1.2 Increasing cost industry

An increasing cost industry is an industry in which input prices increase (decrease) as the quantity produced in the market increases (decreases). Most industries are increasing cost industries, since an increase in the quantity produced in the market will cause firms to increase the demand for the resources used to make the product. These increases in demand for the resources will cause the prices of the resources to increase, which will cause the firm's cost curves to increase. As firms costs increase, a higher price will be required for the firm to remain at zero economic profit when it produces its profit-maximizing quantity.

The following picture (not for the faint of heart – there are many lines) illustrates how to find the LR market supply curve in an increasing cost industry. Begin at point A, with the market price and quantity at P_1 and Q_1 respectively. The firm is earning zero economic profit when the price is P_1 (since it has ATC of ATC_1 and MC of MC_1). Thus, point A is a long-run equilibrium point. Now, suppose demand increases from D_0 to D_1 . The market moves to point B, with price P_2 and quantity Q_2 . The increase in price causes the firm's MR curve to increase from MR_1 to MR_2 . The firm is now earning positive economic profits (since ATC and MC are still ATC_1 and MC_1). Firms will enter this market since there are positive economic profits, and the market supply will increase from S_0 to S_1 . Although this looks like one big increase in supply, it is really a series of smaller increases in supply. The price falls from P_2 to P_3 (notice that P_3 is slightly higher than P_1), and market quantity increases to Q_3 . During this expansion in market quantity, resource prices are being bid up, causing the cost curves (MC and ATC) to increase from MC_1 and ATC_1 to MC_2 and ATC_2 . Although this looks like one big jump, it is really a series of smaller increases in costs as the market quantity progresses from Q_1 to Q_2 to Q_3 . To illustrate the dynamics of the process, start at point B. Imagine the supply curve slowly increasing from S_0 to S_1 (this will cause the market price and the firm's MR to slowly decrease) and the firm's cost curves slowly increasing from MC_1 to MC_2 . At some price (P_3 in this illustration), the firm returns to zero economic profit, and thus to long-run equilibrium. The new long-run equilibrium in the increasing cost industry is shown by point C in the market picture, and the red curves in the firm picture (MC_2 , ATC_2 , and MR_3 if you print this out in black and white). When we draw our line through points A and C, the resulting LR market supply curve is increasing, which reflects the fact that firms must see higher prices in order to expand market output in the LR. This is due to the increase in resource costs that will occur in the increasing cost industry.



4.1.3 Decreasing cost industry

A decreasing cost industry is an industry in which input prices decrease (increase) as the quantity produced in the market increases (decreases). Thus, there will be a downward sloping LR market supply curve. Decreasing cost industries typically occur when the resource providers have not yet begun to experience diseconomies of scale. Consider the calculator market in the 1970s. When demand for calculators was low, the resource providers did not need large facilities and likely did not utilize mass production methods to their fullest extent. However, as demand for the calculators increased, the demand for the resources increased. As resource providers increased production, the prices of the resources fell as the resource providers were able to take advantage of economies of scale, and possibly learning curves, to lower costs. These resource price decreases could be passed along to the calculator manufacturer, which could then be passed along to the final consumer. Thus, as the market output expands, the price of the final product actually falls due to the decrease in resource prices.

The following picture illustrates the decreasing cost industry. The explanation is essentially the same as the increasing cost industry, except that now costs and MR are both falling. The process again stops when the firm is earning zero economic profit.

