Topic 4- Part I

The Supply Functions of a Competitive Firm

1) **The Competitive Firm**
   - Assumptions
   - Price Elasticity of Demand

2) **The Short-Run Supply Function**
   - Short-Run Maximizing Output

3) **The Long-Run Supply Function**
   - Long-Run Maximizing Output

Introduction:

To an economist, a competitive firm is a firm that does not determine its market price. This type of firm is free to sell as many units of its good as it wishes without affecting the market price. Consequently, the challenge in this circumstance is ***not*** deciding what price to charge consumers, but rather what **quantity** to produce at the prevailing market price. We will explore these decisions in the short and long-runs with the assumption that the firm pursues the goal of **profit** maximization.

The Competitive Firm

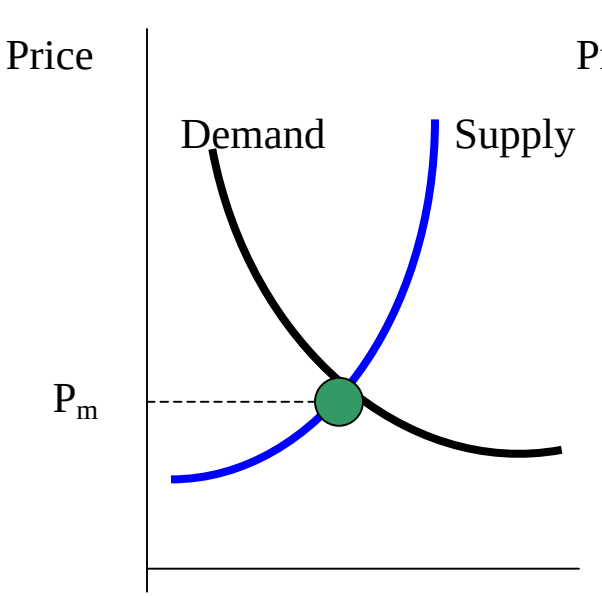
Assumptions:

1) Many firms.

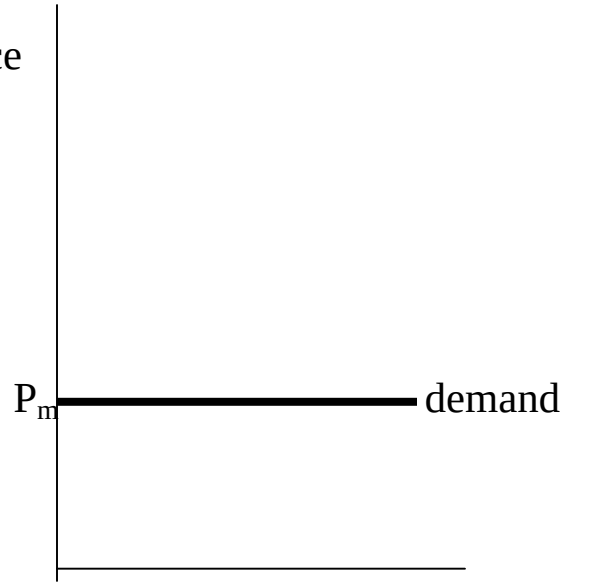
2) Each produces a homogeneous product.

3) Firm is a price taker (market price is independent of the number of units sold by each firm).

4) Firm's demand function is a **horizontal** line at the market price.



Market Demand and Supply



Demand Function for the firm.

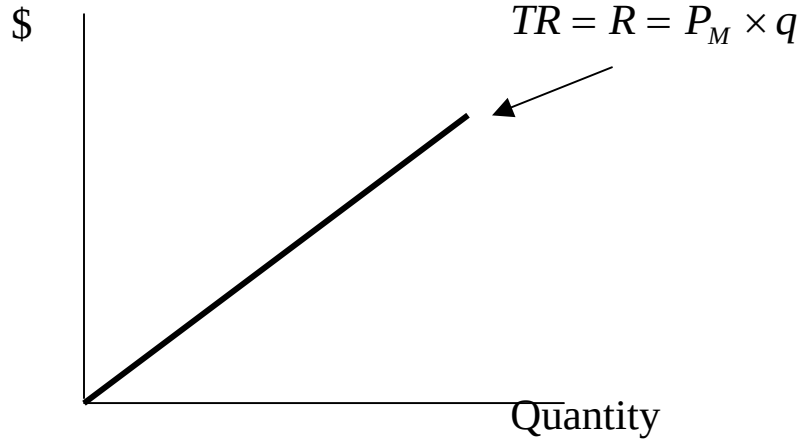
Since market price is determined by the market, a competitive firm's total revenue will increase proportionally with the quantity sold. Total revenue is linear function from the origin.

R=Pq

where R= total revenue

P_m=market price

q=number of units sold



Marginal Revenue:

For a competitive firm, each additional unit of its good sold adds an amount equal to the market price to its total revenue.

Marginal revenue is the change in total revenue due to a change in the quantity sold. For a competitive firm, MR equals the price of the product.

$$\text{MR} = \frac{\Delta R}{\Delta q} = \text{P}$$

Another way to define MR is as the derivative of the total revenue function.

The change in total revenue due to a change in q is:

$$\text{MR} = \frac{\partial R}{\partial q} = \text{P}$$

The slope of the total revenue function is equal to the price of the good.

MR also equals average revenue, since:

$$\text{AR} = \frac{TR}{q} = \text{P}$$

The Price Elasticity of Demand of A Competitive Firm

Recall the demand function of a competitive firm is almost completely flat with a slope approaching zero.

The price elasticity of demand for a competitive firm is infinitely elastic.

Note: Three Factors that determine a firm's price elasticity of demand:

1) **Market share**: the smaller the firm's market share, the more elastic the firm's demand function. And since the quantity supplied by a competitive firm represents a small fraction of total quantity supplied, an increase in the quantity sold has very little effect on price.

2) **Price Elasticity of Market Demand Function:** the more elastic is the market demand function around the current market price, the smaller is the decrease in the price caused by an increase in the quantity produced by a firm. The more elastic is the industry demand function, the more elastic is the firm's demand curve.

3) **Supply Elasticity of Other Firms:** Measures the percentage change in the quantity supplied by other producers for a given percentage change in the market price. The larger the supply elasticity, the larger the percentage decrease in the output of other firms, the smaller the price decline due to the increase in the firm's quantity and therefore the more elastic the firm's demand function.

The Short-Run Supply Function of A Competitive Firm

In the short-run, the supply function of a competitive firm shows the quantity supplied at each price when one factor of production is fixed.

Assumption: The firm attempts to maximize profit by constantly adopting cost saving technologies in order to:

- survive
- avoid a takeover

Short-Run Profit is denoted as:

Profit = Revenues – Costs

$$\Pi(q) = (P \times q) - [V(q) + F]$$

$$\Pi(q) = (P \times q) - V(q) - F$$

When the firm decides to shut down production, [q=0], the firm loses (-F). That is, profit is equal to minus fixed cost.

In the short run, the firm will only engage in production if total revenue is equal or greater than total variable cost.

$$Pq \geq V(q)$$

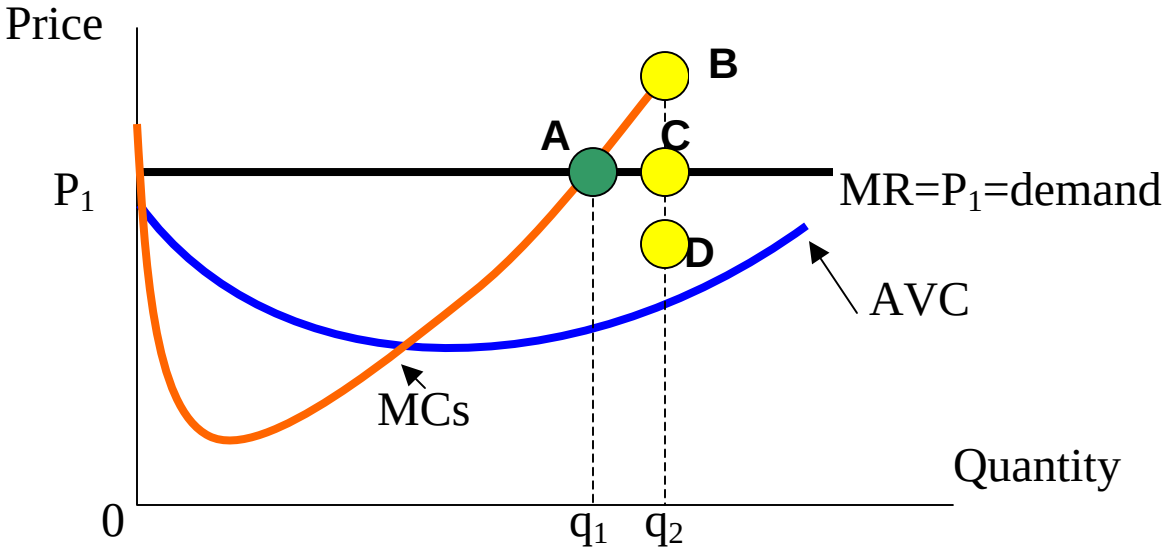
In the short run, the fixed cost is a **sunk cost**, and therefore the quantity produced does not depend on the size of fixed cost.

Deriving The Output That Maximizes Total Short-Run Profits

In the short run, we will assume that capital is fixed. To maximize short run profits, the firm selects a level of output where marginal revenue, MR, equals short-run marginal cost.

$$MR = P = MCs(q)$$

"A competitive firm produces a quantity where price equals short-run marginal cost, and marginal cost is rising."



❒The firm's horizontal demand function is located at the market price P_1.

❒The firm maximizes short-run profits by producing q_1 units where $MR=P_1=MCs$.

❒Total profit will fall if the firm produces a larger or smaller output than q_1.

For example, suppose the firm was producing an amount that was more than q_1, (q_2). At this higher amount, the MR will be less than the MCs. The firm's total profits will decrease.

MR from selling q_2-q_1 = ACq_2q_1
MC from producing q_2-q_1 = ABq_2q_1
Total Revenue falls when producing q_2 units from q_1 units.

The Short-Run Supply Function of A Competitive Firm

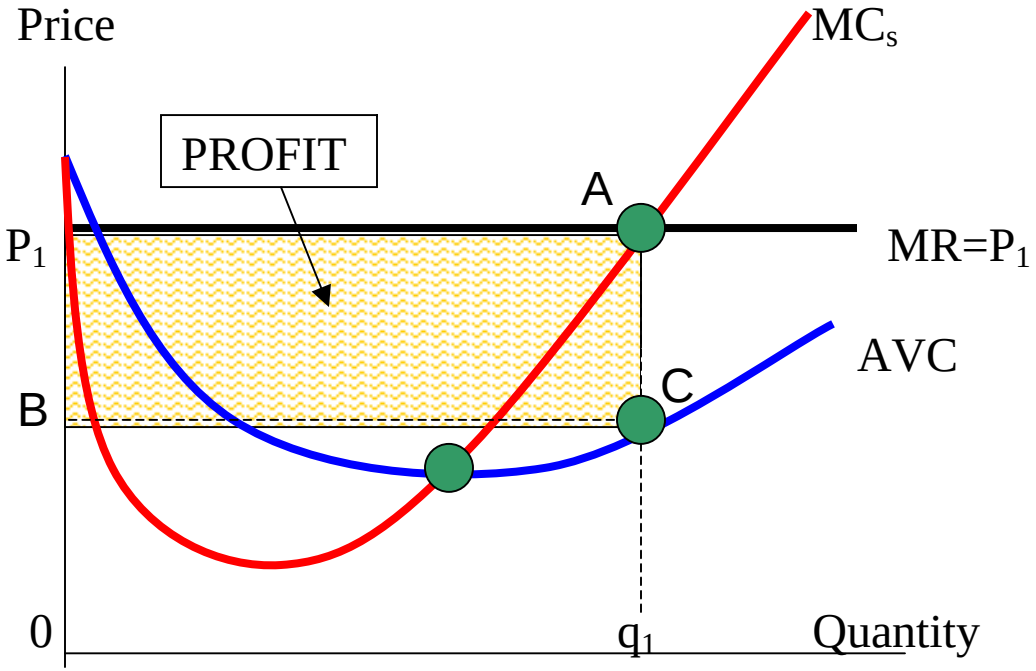
By applying the MR=P=MCs rule, we have derived one point on the firm's short-run supply function. I.e. At price P_1, the firm should supply q_1 units.

The quantity the firm supplies at any price can also be found by using this rule for profit maximization.

Consequently, the firm's short-run marginal cost function is the firm's short-run supply function where total revenue equals or is greater than total variable cost.

The firm's short-run marginal cost function is the firm's short-run supply function as long as total revenue $\geq$ total variable cost.

Note: You need to know the position of the SAC curve in order to determine whether the firm's is making a profit or a loss in the short-run. But the firm can determine its short-run profit maximizing output without knowing whether it is earning a profit or a loss. If a firm sets output where price equals short-run marginal cost, it is operating as well as it can at the given price level.



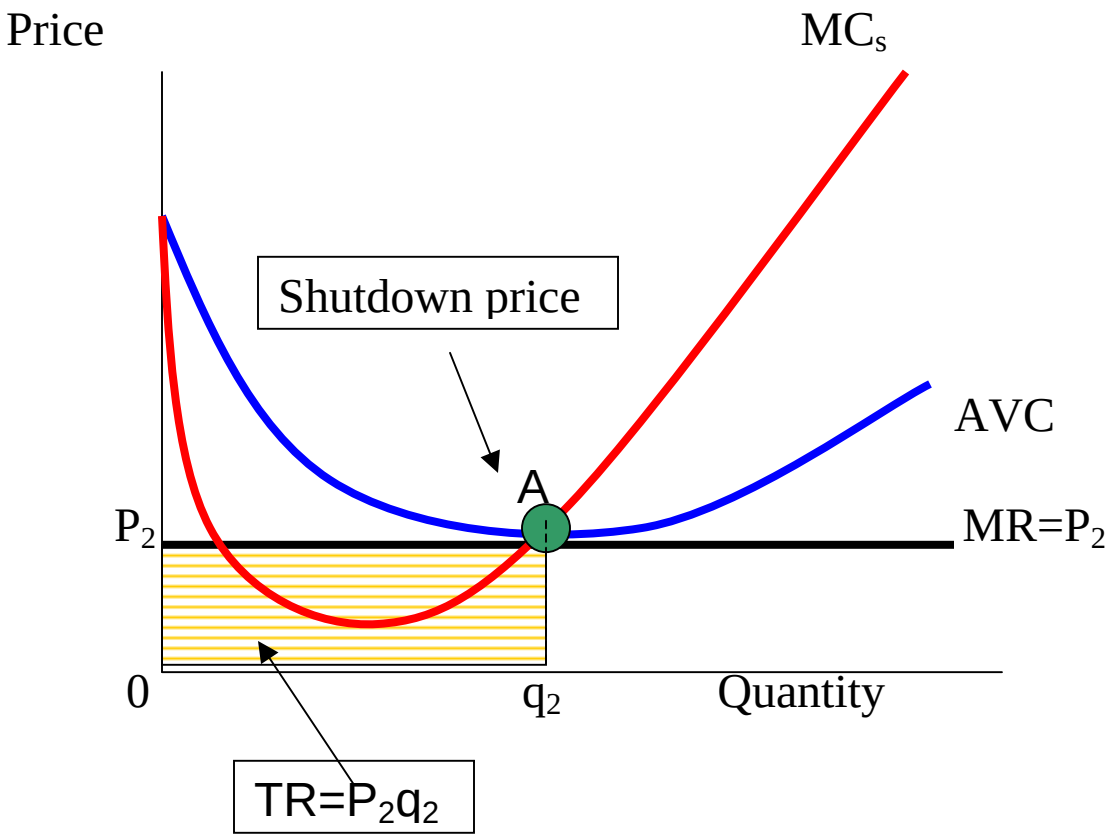
When the price is equal or greater than minimum average variable cost, the firm will maximize its profit by producing where MC=MR.

When the market price is P_1, the firm supplies q_1 units.

Total revenue equals the area $0P_1 Aq_1$.

Total variable cost equals $0BCq_1$.

Since TR>TVC, the firm will make a **profit** in the short run.

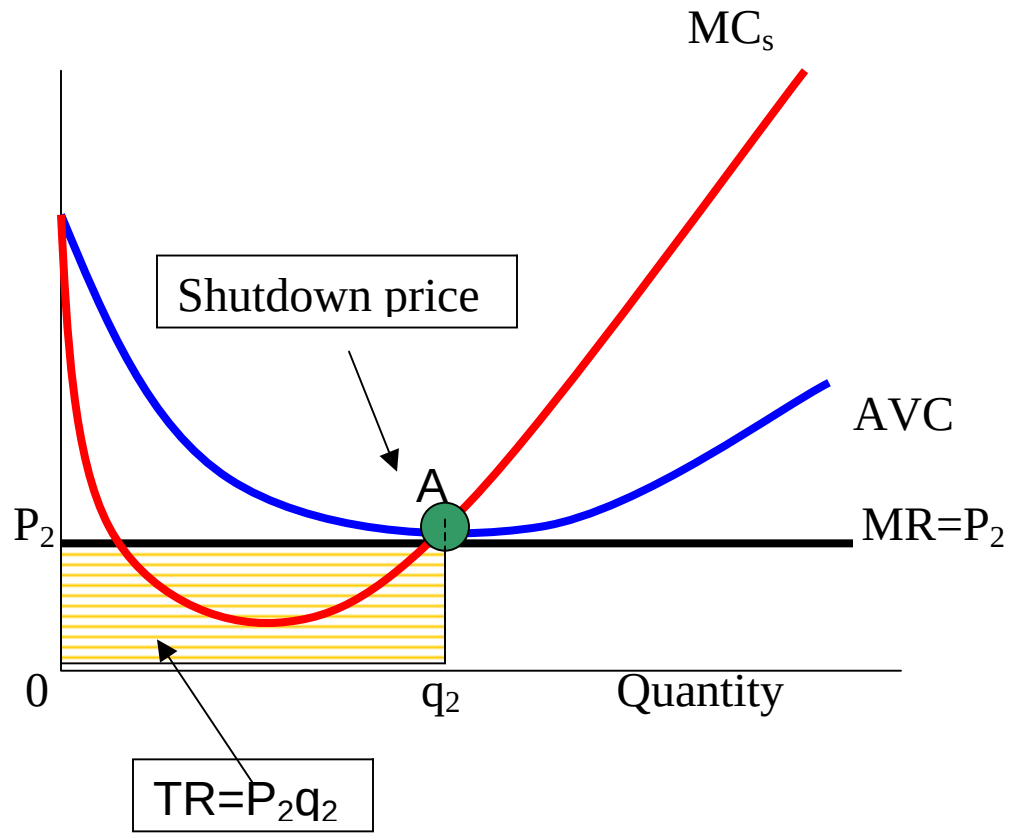


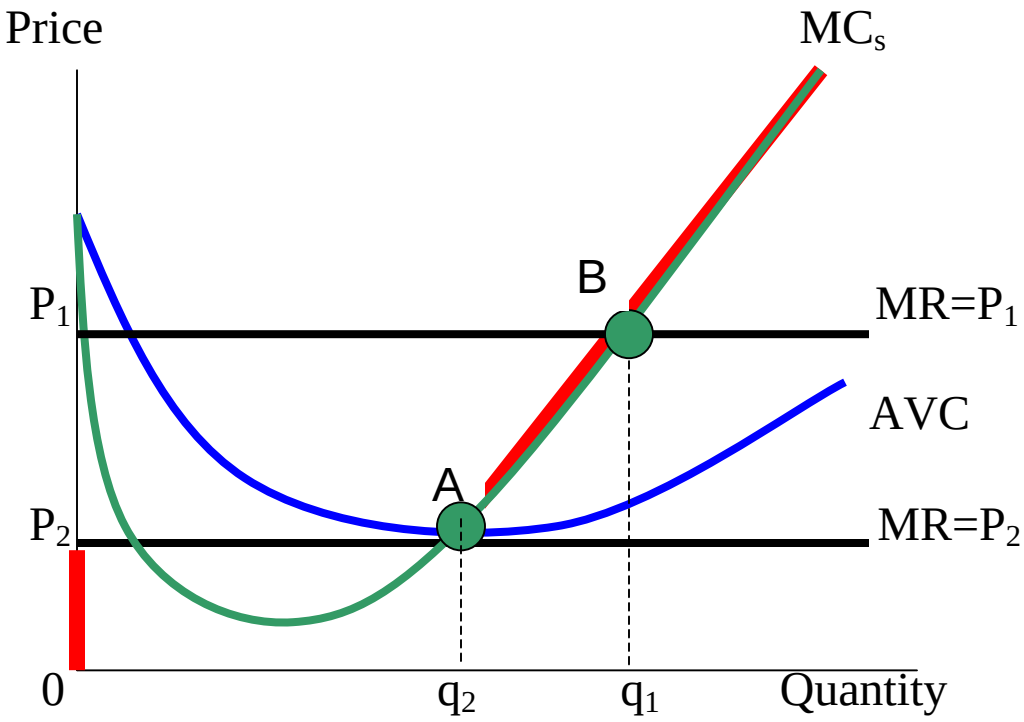
Suppose the market price is P_2. The firm supplies q_2 units.

In this instance, the market price P_2 equals the short-run marginal cost and minimum average variable cost.
Total revenue= total variable cost.

If the market price is less than P_2, total revenue is less than total variable cost. The firm will supply nothing and incur the loss equal to fixed cost, rather than incur a larger loss.

P_2 is referred to as the **shutdown price**.





The firm's short-run <u>supply</u> function consists of two parts:

- The red vertical line from 0 to P_2.
- The red line/ short-run marginal cost curve for price above P_2.

The Long-Run Supply Function of A Competitive Firm

- In the long run all factors of production are variable.

- The competitive firm remains a price taker and is motivated to maximize its profit.

- The firm will select the combination of factor inputs that will produce the quantity that will maximize profit at each market price, and will produce that quantity at the lowest total cost.

Long-Run profit equals total revenue minus long-run total cost:

$$\pi(q) = Pq - C_L(q)$$

where

$\pi(q)$ represents the profits of the firm

$C_L(q)$ represents the long run total cost function of the firm.

A firm will enter an industry when it expects its profits to be zero or positive:

$\pi(q) \geq 0$ [Nonnegative Profit constraint]

Output That Maximizes Long-Run Profits

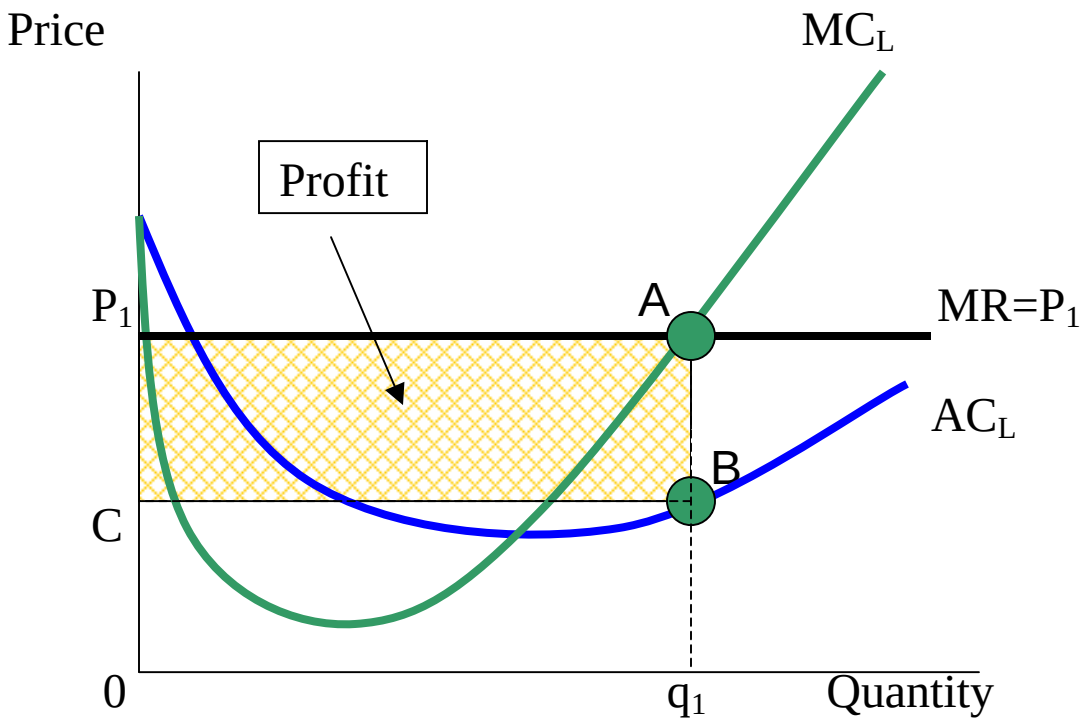
❒A price taking firm will maximize profit by producing the quantity of output where MR equals long-run marginal cost.

Since marginal revenue equals price:

$$MR = P = MC_L(q)$$

[Determination of Quantity in the long run]

If the firm is producing a quantity where price is greater than marginal cost, it should produce more units. This will produce more revenue than it costs to produce, and profits will increase.



Profit = P_1ABC

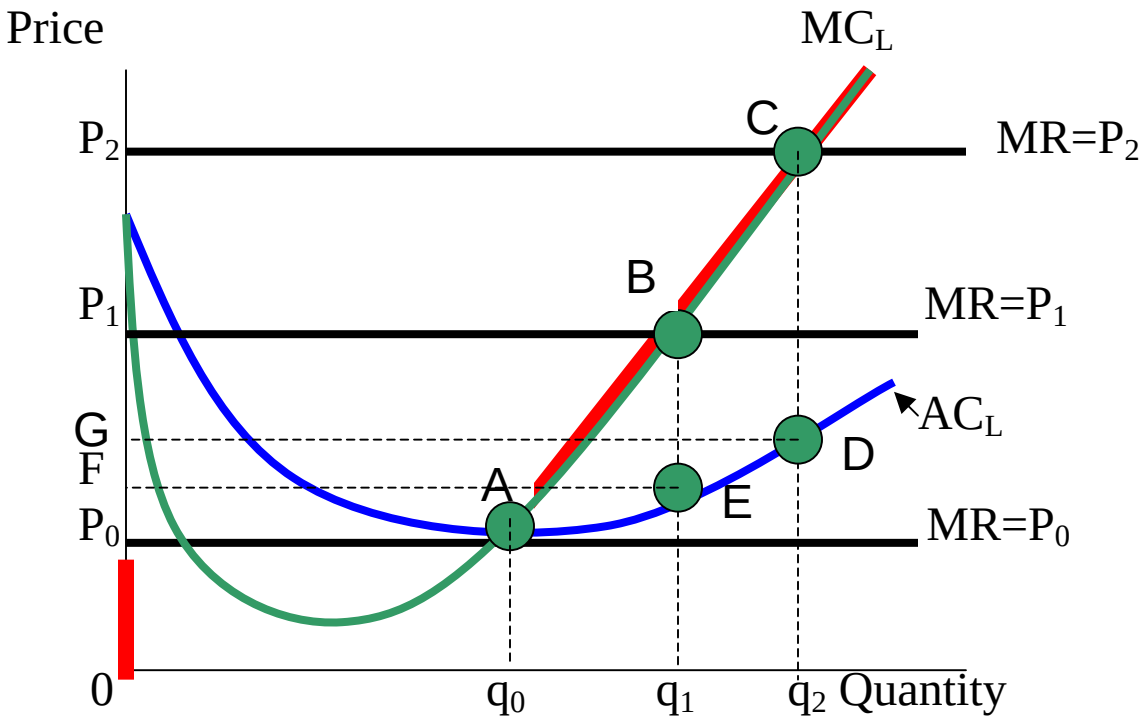
$TR=P_1q$

Market price is P_1; cost =C;

Firm produces q_1 at an AC of C.

The Long-Run Supply Function Of A Competitive Firm

The firm's supply function can be generated by repeatedly finding the point where price equals long run marginal cost.



The firm will supply q_1 units at market price P_1. Profit = P_1BEF

The firm will supply q_2 units at market price P_2.

⇨Profit = P_2CDG

The firm will supply q_0 units at market price P_0. Profit = 0

The firm will ***not*** supply any quantity at a market price lower than P_0.

When the firm produces q_0 units, long-run MC equals long-run average cost, and long-run average cost is at a minimum.

Profits are zero.

⇨Equilibrium in the long-run.

The firm's **long-run supply function** has two parts:

1) The vertical line for prices less than P_0.

2) The firm's long-run MC function for higher prices ($\geq P_0$.)

"The firm's long-run marginal cost function is the firm's long-run supply function for prices above the minimum of the long-run average cost function."

Final Note:

From this analysis, we can infer that a competitive firm exhausts all of its internal economies of scale in the long run. A competitive firm would not produce an output over the range where average cost is declining in the long run. Hence, we cannot assume that declining prices in a competitive industry is due to firms achieving greater economies of scale. Otherwise, we would have to conclude that the firms are not pursuing a goal of profit maximization. If a competitive firm is maximizing profits, it will produce q_0 or more units and exhaust all internal economies of scale. Hence, economies of scale ***cannot*** explain why prices decline in a competitive industry.

Topic 4 Part II

Price Determination In A Competitive Industry

1) **Requirements for Equilibria**
   - Long Run Industry Equilibrium
   - Short Run Industry Equilibrium

2) **Price Determination in A Constant Cost Industry**
   - Assumptions
   - Long Run Industry Supply Function
   - Long Run Industry Equilibrium

3) **Moving from One Long Run Equilibrium to Another**
   - Short Run Industry Supply and Price
   - High Prices
   - The Role of Profits

4) **Price Determination in An Increasing Cost Industry**
   - Rising Factor Prices
   - Economic Rent
   - Producer Surplus

5) **Raising the Costs for New Entrants**
   - Licensing and Long Run Supply Function

6) **The Effect of Taxes, Trade Limitations, and market Restriction on Total Surplus**
   - Imposing A Per Unit Tax
   - Long Run Effects
   - Gains From Trade
   - Consumer and Producer Surplus and Per Unit Tax

Introduction:

The objective of this section is to explore how price is determined in a competitive industry. We will assume that there is free entry and departure in the industry. By "relaxing" some of the supply side assumptions, we will be able to analyze a model that more clearly resembles reality. In particular, we will examine (i) how a competitive industry operates when there are varying costs to each firm, (ii) how and when is the "right" time to incorporate a cost-savings technology, (iii) how barriers to entry stop new firms from entering the industry, and (iv) how a competitive industry responds when trade restrictions and taxes are imposed. As we examine this section, pay attention to the role that price plays in signaling the demands of consumers to producers and how producers respond to price signals.

Requirements For Long and Short Run Industry Equilibria

Our analysis will now extend from the study of a **single** firm to **industry** equilibrium.

Firms will be examined within the context of being either inside or outside of the industry.

When we refer to an industry being in a **state of equilibrium**, we are referring to an industry where the market price and quantity produced is stable given the market demand and supply functions. No firm outside the industry desires to enter the industry and no firm within the industry leaves.

Long-Run Industry Equilibrium

Conditions:

All factors of production are variable.

Firms can enter or exit from the industry

Hence, a competitive industry is in long run equilibrium if:

Each firm has no incentive to change its method of production or the amount of output.

Profits are zero, so the firm has no incentive to enter or exit the industry.

Short-Run Industry Equilibrium

Conditions:

No firm within the industry can change the "fixed" factor of production.

No new firms can enter the industry.

Hence, a competitive industry is in short-run equilibrium if the firms in the industry have no incentive to change the quantity they produce.

The models we will examine relate to industries where:

1) The firms are price takers
2) Entry into the industry is free

Price Determination In A Constant Cost Industry

Objective: To develop a model that illustrates how price is determined in a long-run industry equilibrium after a change in demand.

Assumptions: The industry supply function will be horizontal in the long-run because:

All firms have identical long-run total cost functions, long-run average cost functions and long-run marginal cost functions.

Each firm is exactly the same. They face the same cost functions.

Each firm's long-run average cost function does not shift as industry output changes.

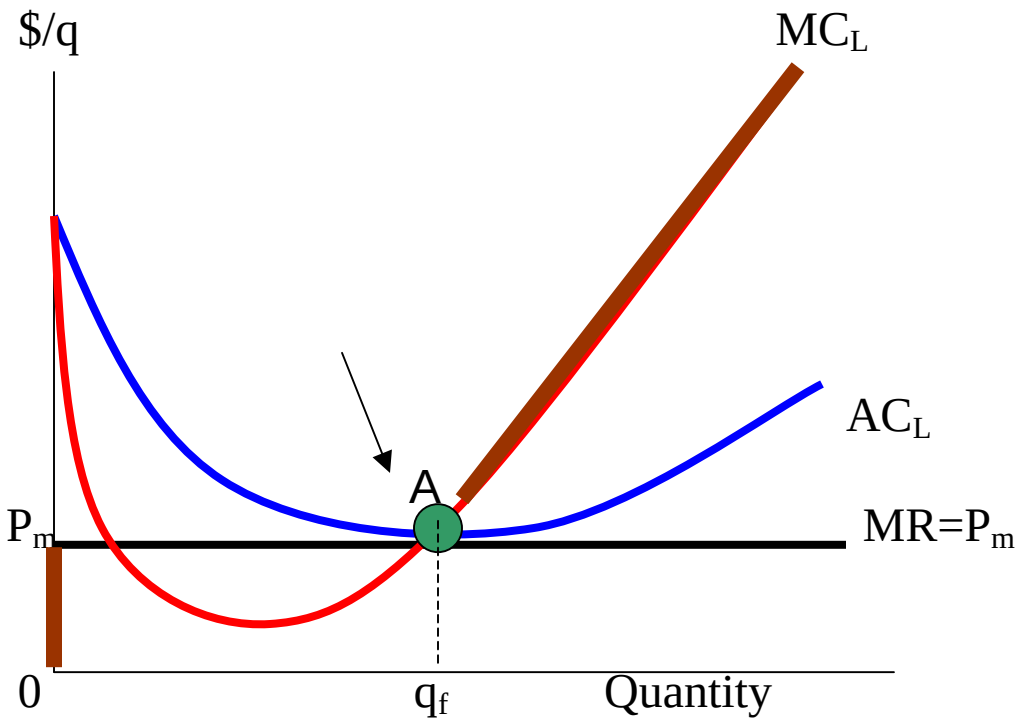
⇨Implying that a change in industry output does not change the price of factors of production or change the production function.

⇨Each firm is assumed to be small relative to the size of the industry and does not employ unique or unusual' factors of production.

In the long run, new firms can enter and each firm will be willing to supply the same number of units at the market price.

An indefinite quantity will be supplied at this price because identical firms are each willing and able to supply the same number of units at the market price.

Hence from these two assumptions, a **constant cost** industry has a long-run industry supply function that is ***horizontal*** at the market price.



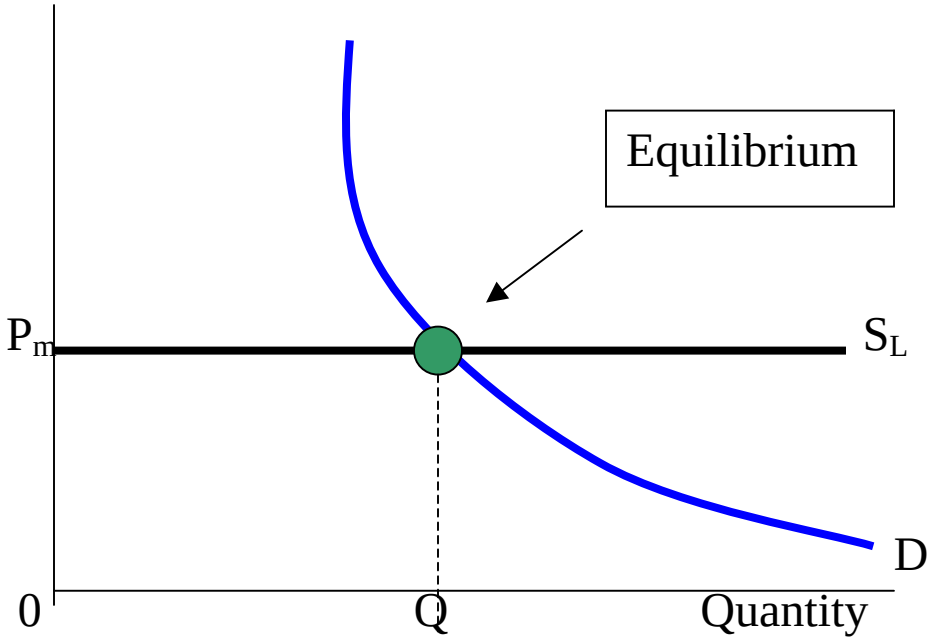
The LAC and MC Functions of the Firm

The red lines show the long-run supply function of a competitive firm.

At point A, the firm is operating at minimum long run average cost.

Produce where $MC_L=MR=P_m$

Profit is zero.



Long Run Industry Equilibrium

The market price is P_m and the quantity produced is Q. At this price, no existing firm will change the amount produced and no new firms want to enter the industry.

The long run industry supply function is S_L.

The market demand function is D.

The long run equilibrium price is P_M.

Equilibrium quantity is Q units.

Since P_M is the market price, each competitive firm maximizes profits by producing q units, the level of output where $P_M=MR=MC_L=AC_L$.

When the price is P_M, no firm earns a profit in the long run. The number of firms in the industry will equal N=Q/q.

For example, if the industry produces 10,000 litres of paint per hour and each firm produces 1000 litres per hour, then there will be 10,000/1000=10 firms in the industry when it is in the long run equilibrium state.

A Change in Long-Run Equilibrium

What would motivate a firm to be in an industry where profits are zero?

To create a more realistic model, let's assume that demand changes and map out the process of moving from one state of long run equilibrium to another.

Situation: ***Demand for the product increases***

1) How do <u>existing</u> firms in the industry respond to a shift in demand?

Assume before market demand increases there are: N_0 firms.

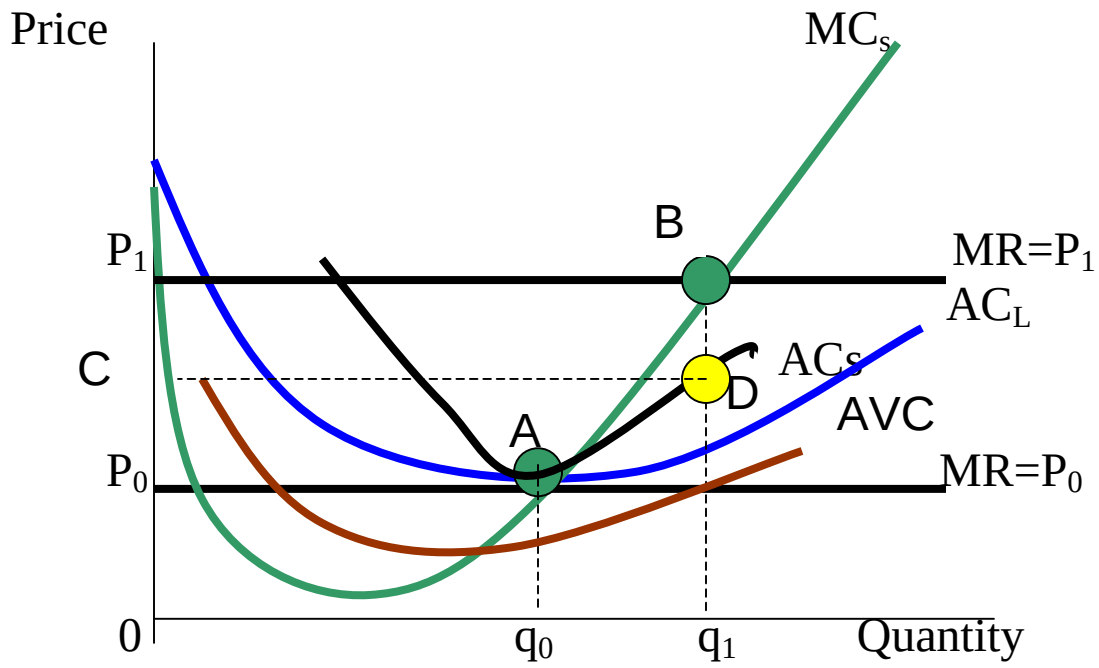
Each firm operates a plant with SAC and MC as shown in the previous diagram.

Each plant produces q_0 units at the minimum long run average cost of AC_L.

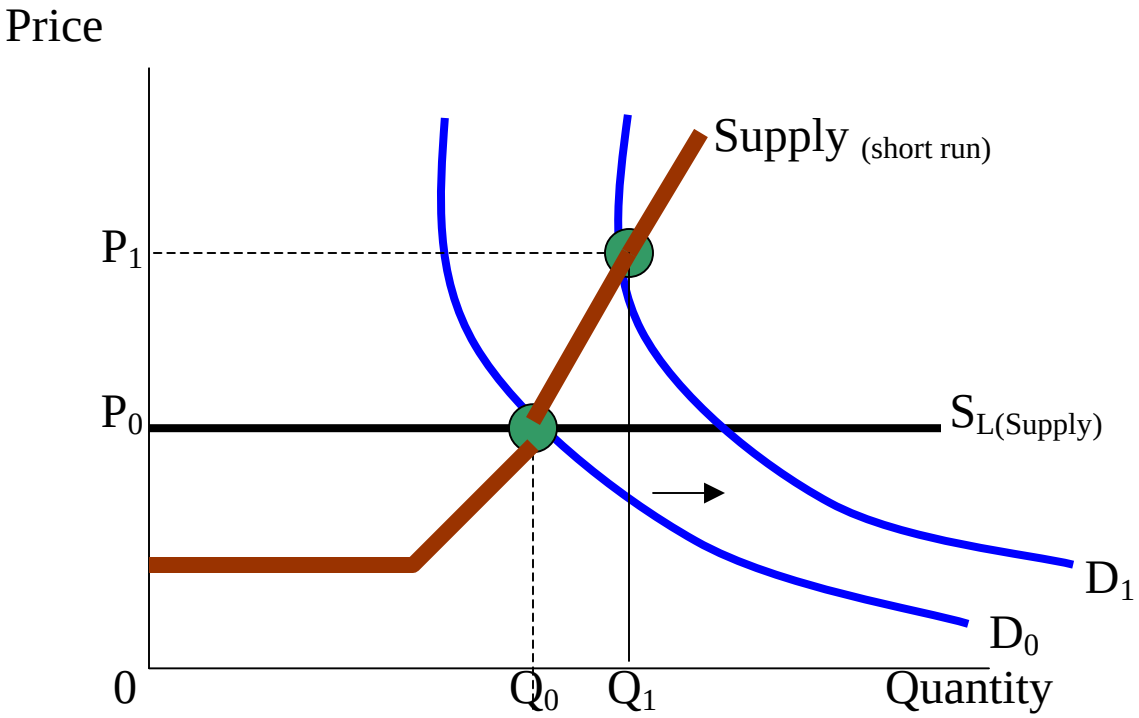
Each firm maximizes short-run profits by producing q_0 units when price is P_0, and q_1 units when price is P_1.

The firm's short run MC curve is the firm's short run supply function for prices above minimum average variable cost.

Short Run Supply Curve of the Firm:



Industry Supply Curve:



The short-run industry supply function is the horizontal sum of the short-run supply functions of the N_0 firms. (Red line.)

The short-run industry supply function shows the quantity that existing firms in the industry supply at each price.

The total quantity supplied in the short run when price is P_0 is equal to $Q_0=q_0N_0$.

The long run industry supply function intersects the short run industry supply function at $Q=Q_0$.

Note: The short run industry supply function has a horizontal segment. This is because firms will not supply any output below the minimum average variable cost and will leave the industry leaving the remaining firms to produce at minimum average variable cost.

Note: The short run supply function is less elastic (steeper) than the long-run supply function. This implies that any change in demand will cause the price to change more in the short run than the long run.

Analysis:

The above figure shows the original demand function D_0. When demand increases, the new market demand function is D_1. The new short run equilibrium is point B and prices rise to P_1. Point B is the new short run equilibrium because the market clears with just the existing firms.

***Question:* How does this increase in demand affect each competitive firm?**

At the higher price P_1, each firm maximizes its profits by producing q_1 units.

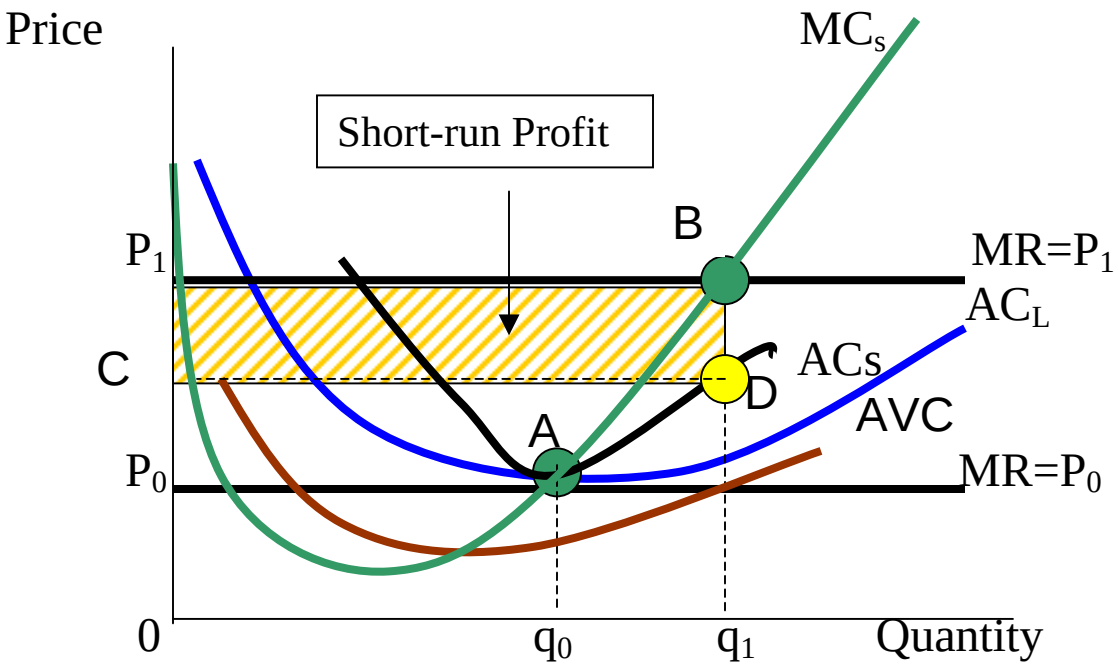
The firm's short run average cost increases from $0P_0$ to 0C when the firm increases output from q_0 to q_1.

Each firm earns a profit of CP_1BD.

An unexpected increase in market demand increases price, firm output, and industry output. Each firm earns a profit in the short run. Each firm's revenue now exceeds the minimum payment necessary to retain factors of production in this industry.

Situation: ***Demand for the product increases***: each firm makes a profit.

Short Run Supply Curve of the Firm



2) ***How does the industry respond to a shift in demand when firms can freely enter the market?***

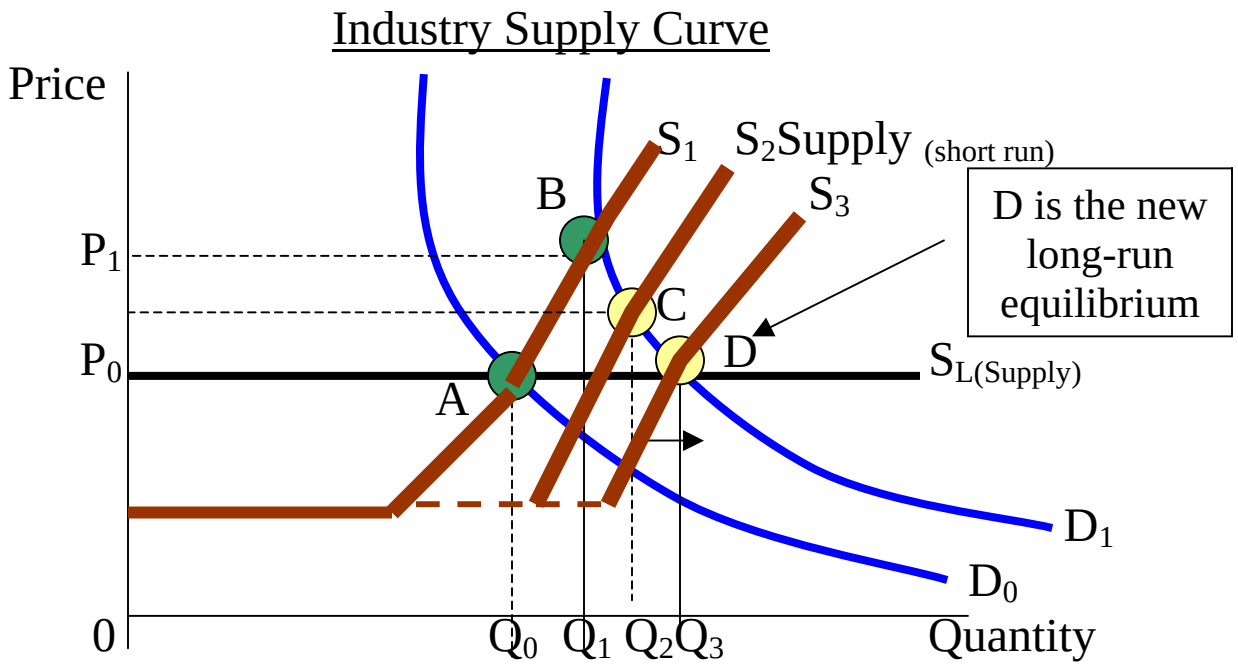
Assume before market demand increases there are: N_0 firms.

The increase in market demand, which caused an increase in market price, has made the industry profitable and attractive.

New firms enter the market in order to sell at this attractive price.

The amount of time a firm continues to make a profit depends on how long it takes new firms to enter the industry.

Once new firms enter the industry, price declines. This is because short-run industry supply shifts to the right as more and more firms enter the market. The rightward shift in the short-run function causes price to fall to P_2 and then to P_0.



<u>Question:</u> ***How does this increase in the number of firms in the industry affect the total amount produced***?

As more firms enter the market, market price falls to P_2 and the quantity produced by each firm falls to q_2.

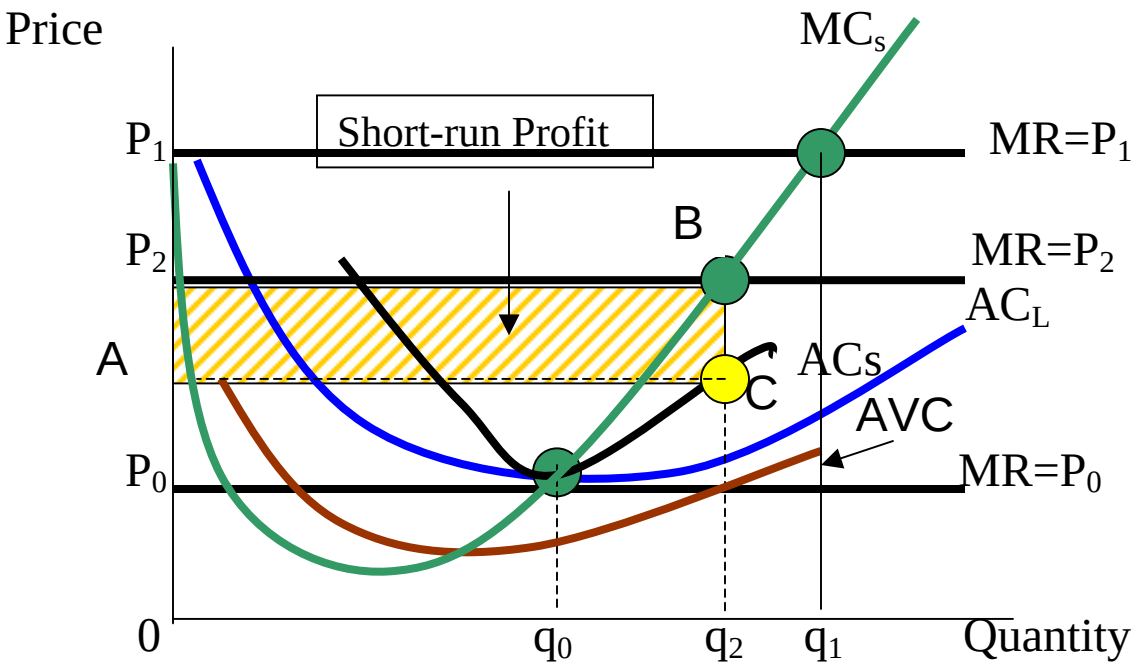
So, although the total industry quantity supplied increases because of the additional output supplied by the new firms, the amount of output produced by existing firms falls.

The entry of firms causes short run supply to shift to the right and pressures the market price and firm profits down to the original level.

Eventually, there are more firms in the industry, each one producing the initial level of output.

An increase in market demand causes equilibrium industry output to increase but does not change the long-run equilibrium price in a constant cost industry.

Short Run Supply Curve of the Firm



Note: An increase in demand is responsible for the profit earned by existing firms in the industry. The profit earned from higher prices, is ultimately responsible for lowering prices back to the original level, and increasing the supply of the product now in greater demand.

Profit motivates firms to enter the industry and causes price to fall back to the original long run level where price = marginal cost = LAC.

Within the context of the constant cost model, the size of the firm remains the same as demand increases. Therefore, growth in market demand cannot explain the growth in plant size. Since firms do get larger over time, we need to develop a model that explains firm growth.

Price Determination In An Increasing-Cost Industry

Consider an industry that produces a good that contains a specialized factor.

Assumptions:

1) **Firms do not have the same long-run average cost function.**

There is a factor of production that is not in perfectly elastic supply. To increase output the product price must be increased in order to pay for the increasing cost of the factor.

2) **The position of the firms LAC function will shift as industry output changes.**

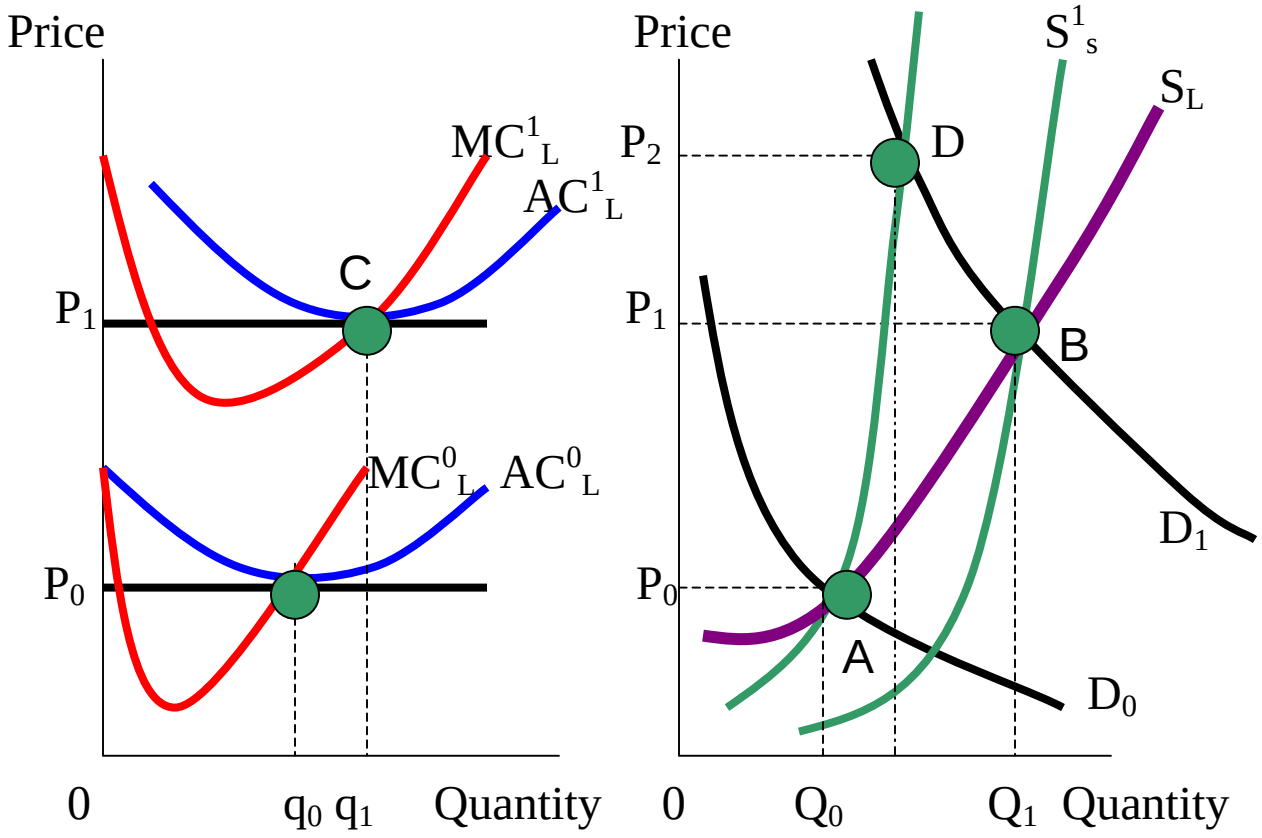
The quantity supplied will increase in the long run only if the industry receives a higher price. The long run industry supply function has a positive slope.

Situation: Rising Factor Price When Industry Output Expands:

Definition: **External pecuniary diseconomy of scale:** an increase in industry output causes a factor price to increase.

In an increasing cost industry the price of a factor of production increases as industry output increases. The industry's long run supply function slopes upward. This is referred to as an external **pecuniary diseconomy of scale.**

S^0_s



AC_L and MC of the Firm **Industry**

The first diagram illustrates two pairs of long-run AC and MC functions of a competitive firm.

When the industry output is Q_0, the firm's long-run AC function is AC^0_L.

When the industry output increases to Q_1, the firm's long-run AC function is AC^1_L.

Analysis: Demand increases

Initially, the industry produces Q_0 when market price is P_0. Each firm in the industry produces q_0 units.

After demand increases, the firm's LAC function shifts upward.

This is because an increase in industry output increases the price of a factor of production and causes every firm's LAC and MC functions to shift upward.

For each firm, the quantity where LAC reaches a minimum is at q_1 due to the increasing factor cost.

(Note: This new quantity of output could have stayed the same or decreased. In this example it increases.)

When the price of a factor increases as the industry expands output, there are **external pecuniary diseconomies** of scale

In the second diagram we can illustrate what happens in the industry as demand increases:

Initially, market demand is D_0, market price is P_0 and quantity supplied is Q_0. Each firm produces q_0 units and there are N_0 firms in the industry.

After market demand increases to D_1, the price increase to the new short run equilibrium price P_2 and the existing firms earn a profit.

This motivates new firms to enter the industry, and the short-run supply function shifts to the right and becomes S_s^1.

The price falls from P_2 to P_1.

The new short run supply function intersects the long run supply function at point B at the market equilibrium price P_1.

Industry output increases to Q_1.

Firms increase their output to q_1.

When there are external pecuniary diseconomies, an increase in market demand increases the long run equilibrium price and industry output.

Firms in the industry earn ***zero*** profits.

Note: External pecuniary diseconomies are more likely in an industry that requires the use of a **specialized** factor of production.

Example:

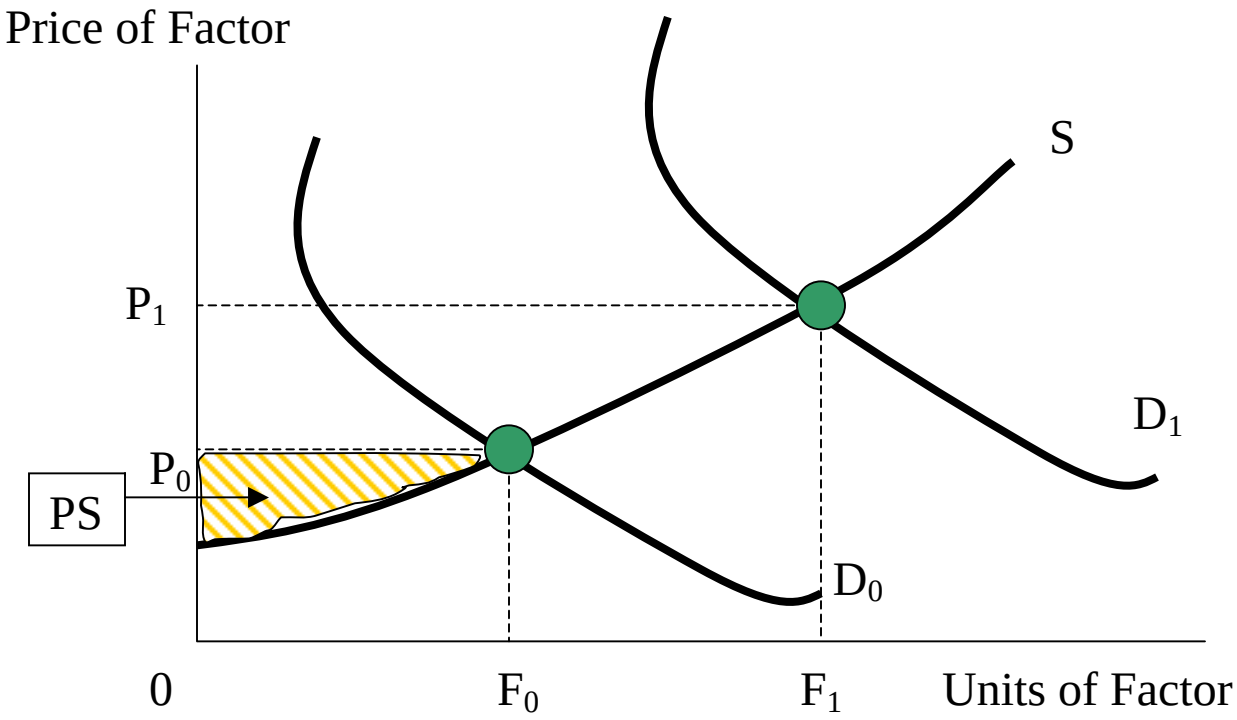
Land
Skilled labour

Economic Rent or Producer Surplus

When the supply curve of a factor of production has a positive slope, the factor earns an economic rent and the price is above the minimum price required for it to be supplied.

The difference between the price and the minimum price required before that unit will be supplied is **economic rent** or **producer surplus**.

An economic rent or producer surplus exists when the price received for a factor **exceeds** the minimum price required to employ the factor.



Price of Factor Increases When the Demand for Specialized Factor Increases

Cost Reducing Innovation

Technological change creates new techniques of production that reduce the cost of production and shift the supply functions to the right.

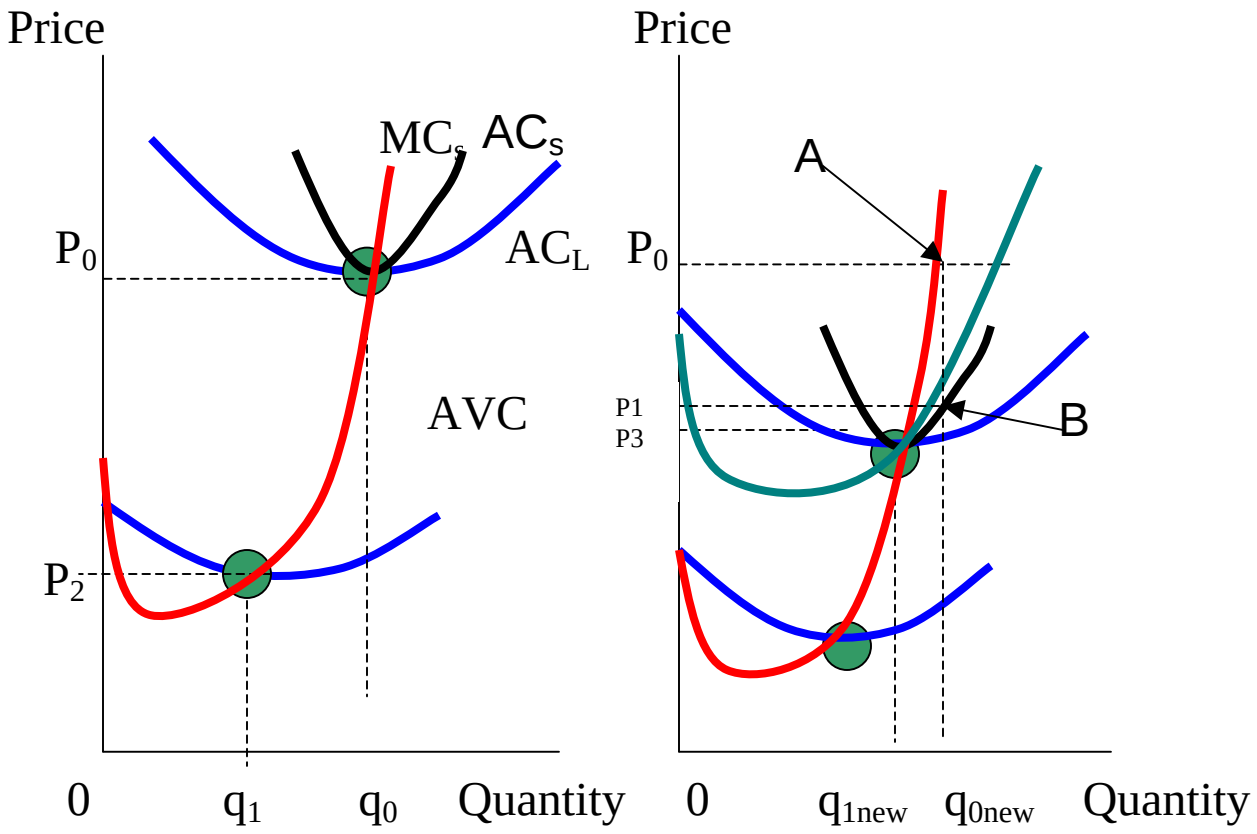
What happens in a competitive industry when there is a technological change that lowers the firm's long run average cost function?

To answer this question we will assume that it is new firms outside the industry that adopt the cost reducing innovation first and begin supplying the product to the market. So, there are two sources of supply: old technology companies and new technology companies.

The old firms in the industry are forced to decide either to adopt the new technology or wait and continue to produce using their old equipment until it wears out.

Decision:

The firm should keep the old plant when its average variable cost is less than the long run average cost of the new plant.



Firm: Old Technology

Firm: New Technology

When market price is P_0, profit for new technology firms is P_1P_0AB.

If price is P_2, the old plant remains open.

Industry

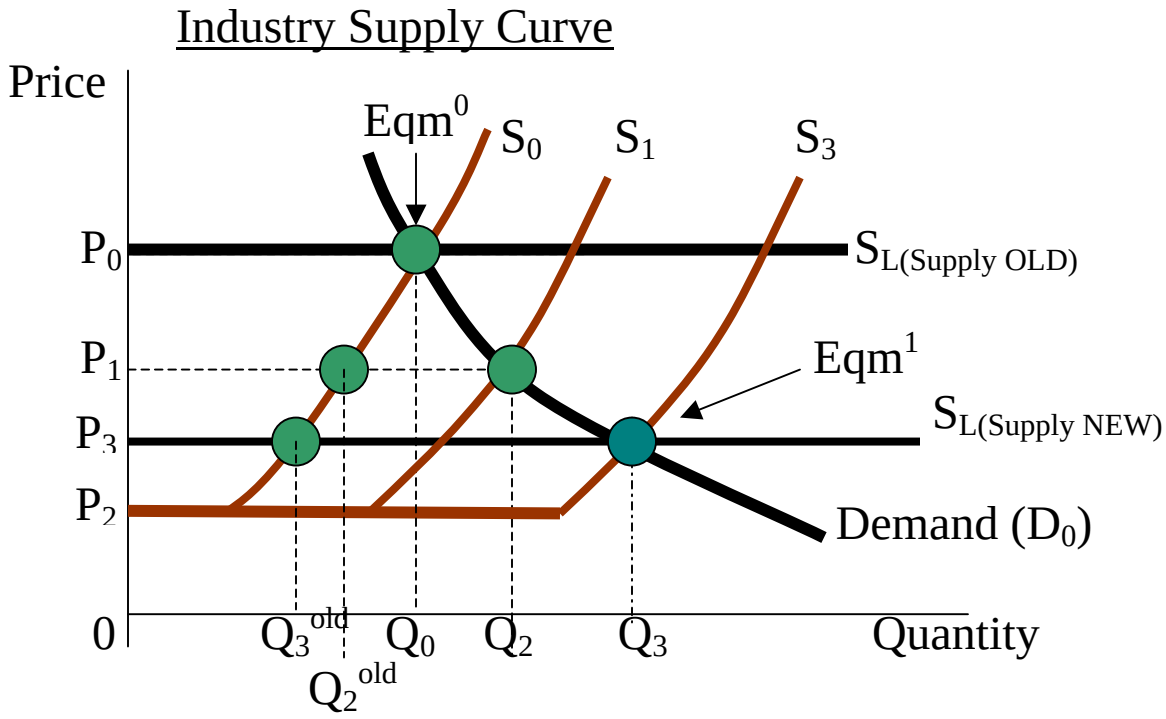
Before the new technology is introduced, there are 'N' firms in the industry.

At market price P_0, each firm produces q_0 units.

The industry demand curve is D_0.

At this market price, the industry produces Q_0 units.

Once the new technology is introduced, new firms enter the industry. With the new technology, they operate at lower long-run average costs.



At price P_0, new firms experience a profit.

By employing the new technology the long run average cost curves are lower than the old firms and the new firms expect to make a profit.

As more and more firms enter the industry, the short run supply curve shifts to the right as industry output increases.

Market price is forced down to P_1.

Old firms accumulate losses, but do not adopt the new technology until the firm's AVC lies above the long run average cost function of the new plant.

Quantity produced by the old firms decreases, and quantity produced by new firms increases. They offset each other to some degree.

Note:

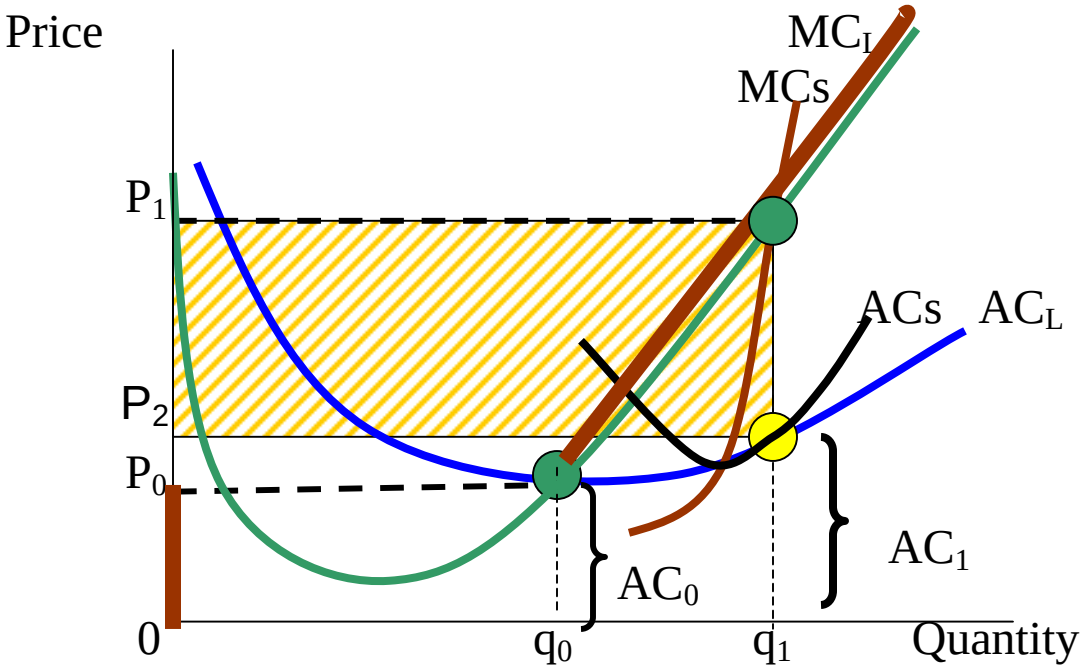
A cost reducing innovation can either increase or decrease the quantity where long-run average cost reaches a minimum. The amount that new firms actually produce could be quite different to the old firms. If the amount is substantially larger, an innovation would increase firm size after the industry reaches the new long-run equilibrium. One way of explaining why firms grow as equilibrium industry output increases is that technological change favours larger firms by increasing the quantity at which long run average cost reaches a minimum.

Equilibrium is at price P_3. Long run average cost is minimized for new firms with new technology.

Raising the Costs For New Entrants: Barrier to Entry: Licensing

In order for firms to maintain their short-run profits in the industry, they may lobby to limit the number of new firms into the industry. One way to slow down the increase in supply by new firms is to require a firm to have an operating license.

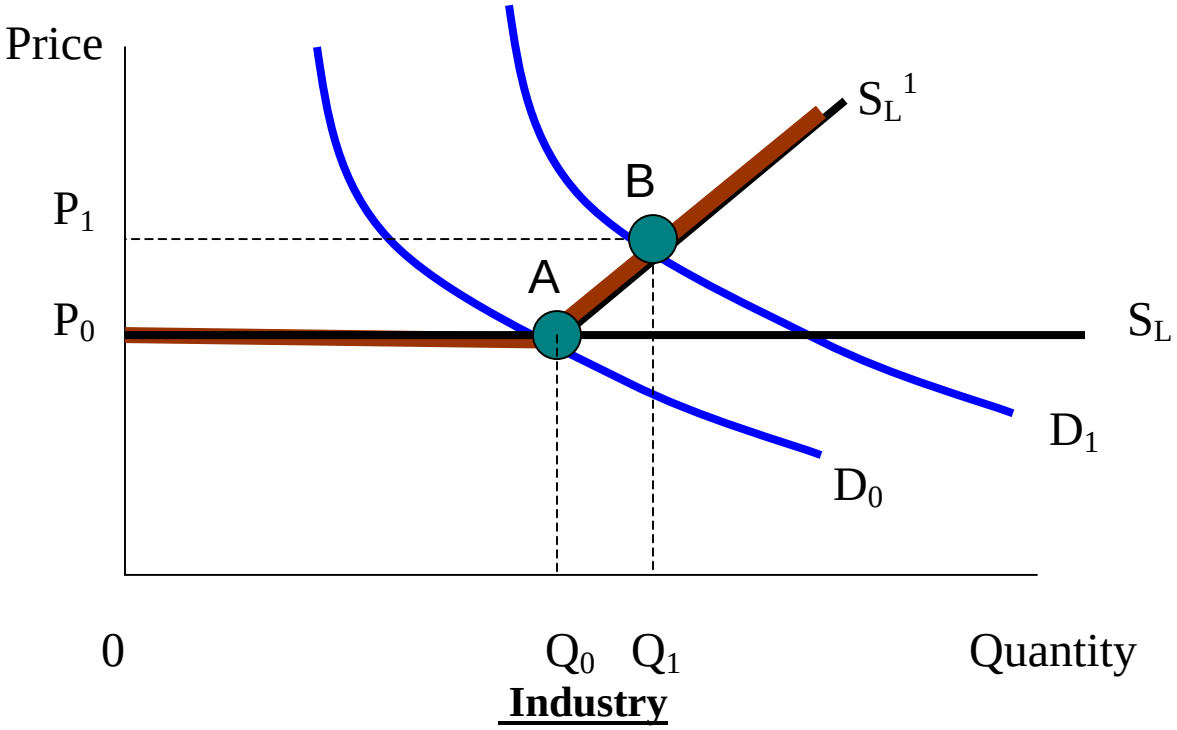
The Impact of a Licensing Using the Constant Cost Model:



The price taking firm produces q_0 units when the equilibrium price is P_0.

Now assume that regulation is introduced that requires that each existing firm in the industry must have a license in order to supply the product. Licensing blocks further entry into the industry.

Now, what happens to the industry?



The market demand function initially is D_0 and the long run industry supply function is S_L.

Once the licence is issued, long run industry supply changes.

In the long run, each firm will produce where long run MC equals price. If the price is P_1, the firm will supply q_1 units in the long run at a long run average cost of AC_L. ($0P_2$) (former diagram.)

For the industry, the new long run industry supply function has the same horizontal segment as before from P_0 to point A. Industry output can only expand if each licensed firm produces more units by supplying more output along its long run marginal cost function. Hence, the industry supply function includes the segment from point A to S_{L1}.

Licensing the existing N_0 firms does not change the equilibrium price P_0. Each firm is still a price taker and cannot raise its prices even if firms are prevented from entering the market due to the license.

If demand increases to D_1, the equilibrium prices will increase to P_1 and total industry supply will increase to Q_1.

⇨Each firm will supply q_1 units.

This increase in demand creates long-run firm profits equal to the shaded area. Since licensing prevents new firms from entering the industry and competing the profit away, profits of the license holders will persist.

Each firm will produce q_1 units at the point along the long-run average cost by building a larger plant. This new plant will have a SAC function AC_S that is tangent the LAC at q_1. (Not located at minimum point of AC_L.)

The restriction on entry creates a cost inefficiency. Total output of Q_1 is not produced at the lowest total cost. This output would have to be produced by firms each producing q_0 units and there would be more than N_0 firms.

Hence, licensing raises the price to consumer and creates a cost inefficiency by raising the total cost of producing Q_1 units.

Licensing prevents new firms from entering, harms consumers because price increases, creates profits and does not minimize the cost of producing industry output.

Taxes, Trade Limitations and Market Restriction On Total Surplus

Total Surplus = consumer surplus + producer surplus

A Per Unit Tax on A Competitive Firm

When a per unit tax is imposed on the firm, the firm's profit function becomes:

Total profit = total revenue - total long-run cost - total taxes

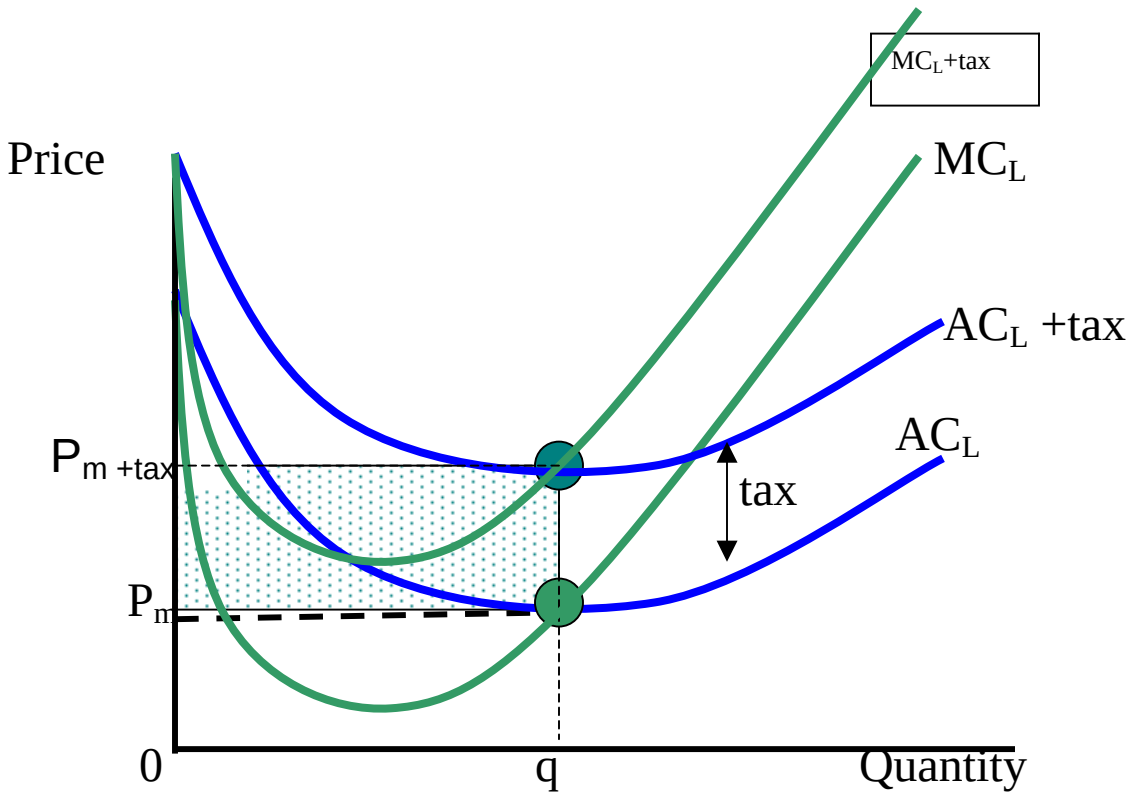
$$\pi(q) = Pq - C_L(q) - tq$$

where tq are total taxes paid by the firm to the government. (t=tax; q= quantity produced)

In order for the firm to maximize profits, it must produce an output such that it must satisfy:

$$P = \frac{\Delta C_L(q)}{\Delta q} + t$$

The firm considers the per unit tax a cost of doing business. It determines output where price equals the sum of long run MC and t.



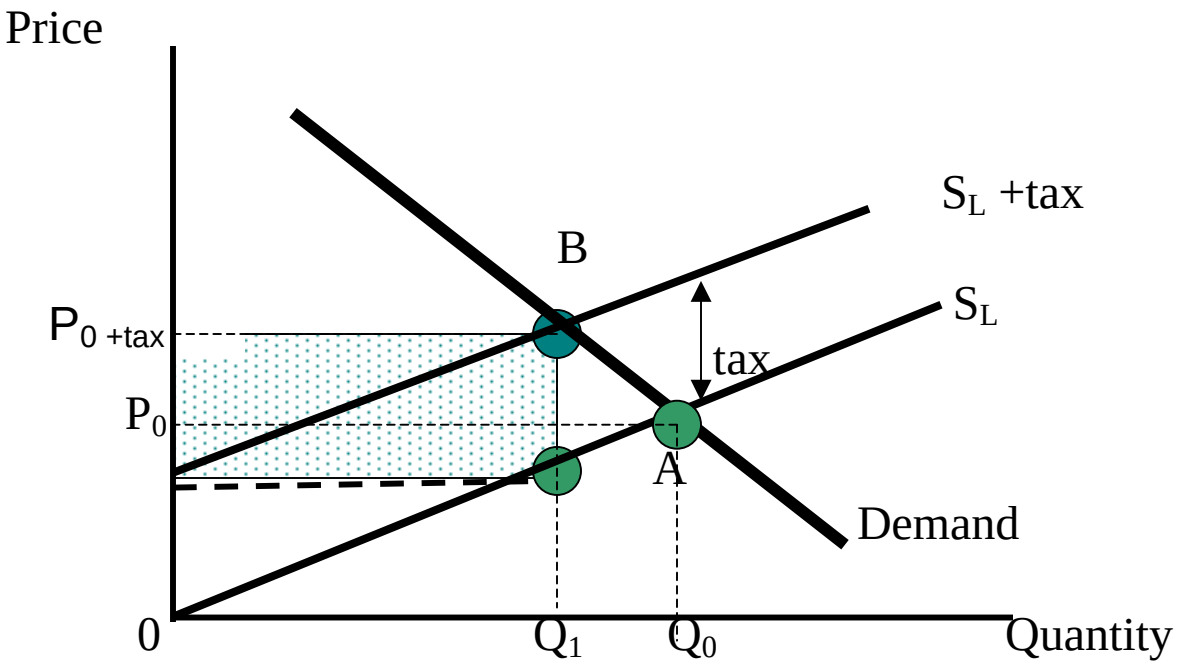
For the firm, when it considers the tax as another cost, the long run average cost of the firm becomes AC_L + tax.

The curve is exactly the same as the pre tax LAC curve, only shifted up by the amount of the per unit tax.

The MC function also shifts up by the amount of the tax and becomes MC_L + tax.

Since the average and marginal cost functions shift upward by the amount of the ‘tax’, the new and old long-run average cost functions reach a minimum at the same quantity produced.

Both long run average cost curves reach a minimum at q.



The green box represents the total amount of tax revenue collected by the government.

For the industry, the long-run equilibrium price increases from P_0 to P_0+tax.

The equilibrium quantity produced decreases from Q_0 to Q_1.

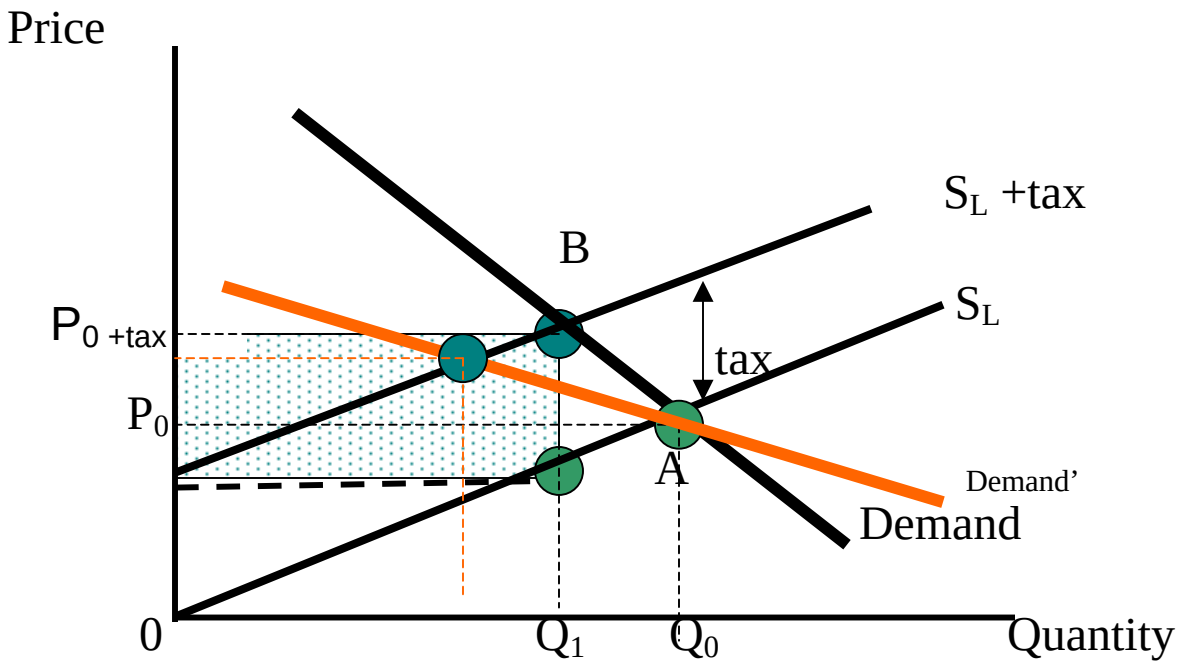
By raising the per unit tax, the government increases the price of the product and decreases the quantity demanded.

Before tax, industry output at point A at price P_0.

The amount by which the price increases depends on the price elasticity of demand and of supply.

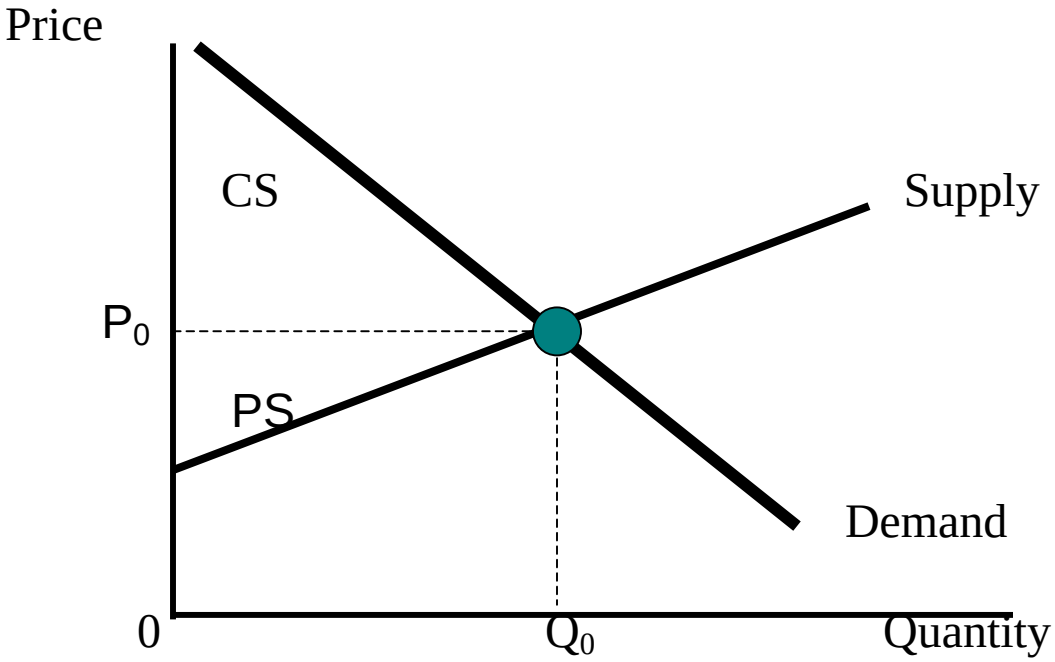
The greater the price elasticity of demand function, the smaller the price increase caused by a per unit tax.

The greater the price elasticity of supply function, the greater the price rise caused by a per unit tax.


Price
S_L +tax
B
S_L
$P_{0\ +tax}$
tax
P_0
A
Demand'
Demand
0
Q_1
Q_0
Quantity

The Effect of A Per Unit Tax on Consumer and Producer Surplus

It has been shown that the behaviour of consumers and producers change when a tax is imposed. Taxes have social consequences.



Before the government imposes a per unit tax, the long-run equilibrium price and quantity in a competitive industry are P_0 and Q_0.

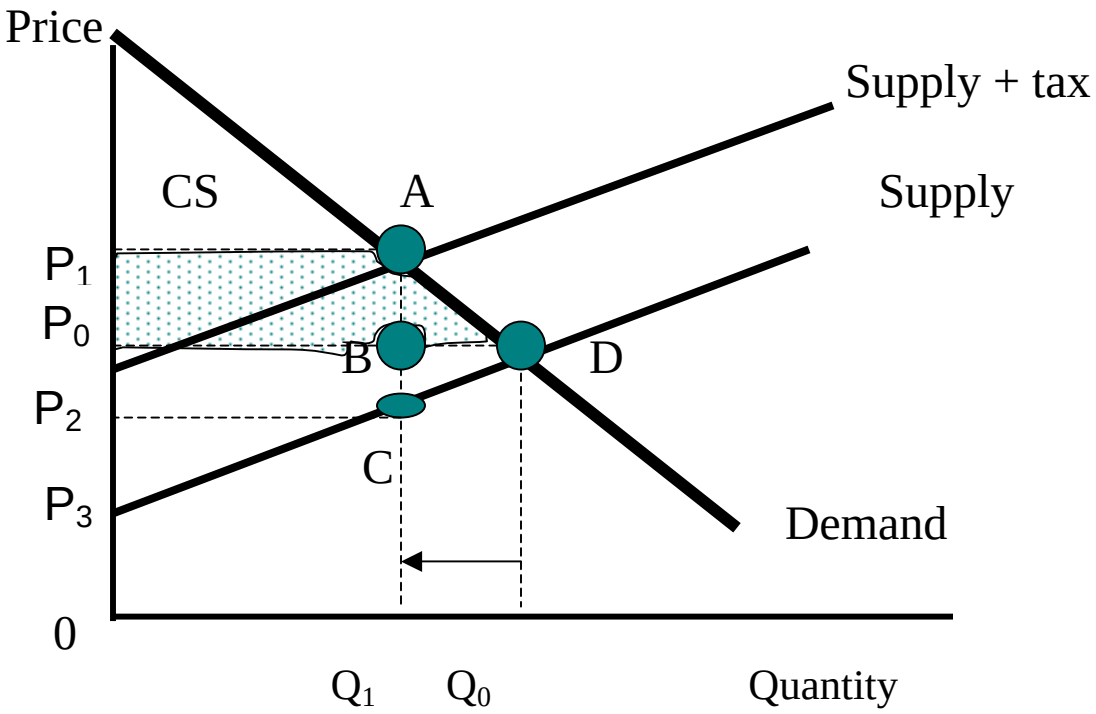
Consumers benefit because they are willing to pay more than P_0 for each unit up to the Q_0^{th} . The area between the demand curve and the price measures consumer surplus.

Producers receive P_0 for all the units they sell, even though they are willing to supply all units up to the Q_0^{th} unit at lower prices.

The area between the price line P_0 and the industry supply function represents producer surplus when producers sell Q_0 units are price P_0.

Now impose the Per Unit Tax:

The sum of consumer and producer surpluses **decreases** when the government imposes a per unit tax on a competitive industry.



The market price increases to P_1 and equilibrium quantity decreases to Q_1 when the tax is imposed.

Consumer surplus decreases by area P_0 P_1 AD.
Consumer surplus is now P_1 P_4 A.
Producer surplus in now area P_3 P_2C.

Although producers receive P_1 for Q_1 units, they must pay the government the tax of area P_2P_1 AC.

Producer surplus has decreased by area P_2P_0 DC.

Dead weight loss= ADC (loss of consumer and producer surplus that is not offset by an increase in value to some other group.