Perfect Competition

Readings: Ch. 11

Much of what we will do throughout the rest of the semester requires us to make some assumptions about the factors that drive a firm's decisions, i.e. the firm's objectives. The assumption we will typically use is profit maximization.

Objective: Understand what profit is and the difference between economic and accounting profit.

When we talk about profit, we will be talking about the difference in the total revenues generated from an activity and the total cost of engaging in the activity.

Economists like to make a distinction between accounting profit, for example the profit regularly reported to the stockholders of a firm and economic profit, the profit we will use as the firm's objective.

The difference in accounting and economic profit is what counts as a cost. Economic profit takes into account all costs, explicit and implicit, while accounting profit only takes into account explicit costs.

For example, economic profits include opportunity costs, while accounting profits ignore these costs.

A good example is farming. Suppose a farmer produces 150 bushels of corn per acre on land that he owns, which he sells for $3 a bushel. The cost of seed, fertilizer, and pesticides is $300 an acre. The cost of the tractor (including fuel, repairs, and depreciation), and other equipment used to plant and maintain the crop is $50 an acre.

Question: What is the farmer's accounting profit per acre?

Accounting profit = $3×150 - $300 - $50 = $100.

Question: What is missing from this equation if we want to talk about economic profit?

If the farmer did not farm his land, he could rent it to another farmer. Therefore, there is an opportunity cost to using the land to produce corn even if the farmer already owns the land.

Additionally, if the farmer was not working the land, he could be doing something else — another job perhaps. Therefore, there is the opportunity cost of the farmer's time that is not included in accounting profit.

Can you think of other implicit costs not included in the farmers accounting profit above?

Objective: Understand why assuming profit maximization is a good bet.

Often people question whether profit maximization is such a good assumption. As we will see, maximizing profit requires careful and detailed analysis that is not always apparent in firm level decision making. Some firms' decisions appear rather random, others use careful and detailed analysis, and still others simply mimic the behavior of other firms.

All this is OK. Firms in a competitive market are rewarded based on profitability. Their profitability gives them the ability to obtain the resources needed to continue and expand production if so desired. Unprofitable firms ultimately find themselves in a circumstance where they do not have the resources necessary to continue or expand production. This allows more profitable firms to proliferate, while less profitable firms perish.

It really doesn't matter how firms find the profit maximizing level of activity. Just that firms that do are rewarded and those that don't are punished.

Objective: Understand what economists mean when they refer to perfect competition.

What we have strived for over the past couple of chapters is an explanation for where the supply curve comes from. What we will see over the next couple of chapters is that the answer to this question does not rest solely with production and costs. It also depends on the relationship of firms with each other and the market, which is often referred to as the structure of an industry, organization of an industry, or industrial organization.

The first industrial organization we will consider is perfect competition. Certain conditions will result in perfect competition. These conditions include

1. Sale of a Standardized Product: The product of one firm is indistinguishable from the product of another.
2. Firms are Price Takers: Firms take the price of output and inputs as given. They do not believe their output or input decisions can affect prices.
3. Factors of Production Are Perfectly Mobile in the Long Run: This condition implies firms can freely enter a market when profit opportunities exist or leave a market when production becomes unprofitable.
4. Firms and Consumers Have Perfect Information: This condition implies that consumers always know which producers are asking the cheapest price and producers always know which consumers are offering the highest price.

From a practical standpoint, it would be hard to find an industry that truly matches the definition of a perfectly competitive industry, but commodities such as corn, soybean, and wheat, are often cited as good examples. Even so, perfect competition provides a good benchmark and its predictions often work well even when some of the conditions above do not hold.

Objective: Understand short run production under the assumption of perfect competition.

As mentioned earlier, we will assume that a firm's objective is to maximize profit, which is the total revenue from an activity minus the total cost: $\Pi = TR - TC$. In the last chapter, we saw how to find a firm's short run total cost, so now what we need to do is figure out its total revenue.

We said that perfect competition is characterized by price taking behavior, the level of output a firm chooses does not affect the price received. Therefore, total revenue will be the price of output multiplied by the quantity of output sold: $TR = P_0Q$ where P_0 is the price of output. Graphically, the total revenue curve will be a line through the origin with its slope equal to the price (see Figure 1). Figure 2 shows the total cost function with the total revenue function. In Figure 2, there are several particularly interesting levels of output.

First, Q_0 is found by shifting the total revenue curve up until it is just tangent to the cost curve.

Second, note that at Q_1 and Q_3 total cost just equals total revenue.

Finally, Q_2 is found by shifting the total revenue curve down until it is just tangent to the total cost curve.

Why are these quantities interesting? They are interesting because they tell us important details about what our profit function looks like. In particular, as we increase output from 0 to Q_0, profit is negative because total costs exceed total revenue and decreasing because total costs are increasing faster than total revenue (becoming more negative). Between Q_0 and Q_1 profit is still negative, but now total costs are increasing by less than total revenue, so profit is increasing (becoming less negative). Between Q_1 and Q_2 profit is finally positive because total revenue exceeds total cost. It is also still increasing because total revenue is increasing faster than total cost. Between Q_2 and Q_3, profit remains positive, but now it is decreasing because total cost is increasing faster than total revenue. Finally, above Q_3 profit is again negative and still decreasing.

All this tells us precisely how to graph the profit function illustrated in Figure 3. When output is equal to 0, profit is the negative of the fixed cost of production. When output is equal to Q_0, profit reaches a minimum. When output equals Q_1 and Q_3, profit is equal to 0. Finally, when output equals Q_2, profit is at a maximum.

To better understand what is going on here, we need to introduce the concept of marginal revenue.

Definition
Marginal Revenue (MR): The change in total revenue that results from a one unit change in sales: $MR = \Delta TR/\Delta Q$.

Graphically, marginal revenue for a competitive firm is equal to the slope of the total revenue curve, which is equal to the price of output. Marginal revenue can also be found by calculating the derivative of total revenue with respect to output: $MR = TR'$.

Recall, that the slope of the total cost curve is equal to the marginal cost. Therefore, what makes Q_0 and Q_2 interesting is the fact that MR = MC. In the first case, this result implies profit is at a minimum. In the second, it implies profit is at a maximum. We now have a condition that tells us when profit is at a maximum, but unfortunately the same condition holds when profit is at a minimum.

How can we distinguish between the two? To distinguish between the two, it is useful to look more directly at the marginal revenue and cost curves in Figure 4. What we see in Figure 4 is that the marginal cost curve is decreasing at Q_0 and increasing at Q_2.

Recall that total cost is a function of output, so we can write TC = C(Q). We can then define profit as $\Pi = P_0Q - C(Q)$. Also recall that we can find the maximum of a function by taking the derivative of the function and setting it equal to 0: $\Pi' = P_0 - C'(Q) = 0 \Rightarrow P_0 = C'(Q)$ or MR = MC. However, to assure this is a maximum, the second derivative of the function must be negative: $\Pi'' = -C''(Q) < 0 \Rightarrow C''(Q) > 0$. $C''(Q)$ is the derivative of marginal cost or the slope of the marginal cost curve. Therefore, for MC = MR to tell us the maximum profit, it must also be the case that marginal cost is increasing, $\Delta MC/\Delta Q = MC' = C''(Q) > 0$.

There is one final caveat we must discuss. That caveat is whether or not the firm should produce at all in the short run. Figure 5 is useful for understanding this caveat. In Figure 5, we have two different profit functions Π_1 and Π_2. For both, MR = MC at Q_0 and Q_2. Clearly, Q_0 is not a profit maximizing level of output for either Π_1 or Π_2. But, what about Q_2? For Q_2 or any other level of output, profits are negative.

Question: Does it still make sense to produce at Q_2 even though profit is negative?

Question: What is our profit if we produce nothing?

If we produce nothing, our variable costs are 0, but we still have fixed costs. Therefore, $\Pi = -FC$ (see figure 5).

Notice that the profit maximum at Q_2 for Π_1 exceeds –FC. Therefore, for Π_1 our profit will be higher for Q_2 rather than not producing at all. So, it makes sense to produce at Q_2 for Π_1 even if profit is negative because it will be less negative than not producing at all.

Alternatively, the profit maximum at Q_2 for Π_2 is less than –FC. Therefore, for Π_2 our profit will be higher if we produce nothing rather than Q_2. So, it does not make sense to produce at Q_2 for Π_2 because if we do we lose more than not producing at all.

What all this tells us is that we should produce in the short run only if we can produce where $\Pi > -FC$. Remember that TC = VC + FC. Therefore, we should produce only if $\Pi = TR - VC - FC > -FC$ or $TR > VC$. If we divide both sides by Q, we have $AR = TR/Q > VC/Q = AVC$ where AR is average revenue. For a perfectly competitive firm note that AR will equal the price: $AR = TR/Q = P_0Q/Q = P_0$. We should produce if AR > AVC even if profit is negative in the short run

because it allows us to pay at least part of our fixed cost, which are not going away even if we produce nothing.

Now we are ready to fully characterize a firm's short run profit maximizing rule. For a firm to produce, three conditions must be met:

1. MR = MC (P_0 = MC),
2. Marginal Cost Must Be Increasing (MC' > 0), and
3. AR >AVC (P_0 > AVC).

If these three conditions cannot be met for some positive level of output, then the firm should produce nothing.

This rule tells use precisely what the firm's short run supply curve will look like. It will be equal to the marginal cost curve above the minimum average variable cost and 0 below the minimum average variable cost. Figure 6 illustrates.

Objective: Understand how to derive the supply for a perfectly competitive industry in the short run.

Previously, we saw how to derive market demand from individual demand. The strategy we used summed the quantity demand by each individual for all possible prices, i.e. we took market demand to be the horizontal sum of individual demands.

This procedure also works for finding industry supply from individual firm supply curves. To find the industry supply, we want to horizontally sum individual supply curves.

Consider an example with only two firms. Suppose firm A's supply is 0 if $P < 10$ and $Q_A = 5 + 0.5P$ for $P \geq 10$. Firm B's supply is 0 for $P < 20$ and $Q_B = 10 + P$ for $P \geq 20$. Figures 7 and 8 plot these supply curves.

To find industry supply, we must first note when each individual firm is willing to enter the market. For $P < 10$, neither firm is willing to supply output. For $20 > P \geq 10$, firm A is willing to supply the market, but firm B is not. $P \geq 20$ both firms are willing to supply the market.

Therefore, the industry's supply will be
$Q_S = 0$, for $P < 10$;
$Q_S = Q_A = 5 + 0.5P$, for $20 > P \geq 10$; and
$Q_S = Q_A + Q_B = 5 + 0.5P + 10 + P = 15 + 1.5P$, for $P \geq 20$ (See Figure 9).

Objective: Understand long run production under the assumption of perfect competition.

We found that in the short run firms may choose to produce even with negative economic profits provided total revenue exceeded variable cost. It would continue to produce because when total

revenue exceeds variable cost, it is able to use the excess revenue to pay part of the fixed costs it incurs regardless of how much it produces.

In the long run, all costs are variable, i.e. total cost equals variable cost. The firm's profit maximizing rule does not change. It is still to produce where marginal revenue equals marginal costs: $MR = P_0 = LMC$. We still need to make sure marginal costs are increasing: $LMC' > 0$. Finally, we still need to cover variable cost, but remember all costs are variable in the long-run: $AR = P_0 > LAC$. Figure 10 illustrates.

Figure 10 also shows how we can determine profit using the marginal revenue, marginal cost, and long run average cost when the price is P_0. This profit is denoted by the area **abcd**.

Alternatively, if the price is P_1, the firm may choose to produce in the short run, provided this price covers its average variable cost. But in the long run the firm will incur losses equal to area **efgh**. Since shutting down in the long run would result in no loss, the firm should shut down.

Objective: Understand the implication of perfectly mobile factors of production in the long run on firm profit and supply.

Consider the market equilibrium in Figure 11. In Figure 12, we see the firm earns positive economic profits for this market equilibrium.

Question: Can this result persist in the long run if factors of production are perfectly mobile?

If firms see that there are profits to be made, they will have an incentive to enter the industry. Remember these are profits in excess of total economic costs including the opportunity cost of doing something else. If factors of production are perfectly mobile, then there is nothing stopping them from entering the industry. Let MC_E be the marginal cost curve for a new firm that chooses to enter because of its positive profit potential. This entry results in a shift out in the industry supply to S_1. This shift in supply reduces the equilibrium price and ultimately the profit of all firms in the industry. As long as the equilibrium price is above LAC = MC (the minimum average cost of production), there is positive profit and an incentive for entry into the industry.

A similar argument can be made if the equilibrium price results in economic losses. If this is the case, some firms will find it advantageous to leave the industry. This will shift the supply curve back increasing the equilibrium price. Firms will continue to leave the market as long as price is below LAC = MC.

Therefore, no economic profit or losses can exist in the long run for perfectly competitive market equilibrium. What all this means is that a perfectly competitive market will produce the desired amount of output at the least possible cost in the long run.

Objective: Understand the characteristics of long run supply.

Since any economic profit results in entry into the industry, the long run supply curve must equal the minimum average cost of production. If the increased supply of outputs has no effect on the price of inputs, the long run supply curve will be horizontal (See Figure 13).

Question: Are there any instance where the long run supply curve will be something other than a horizontal line?

Consider the example in Figure 14. In Figure 14, Panel I shows market demand and supply for a product. Panel II shows a firm's long run average and marginal cost of production. Panel III shows market demand and supply for labor and Panel IV shows market demand and supply for capital.

Initially, we start out where the market equilibrium price for Q_S and Q_D is P*. The equilibrium in the labor and capital market are determined from L_S and L_D and K_S and K_D at w* and r*. For w* and r*, the firm's long run average and marginal costs are LAC and LMC.

Notice however that at a price of P* the firm is earning positive economic profit in the long run. Since factors of production are perfectly mobile, we can have none of that. Other firms will be encouraged to enter the market. If a new firm enters the market, the supply of the product will increase to Q_S' for instance which decreases the equilibrium price to P**. But before this can happen, the new firm will have to secure labor and capital. This will shift the demand for labor and capital out to L_D' and K_D' for instance resulting in new equilibrium prices of w** and r**. Higher prices for labor and capital will drive up the cost of production for all firms to LAC' and LMC' for instance.

These adjustments will continue to occur until the equilibrium price in the product market equals the minimum long run average cost.

What does all this mean? It means that as the long run output of the firm increases increased demand for inputs will drive up the minimum long run average cost, so the price a firm has to charge will increase in order to avoid economic losses. Therefore, the long run supply curve will be increasing. All this is attributable to what is called pecuniary diseconomies.

Definition
Pecuniary Diseconomy: A rise in production cost that occurs when an expansion of industry output causes a rise in the prices of inputs.

Question: What conditions must be met to avoid pecuniary diseconomies?

To avoid pecuniary diseconomies, the supply of all inputs must be horizontal so that increasing the demand of the input does not affect the price. Something that is unlikely to occur.

Objective: Understand the price elasticity of supply and how to calculate it.

As with demand curves, we are often interested in how sensitive the quantity supplied is to price. We again also want a measure that does not depend on the units of measurement. The price elasticity of supply is just the quantity we are looking for.

Definition
Price Elasticity of Supply: The percentage change in the quantity supplied divided by the percentage change in price: $e_S = \dfrac{\dfrac{\Delta Q_S}{Q_S}}{\dfrac{\Delta P}{P}} = \dfrac{\Delta Q_S}{\Delta P}\dfrac{P}{Q_S}$.

For example, consider the supply curve $Q_S = 10P - 5$. To calculate the elasticity of supply when $P = 2$ we need to find $\Delta Q_S/\Delta P$ and Q. $\Delta Q_S/\Delta P$ is the inverse of the slope of our supply curve or 10 ($P = 0.5 + 0.1Q_S$, so the slope of the supply curve is 0.1 and its inverse is 10). Q can be found by substituting 2 into $Q_S = 10P - 5$, which is 15. Bringing every thing together yields $e_S = 10\dfrac{2}{15} = \dfrac{20}{15} = 1\dfrac{1}{3}$.

An interesting artifact to note is that the price elasticity of supply will always be one for a linear supply curve that passes through the origin. For example, the general formula for a linear supply curve is $Q = aP$. Substituting in for our elasticity of supply yields $e_S = a\dfrac{P}{aP} = 1$.

There is one final note on the price elasticity of supply. Comparing the price elasticity of supply in the short run to the price elasticity of supply in the long run, you will find that supply is more elastic in the long run. That is, a change in price will have a bigger impact on the quantity supplied in the long run than in the short run because in the long run firms can adjust all factors of production. This increased flexibility allows them to be more sensitive to price in the long run.

Figure 1: Total Revenue for a Competitive Firm

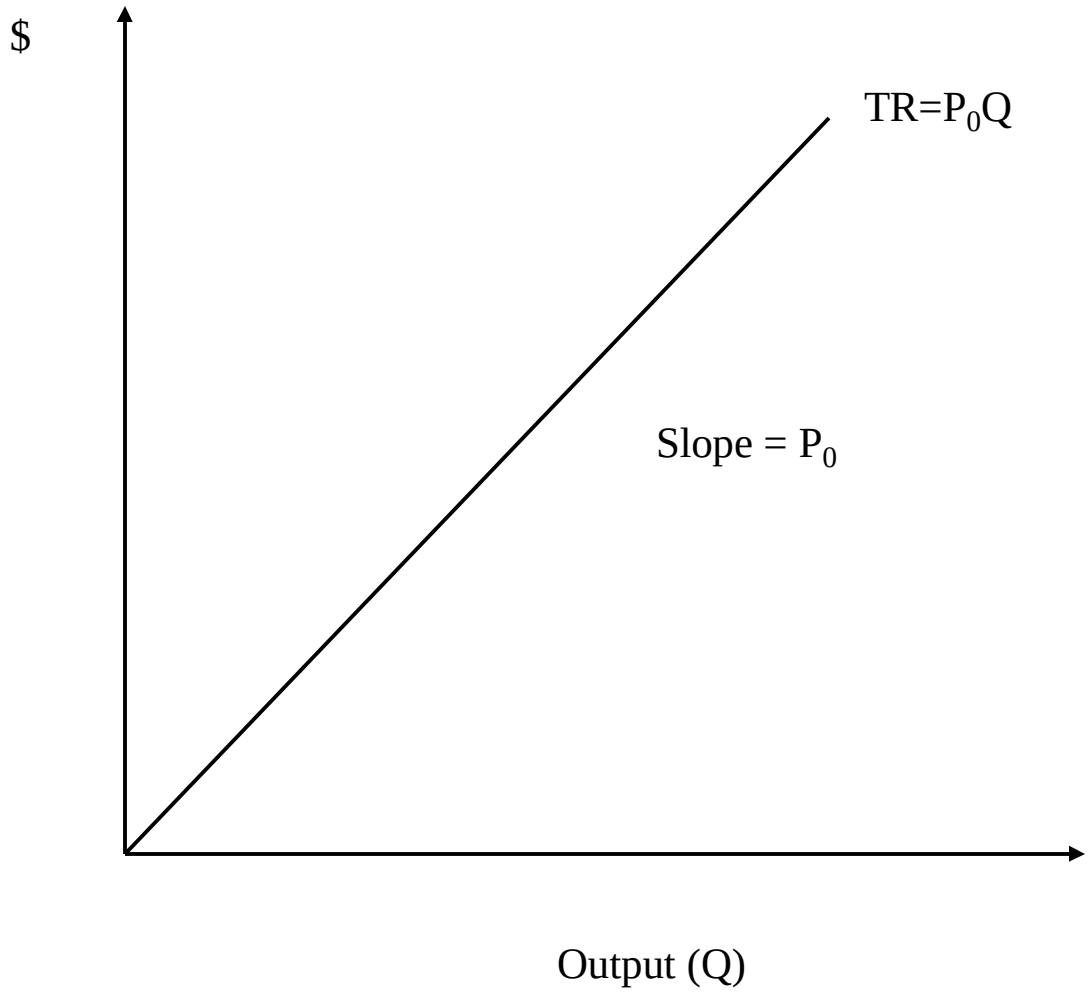

Figure 2: Total Revenue and Cost for a Competitive Firm

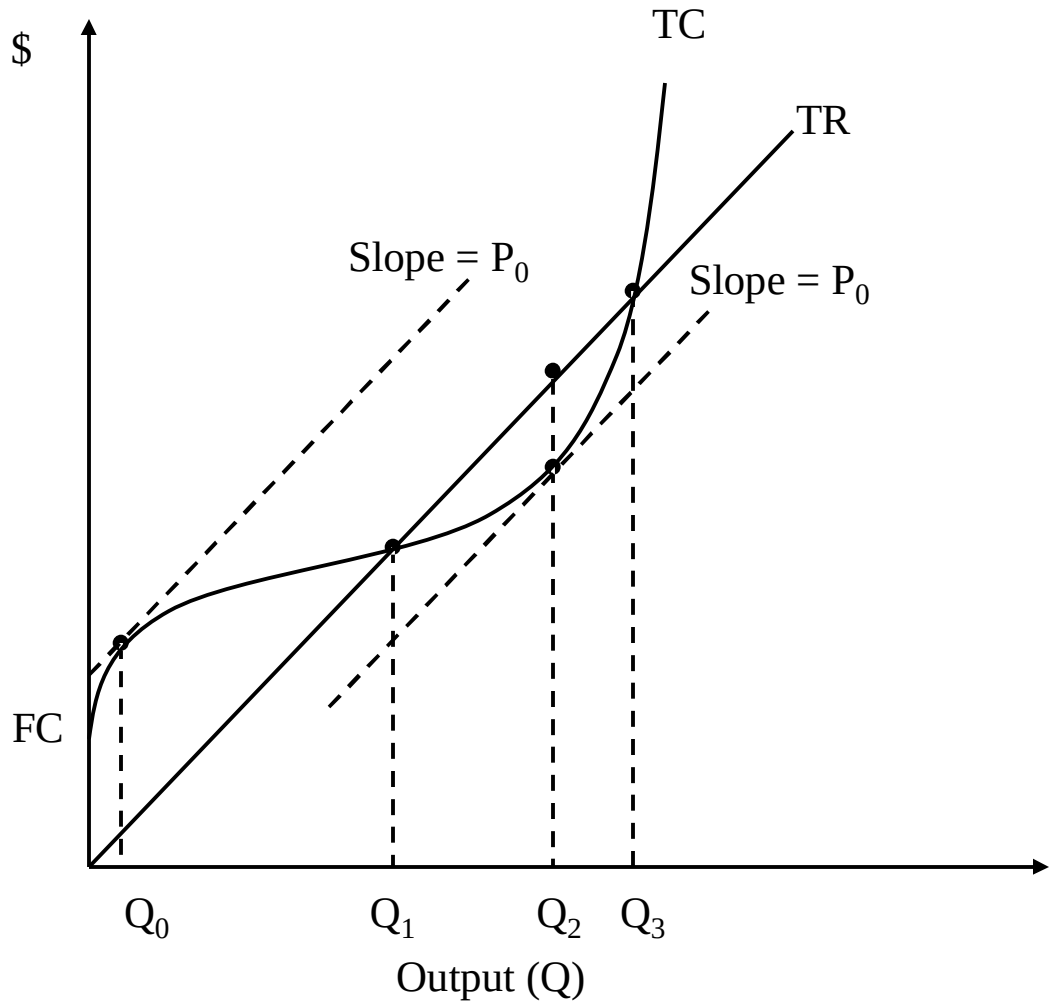

Figure 3: Profit Curve for a Competitive Firm

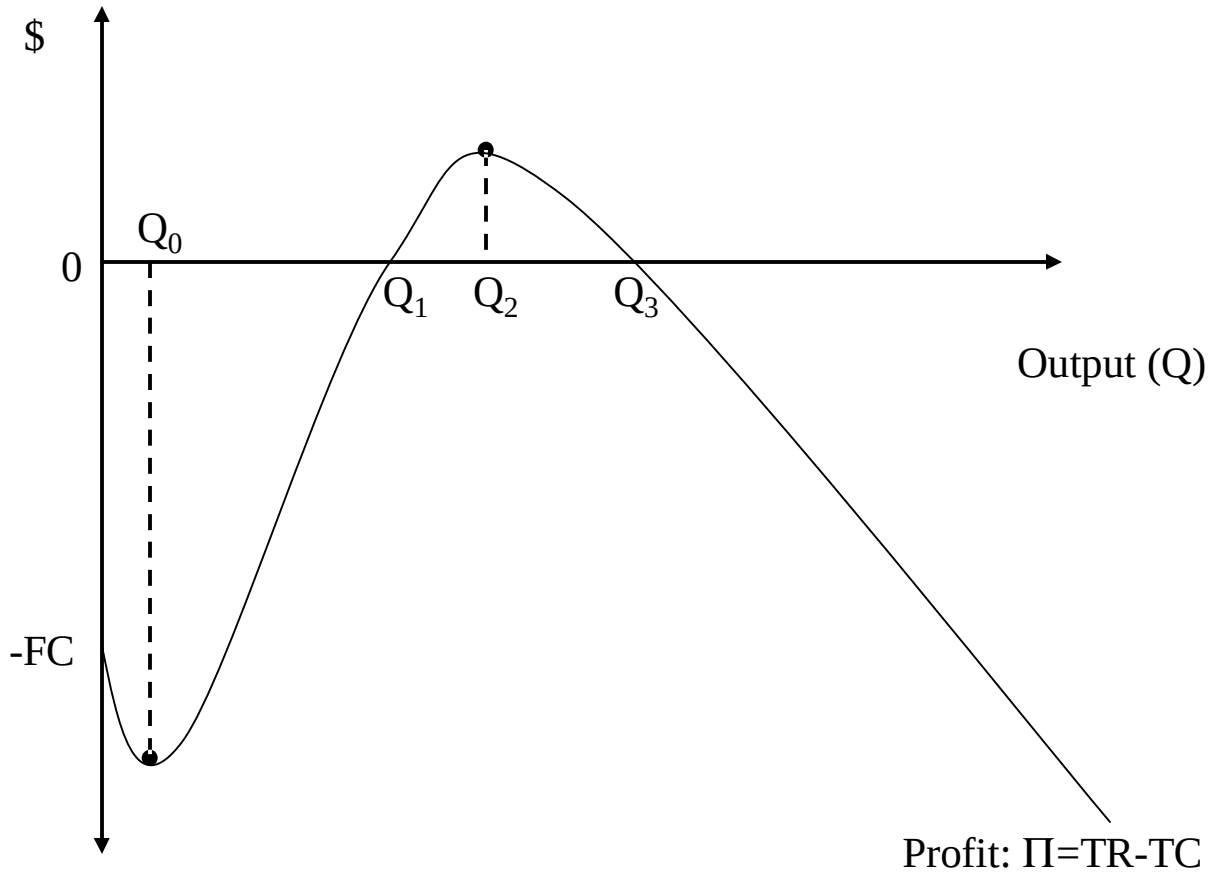

Figure 4: Marginal Revenue and Cost Curves

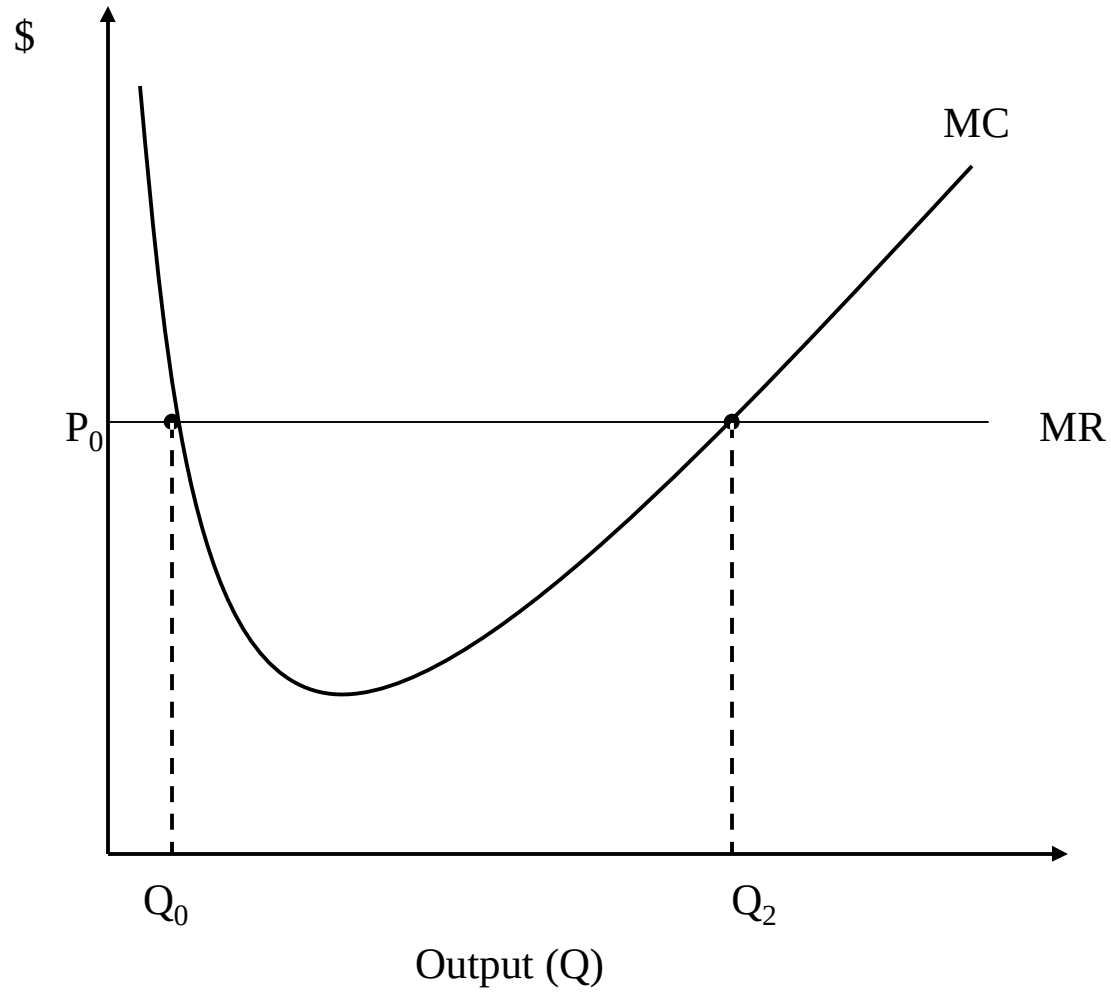

Figure 5: Different Profit Curves for a Competitive Firm

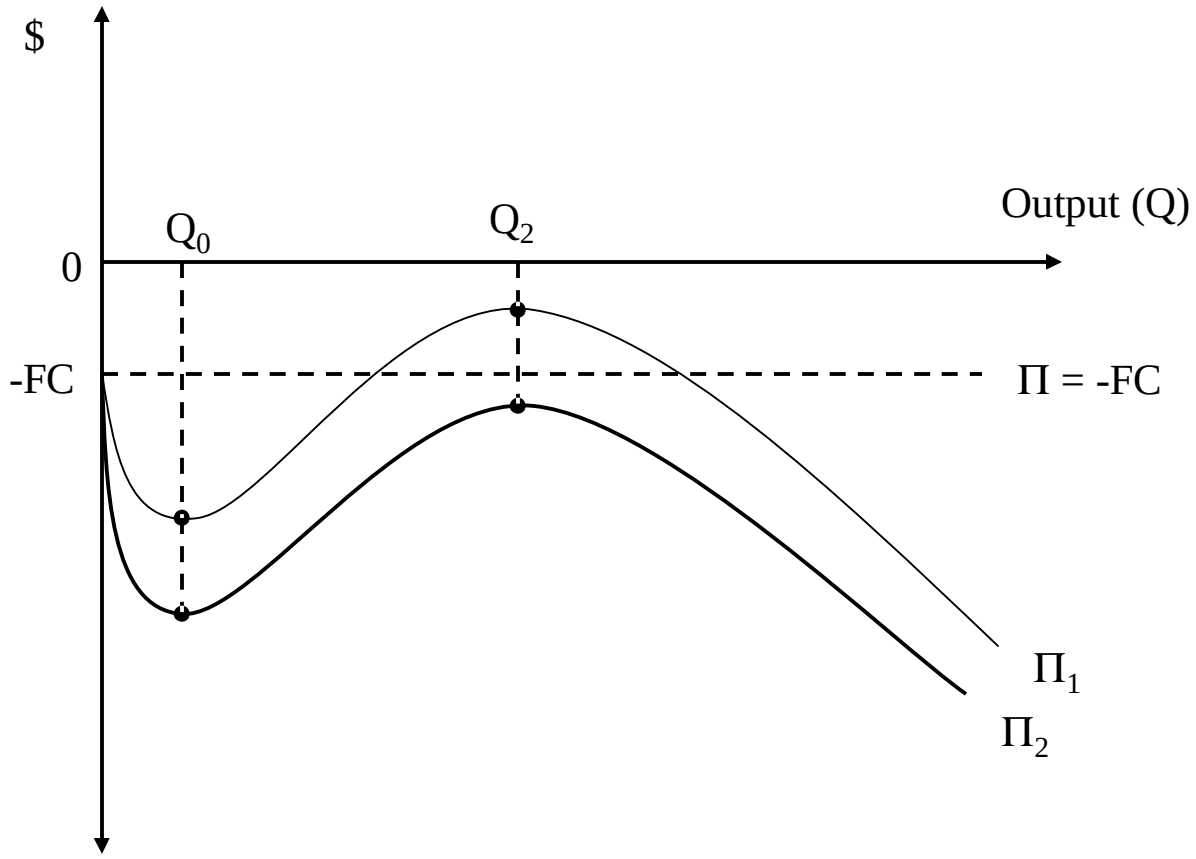

Figure 6: Perfectly Competitive Supply in the Short Run

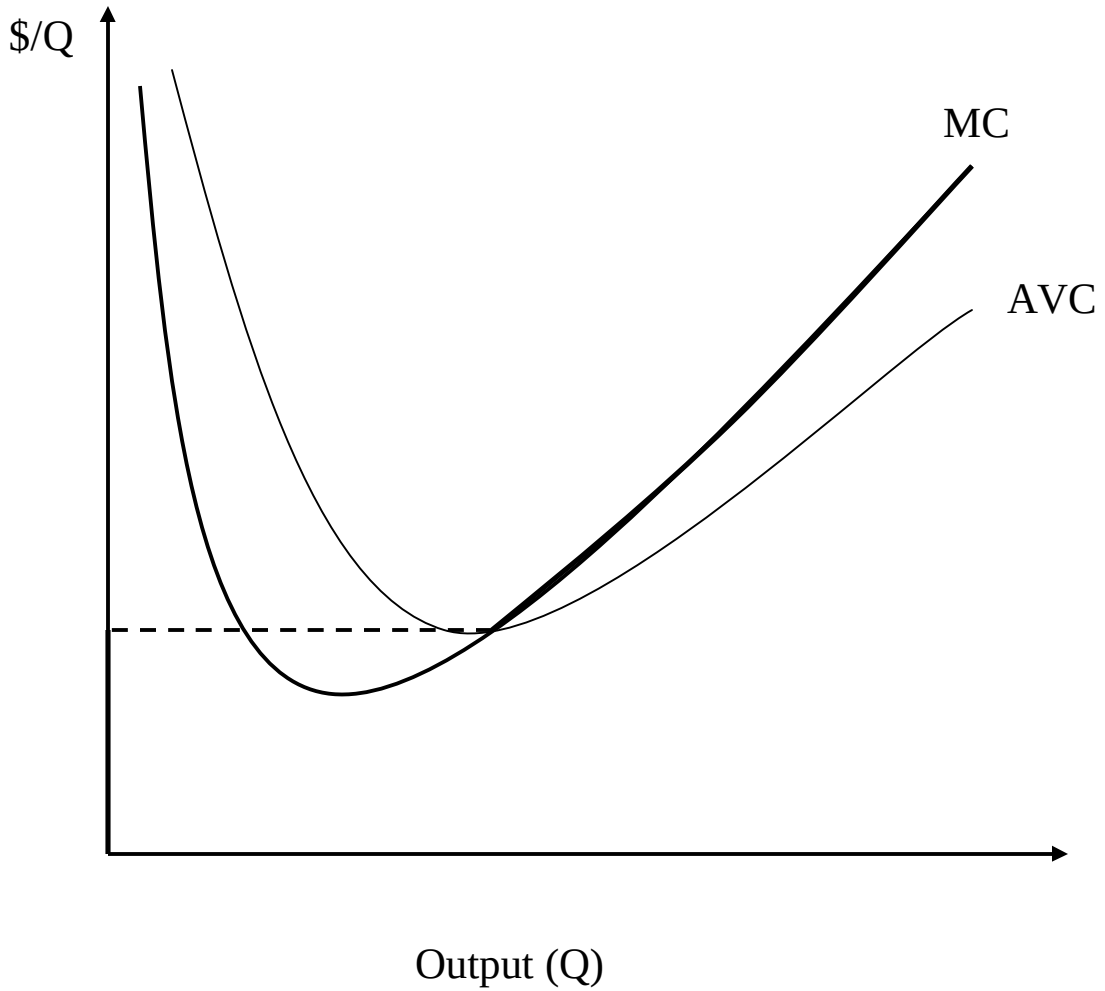

Figure 7: Firm A's Supply

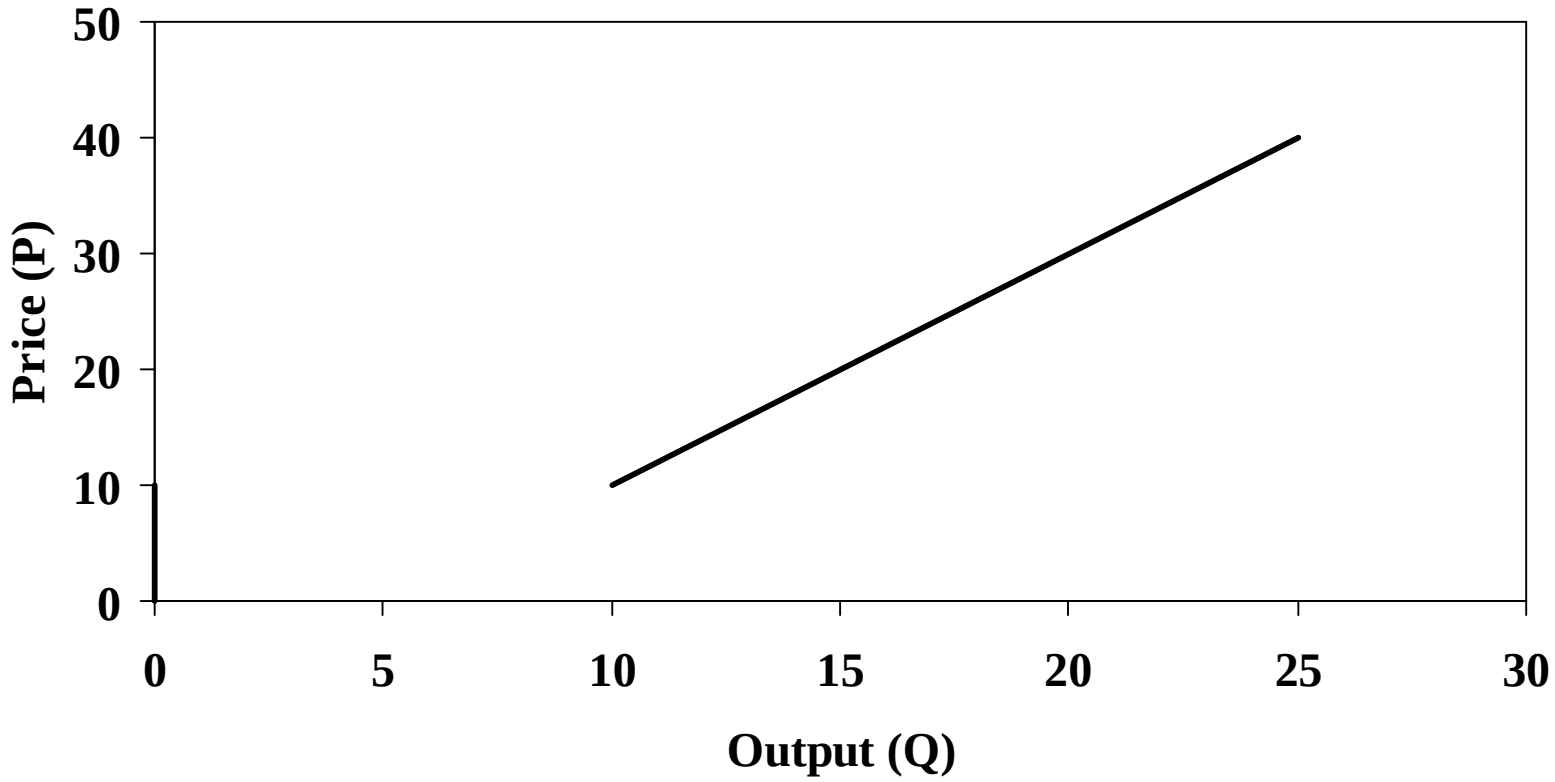

Figure 8: Firm B’s Supply

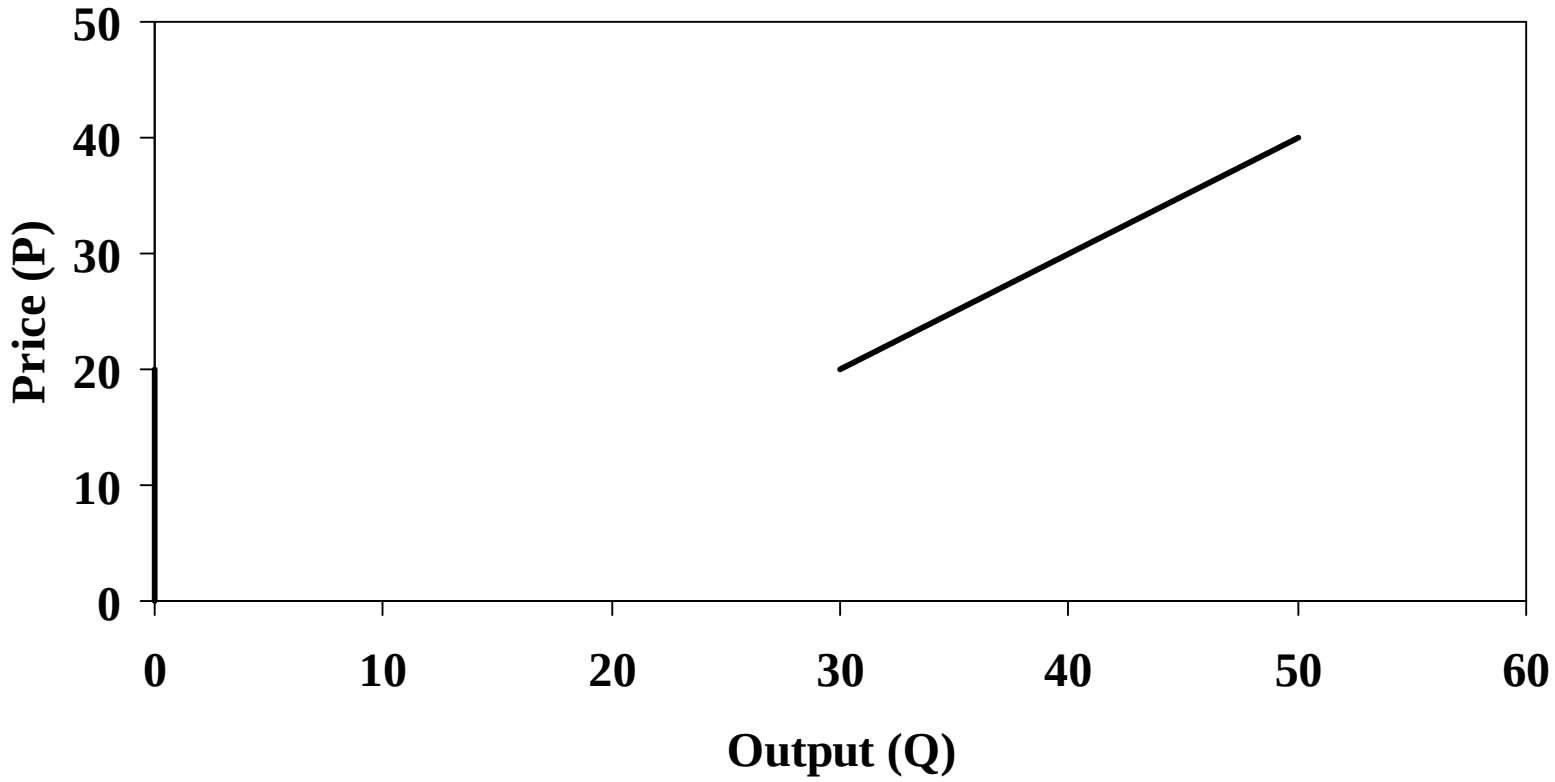

Figure 9: Industry Supply for Firm A and B

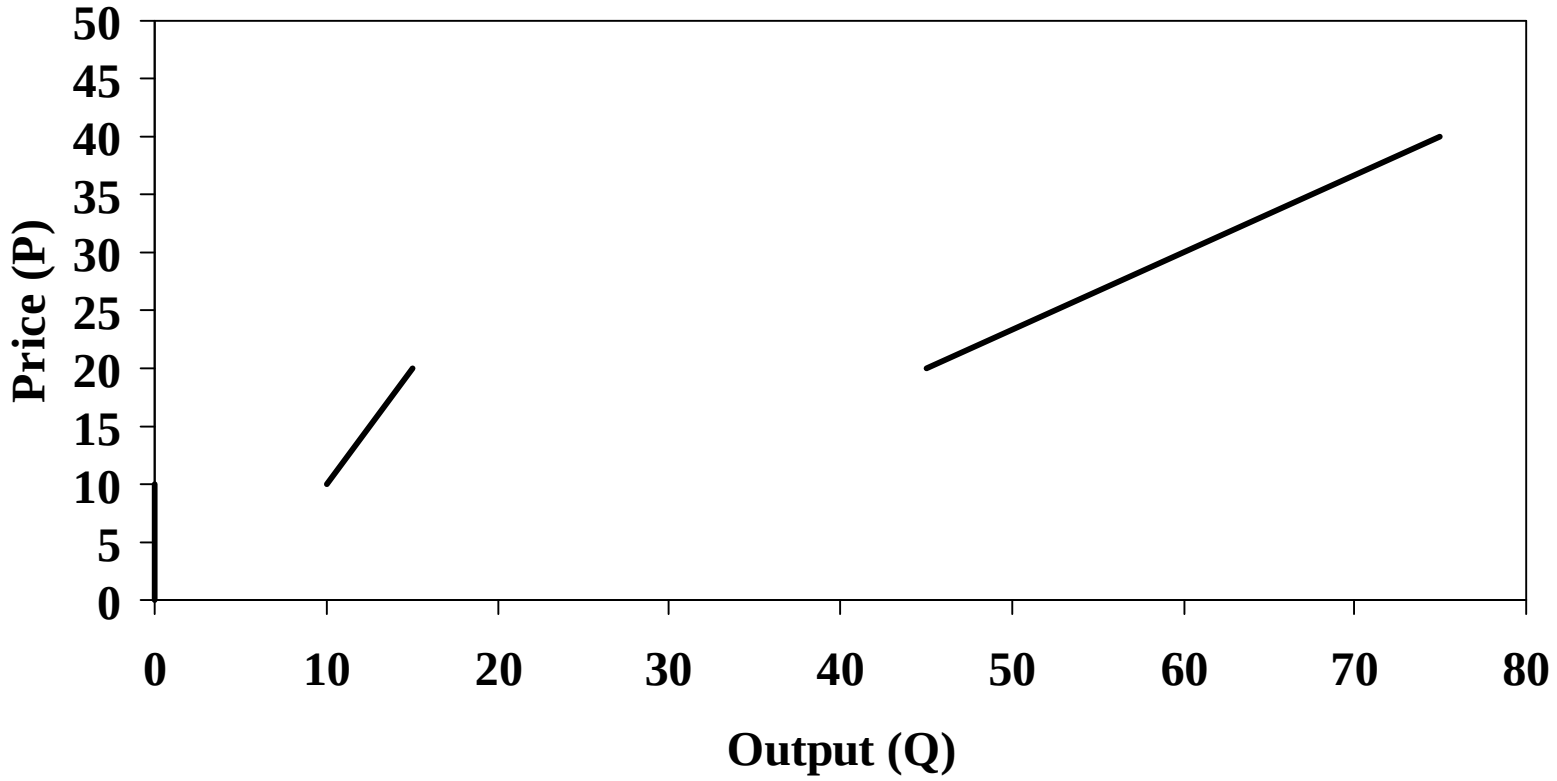

Figure 10: Long Run Production For a Perfectly Competitive Firm

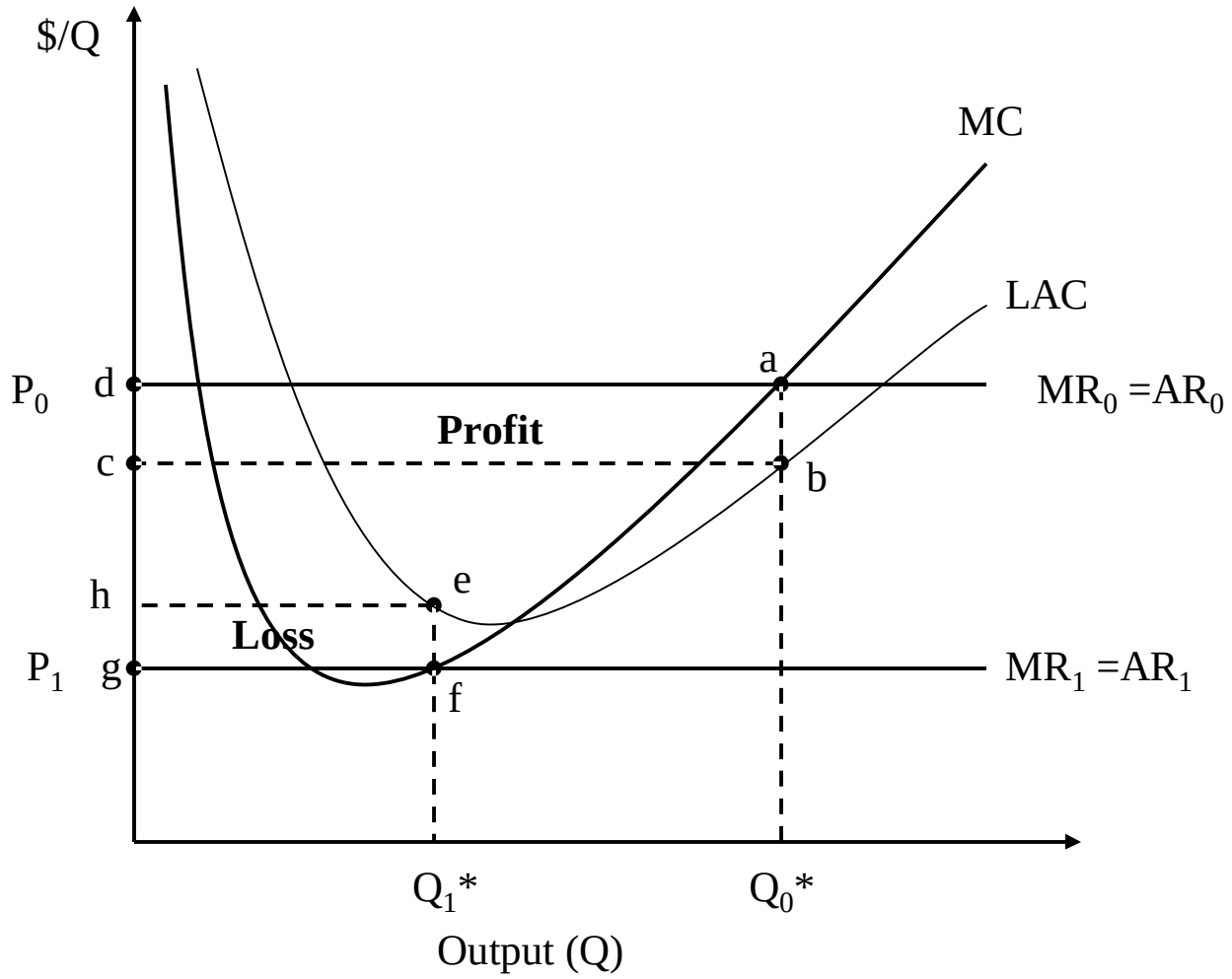

Figure 11: Market Equilibrium

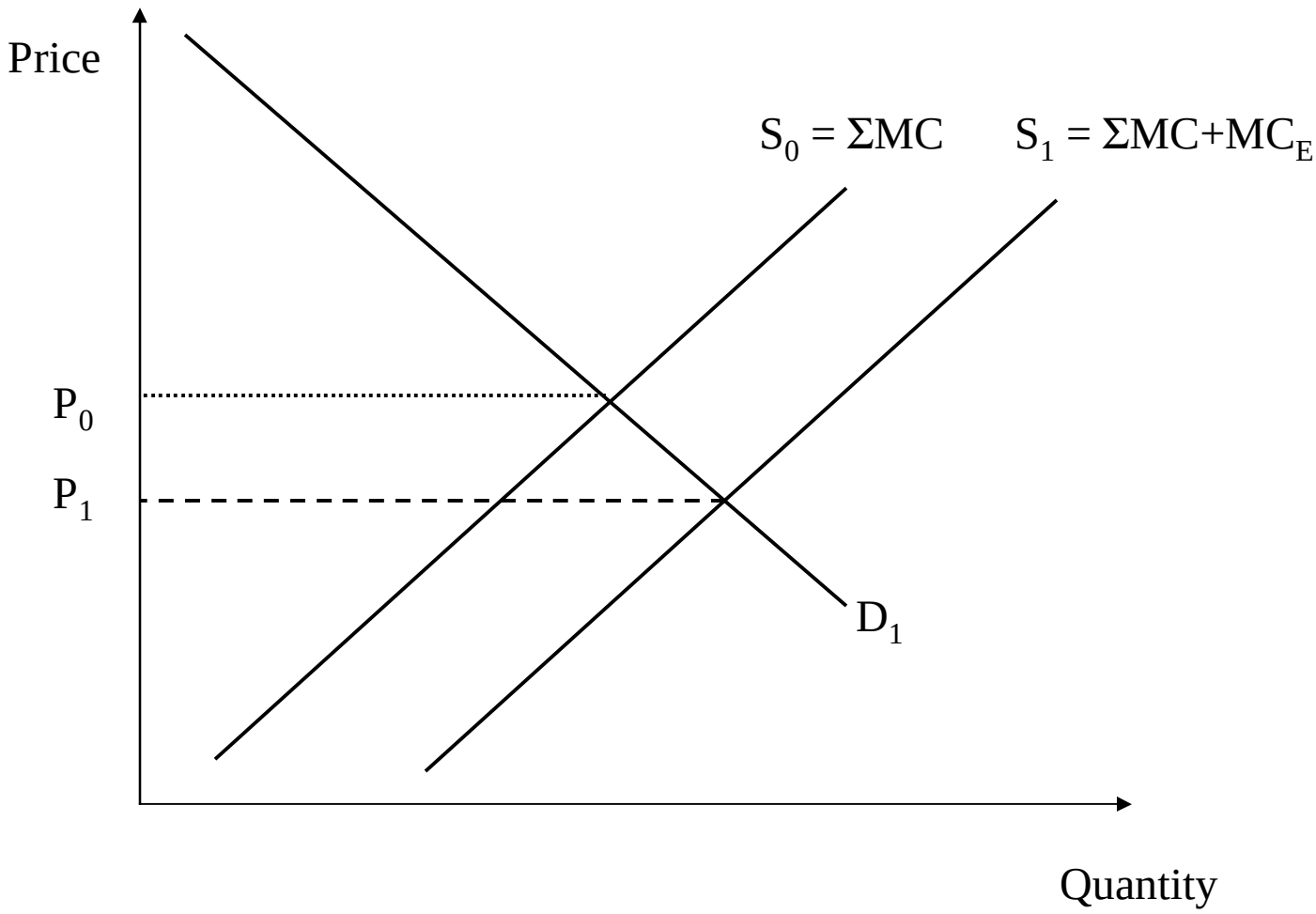

Figure 12: Long Run Profit Maximization for a Perfectly Competitive Firm

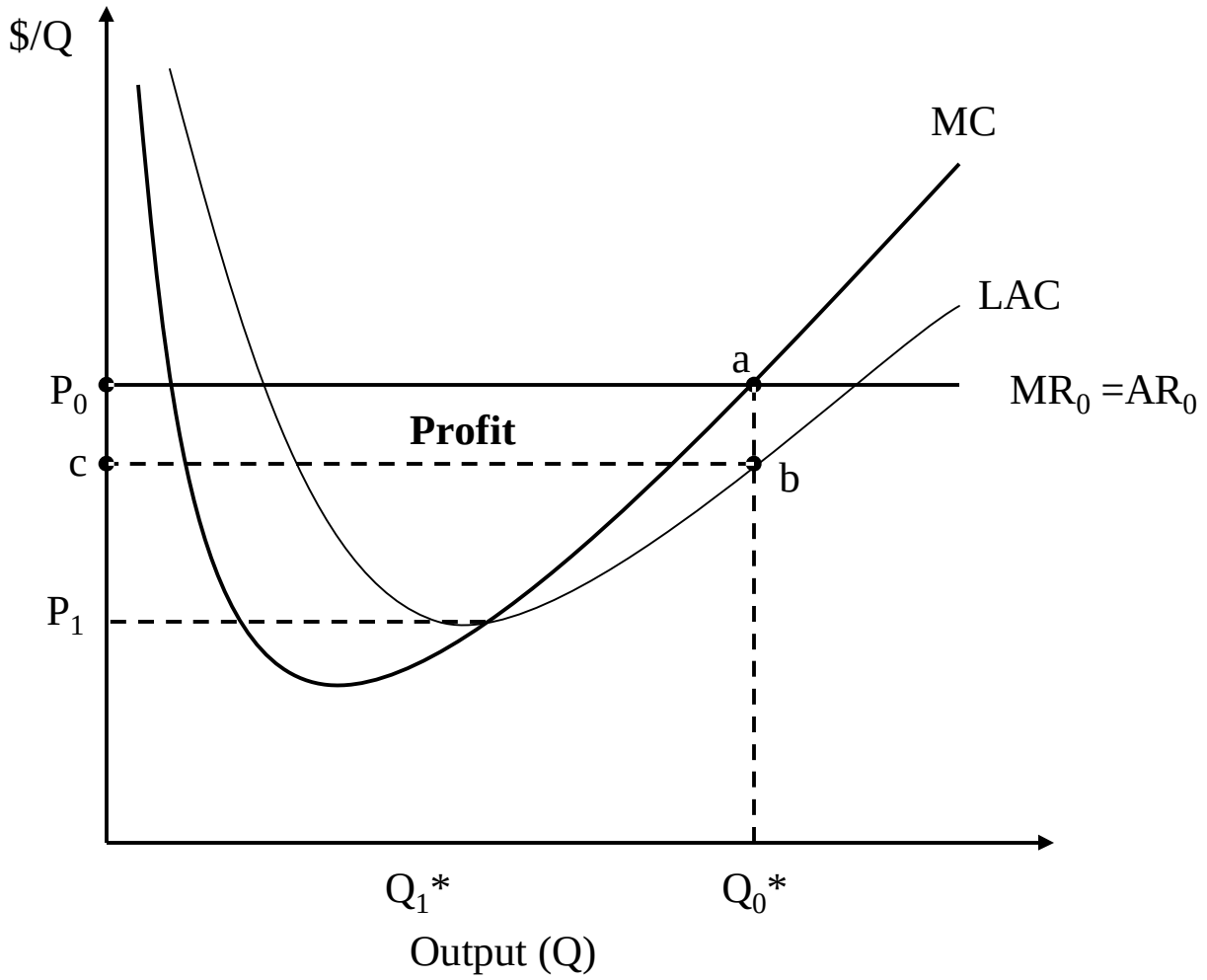

Figure 13: Long Run Supply with Constant Input Prices

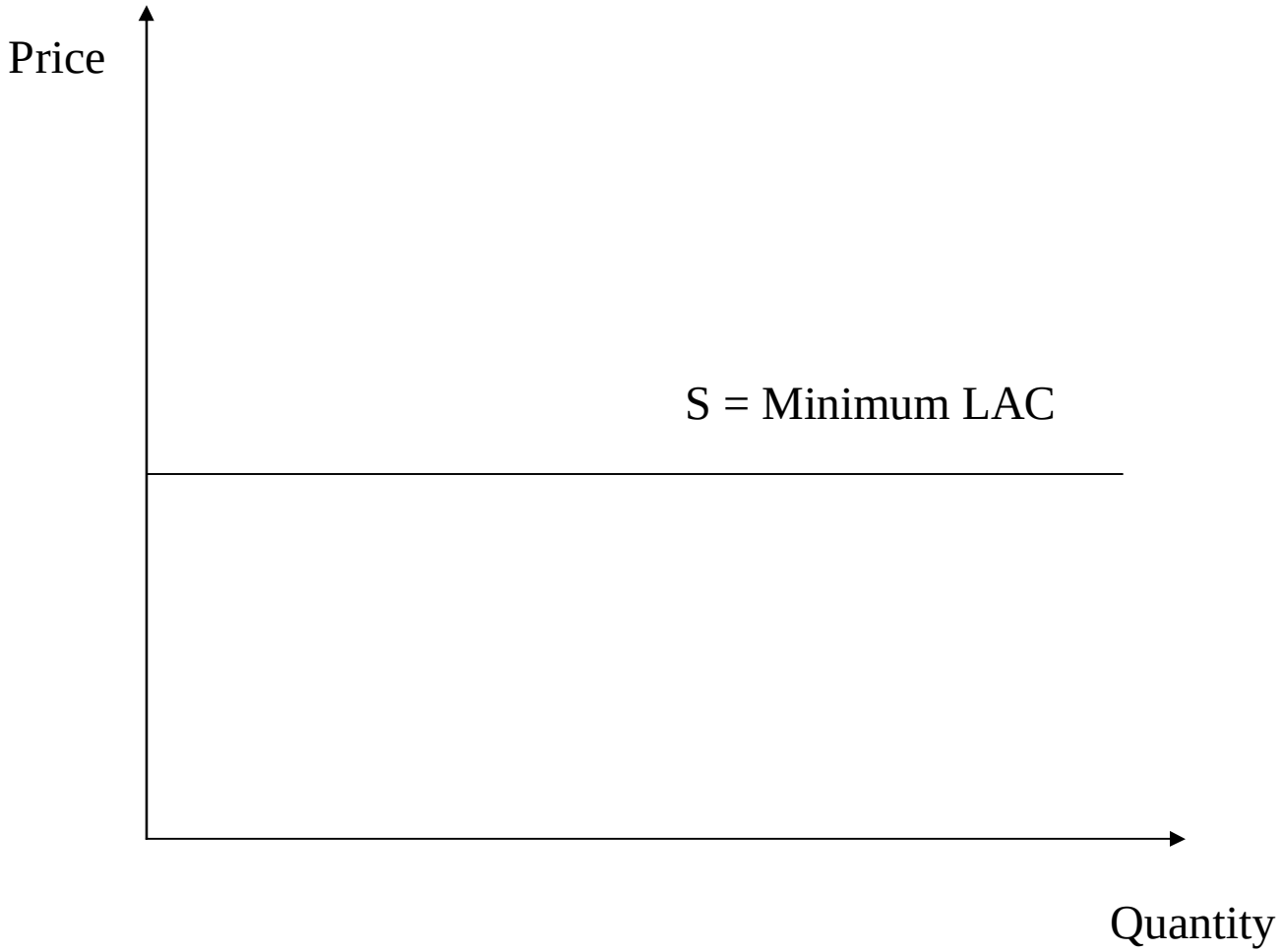

Figure 14: Example of Increasing Long Run Average Cost