

Long Run Equilibrium

Question: What happens in the long run?

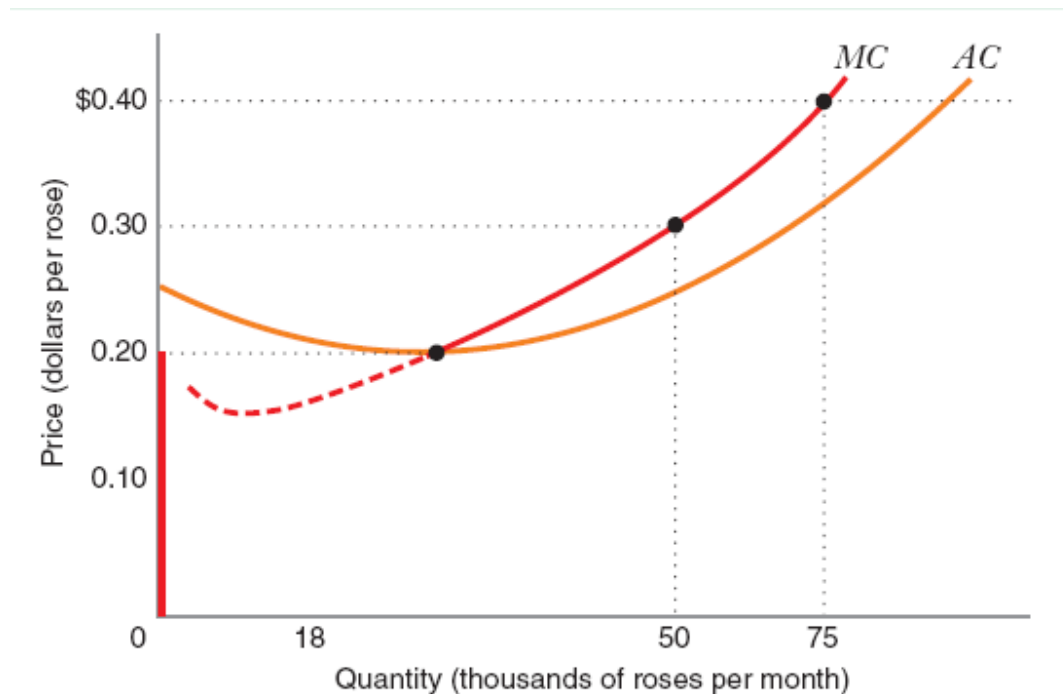
The **long run** differs from the short run in two ways:

1. Firms can **adjust all inputs** and fixed costs are not sunk.
2. There is **entry and exit**: the number of firms in the industry can change. A firm that suffer losses can leave the market, and a firm that anticipates gains can enter.

Long Run Equilibrium

Since there are no sunk costs, the firm exits if $p < \min_q ATC(q)$, and if $p \geq \min_q ATC(q)$ the supply is given by:

$$p = MC(q)$$



Long Run Equilibrium

A **long run equilibrium** is a **price P^*** , **quantity Q^*** and **number of firms n** , such that:

1. Individual firms **maximize profits**: each firm produces q^* such that $P^* = MC(q^*)$
2. No firm wants to exit or enter: firms must be making **zero profits** so that $P^* = AC(q^*)$
3. **Market clears**: market demand equals market supply, $Q^d(P^*) = Q^* = Q^s(P^*)$, where the market supply is $Q^s(P^*) = nq^*$

The difference from the short run is the **zero profit condition**.

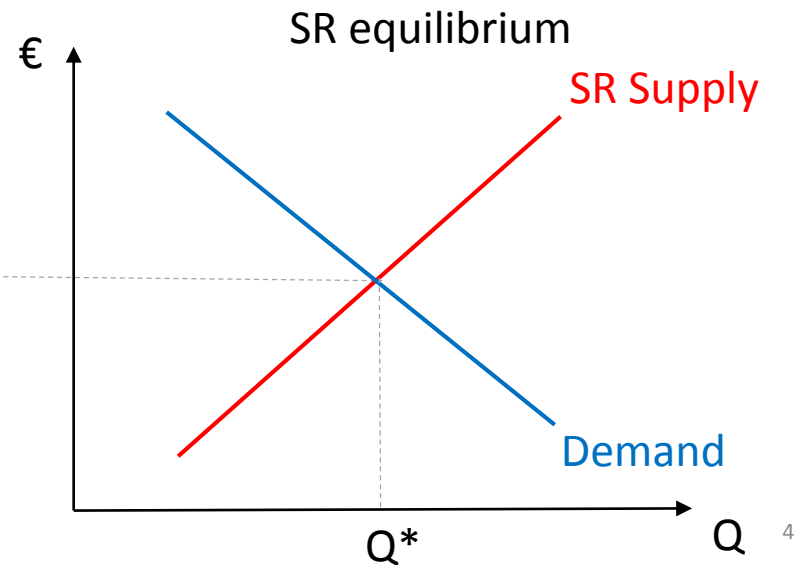
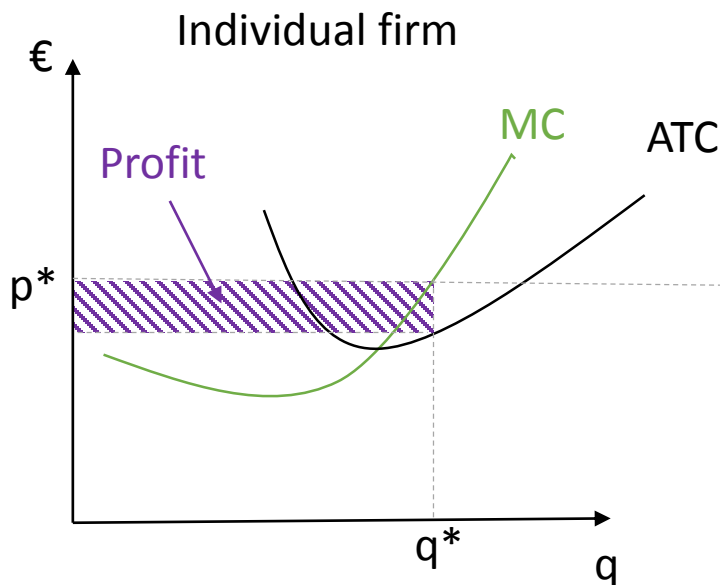
It relies on the assumptions that firms can exit, so no losses are incurred, and there are always firms that can enter, so no profits can be gained.

Long Run Equilibrium

The zero profit condition means that in the long run each firm is producing a **quantity q** such that **$ATC(q)$** is at the **minimum point**. **Why?**

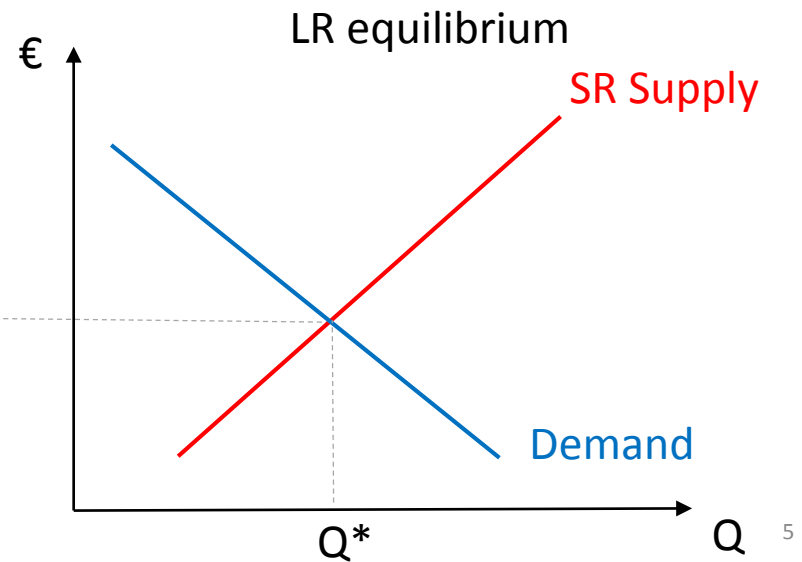
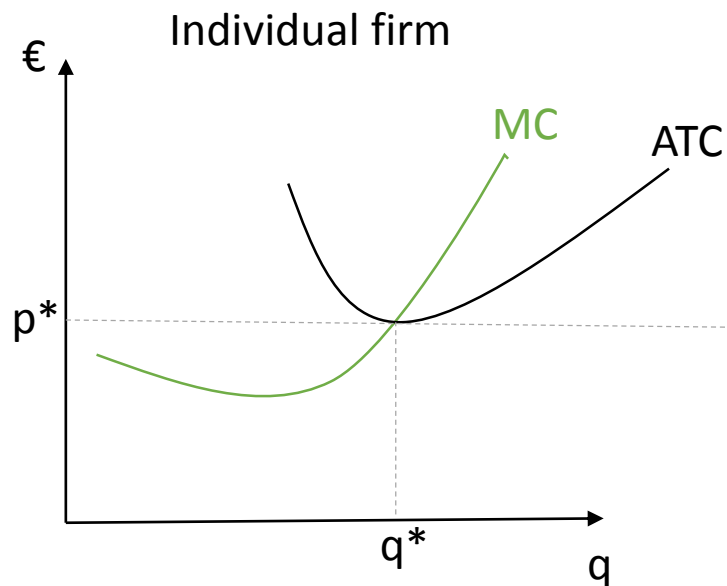
- i. If $p < ATC(q)$ firms make losses, some firms exit and the market price will rise (why?). If $p > ATC(q)$ firms make positive profits, firms will enter and the market price will fall (why?). **Thus $p=ATC(q)$**
- ii. Since each firm is maximizing profits, each firm chooses a quantity q such that **$MC(q)=p$** .

The only quantity level where **$MC(q)=p=ATC(q)$** is the **minimum of the ATC curve**.



Long Run Equilibrium

In the long run, the market price p and each individual firm's output q , must be such that:
 $MC(q)=p=ATC(q)$.



Long Run Equilibrium: example

Suppose that a market has the following demand function: $Q^d(P) = 25\,000 - 1\,000 P$. Firms' cost function is $TC(q) = 40q - q^2 + 0.01q^3$. What is the market equilibrium?

We solve this in three steps:

1. Calculate **individual firm's optimal** output level and then get the market price.

From zero profits: $ATC(q)=P$ and from profit maximization, $MC(q)=P$. Together,

$ATC(q)=MC(q)$, and we can solve for q .

$$ATC(q) = 40 - q + 0.01q^2 \text{ and } MC(q) = 40 - 2q + 0.03q^2$$

And we have that $q^* = 50$ the price is $P^* = 15$

2. Calculate **market quantity**. Since the price is $P^* = 15$, from **market demand** we can calculate the market quantity: $Q^d(P) = 25\,000 - 1\,000 P$, and $Q^d(15)=Q^*= 10\,000$

3. Calculate **number of firms**. Given the market quantity, and the individual firm's quantity produced we can calculate the number of firms: **$nq^*=Q^*$**

Total output is $Q^*=10\,000$ and each firm produces $q^*=50$ units, so there must be $n=10\,000 / 50=200$ firms.

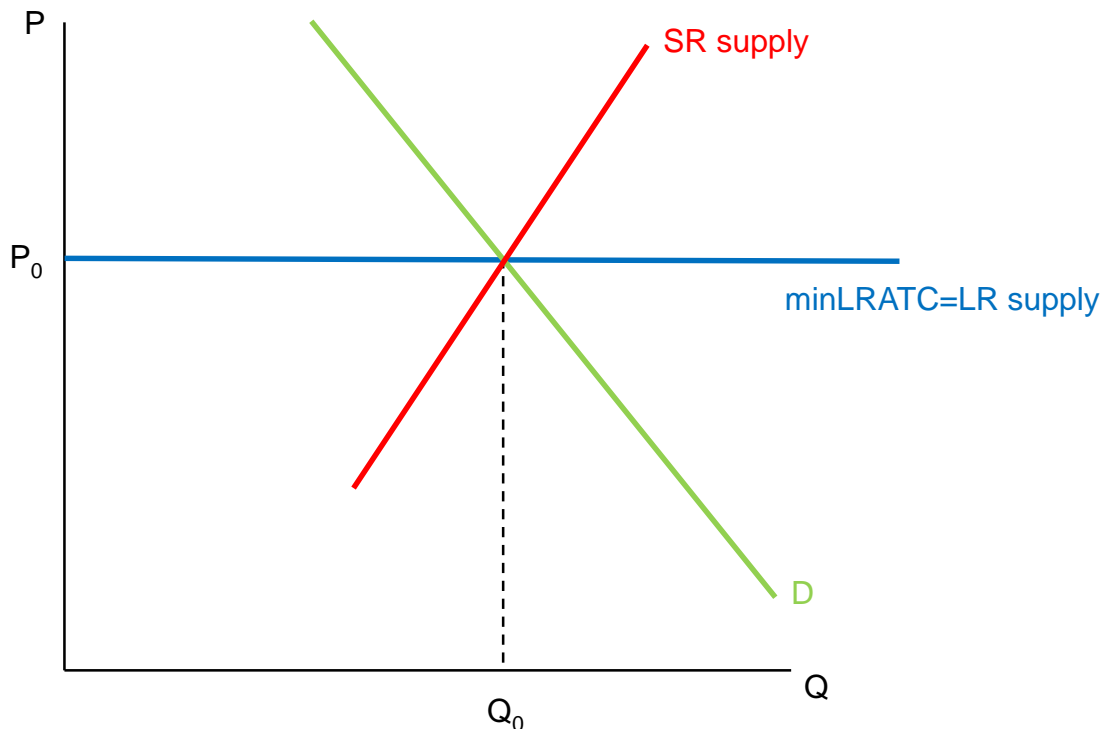
Long Run Equilibrium

Difference in calculating long and short run equilibrium

	Long Run	Short Run
Step 1: Individual firm's output	$MC(q)=ATC(q)=p$	$MC(q)=p$
Step 2: Market quantity	Use price from step 1 and market demand to calculate the market quantity	Calculate market supply, use market clearing condition to get price and quantity
Step 3: Number of firms	Calculate the number of firms	Number of firms is given. Calculate individual firm's output

Long Run Supply Curve

The **long run market supply curve** maps the quantity of output supplied for each given price. The supply of firms takes place after all long run adjustments of inputs and entry or exit of firms.



We cannot calculate it as the sum of individual firms' supply curves because of entry and exit.

Instead, the zero profit condition determines the long run supply.

Output expansion or contraction in the industry occurs along a horizontal line corresponding to the minimum level of long run average cost.

Example: demand-side effect

Market for quinoa grains

Before 2000, supplied by Peruvian and Bolivian rural farmers. Marginal costs were around 2.6 \$ per kg and market price was around 2-3 \$ per kg.

Between 2000-2014 **demand increased** sharply, the price increased to 7\$ per kg.

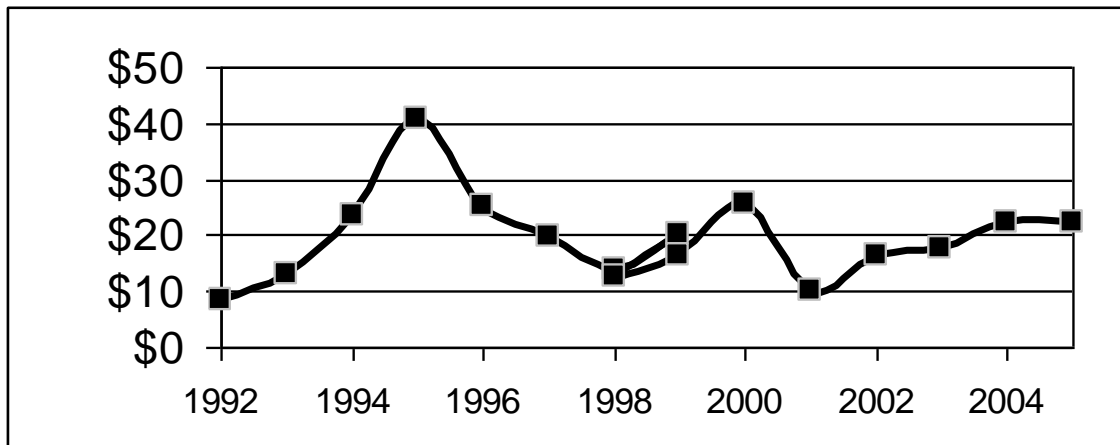
2013: Quinoa grains are grown in 50 different countries and the marginal costs dropped to 2 \$.

2016: Quinoa's price was around 2 \$ per kg.

Example: demand-and supply-side effects

In general, the long run dynamics of prices are shaped by supply-side effects (such as economies of scale) and demand-side effects (such as network externalities – think of cell phones).

For example, the revenue cycle of computer memory chips (DRAM)



Question:

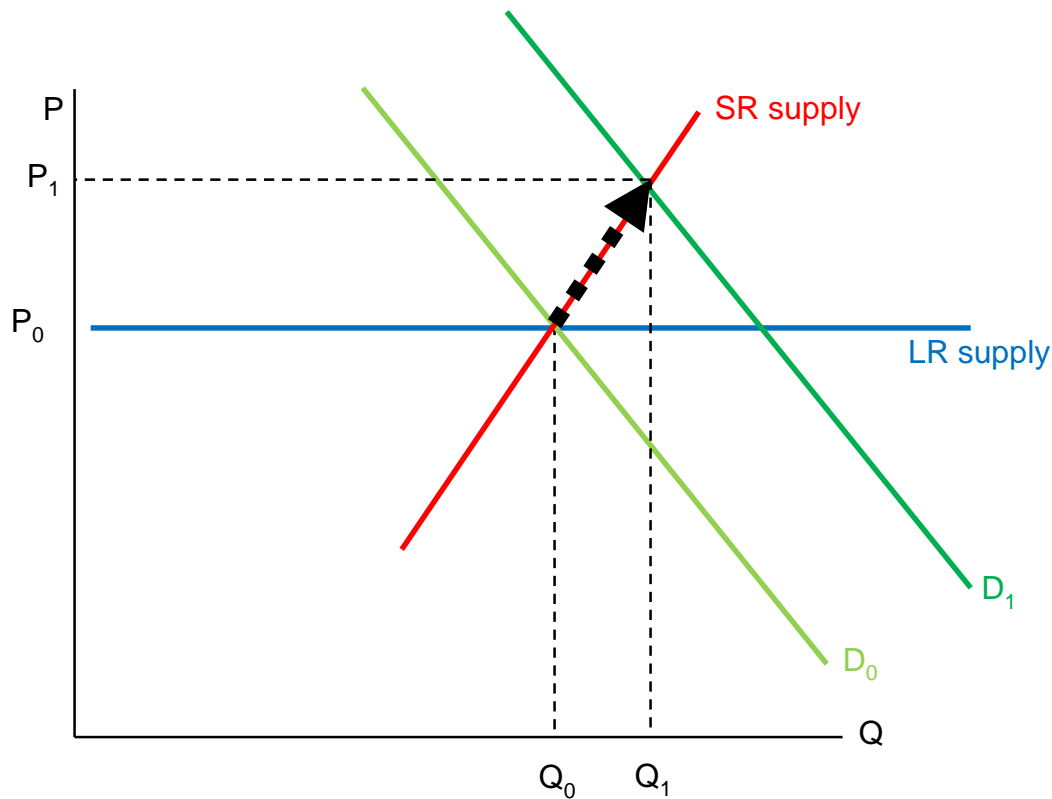
What causes such price cycles?

Long Run Market Dynamics

The next goal is to understand how the **price** in a competitive market responds to a **change in demand**.

Long Run Market Dynamics

Suppose demand increases

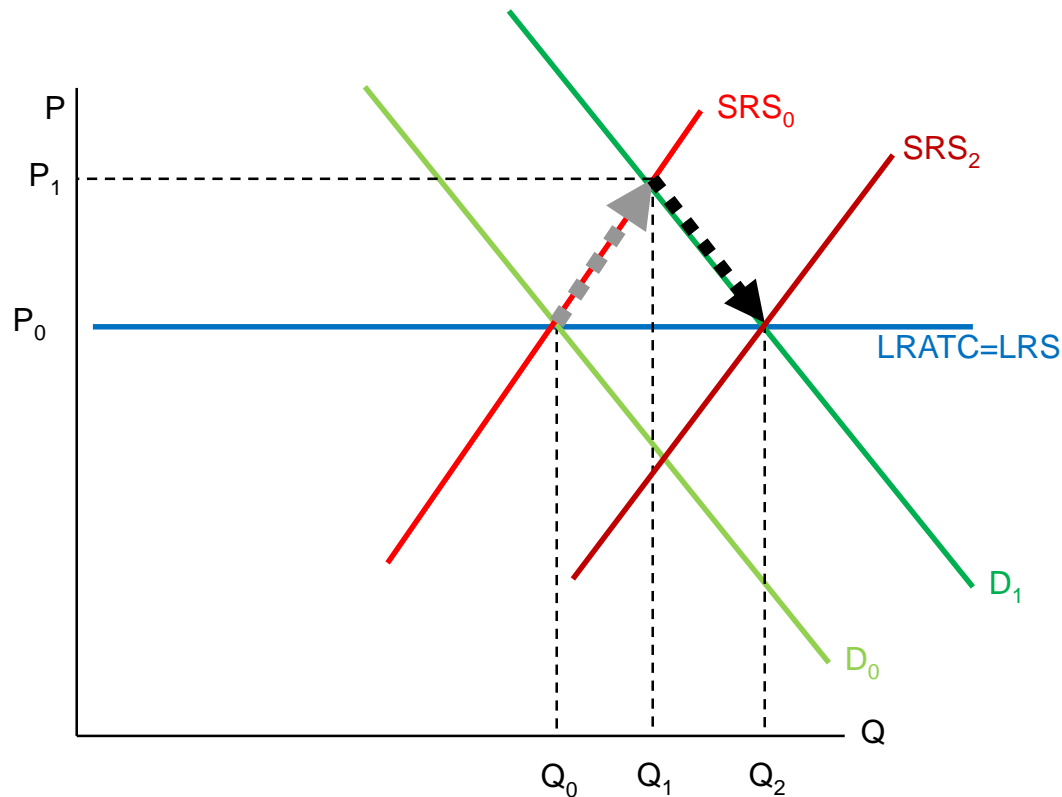


Initially market price increases, and output increases.

What happens next?

Long Run Market Dynamics

Suppose demand increases



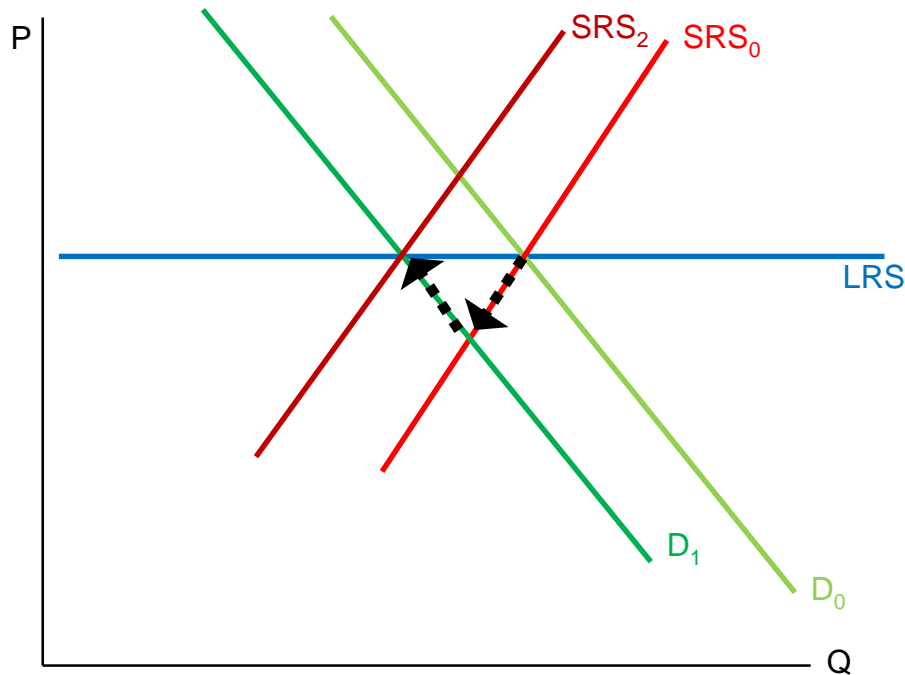
Since prices rise, $p > ATC$, and each firm earns a profit. Leads to entry and an increase in supply.

In the **new LR equilibrium:**

- Price decreases to the original price.
- The number of firms is higher.
- Output increases further.

Long Run Market Dynamics

Suppose demand **decreases**



Initially market price decreases, and output decreases.

What happens next?

Since prices fall, $p < ATC$, each firm suffers a loss in the SR. Leads to exit and a decrease in supply.

In the **new LR equilibrium:**

- Price rises to the original price
- Output decreases further.
- The number of firms decreases.

Long Run Market Dynamics

The previous analysis made two simplifying assumptions:

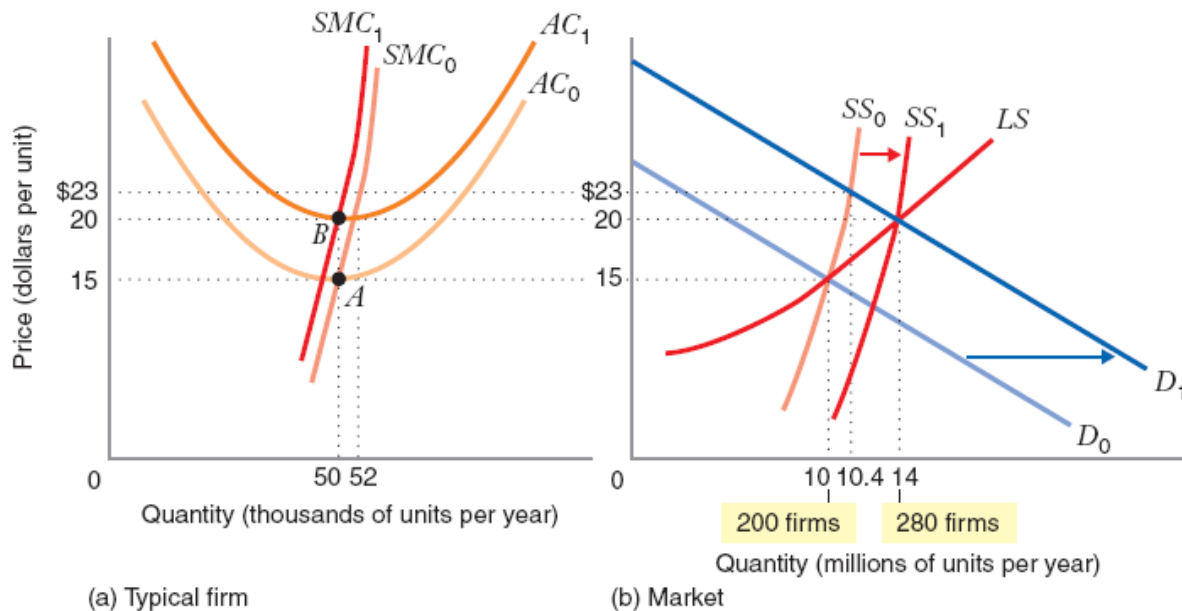
1. As the number of firms increases, the costs of each individual firm do not change.
2. As prices change, consumers do not change their behavior.

Long Run Market Dynamics

1. In a **constant-cost industry** an increase in industry output does not affect the prices of inputs.
2. In an **increasing-cost industry** an increase in industry output increases the prices of inputs.
3. In a **decreasing-cost industry** an increase in industry output decreases the prices of inputs.

Long Run Market Dynamics

Increasing-cost industry: an increase in demand



Step 1 Initial effect: prices rise. Since prices rise, $p > ATC$, each firm makes a profit in the short run. Leads to entry.

Step 2 Entry has two effects:

- Industry supply increases.
- Individual firm's costs increase.

In the new LR equilibrium:

- Price rises above the original price.
- Output increases.
- Number of firms increases.
- Average total costs are higher.

Long Run Market Dynamics

Decreasing-cost industry: an increase in demand

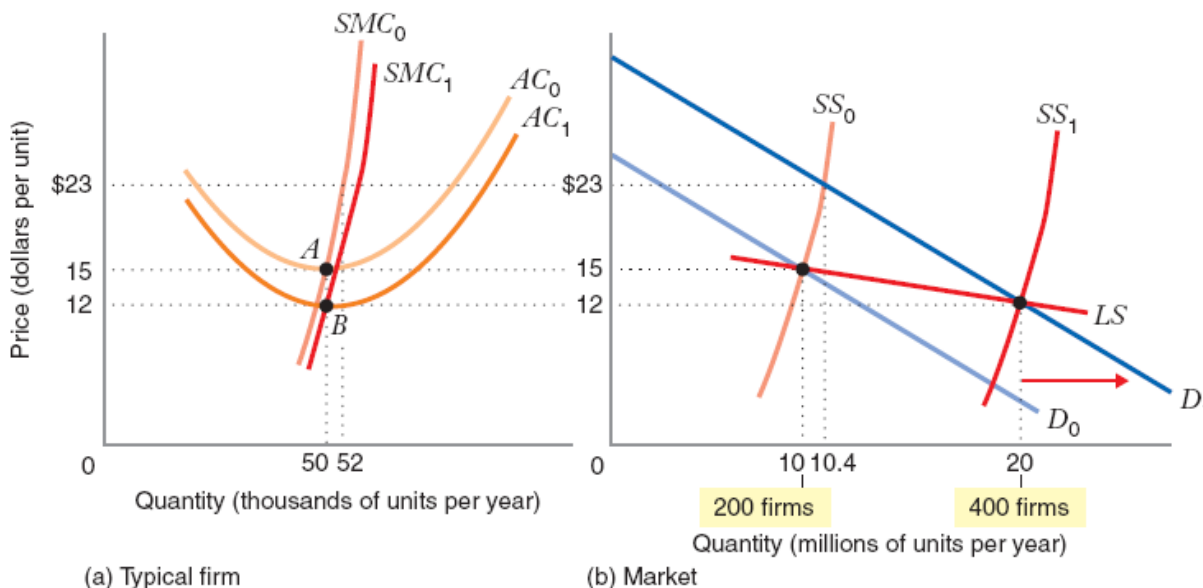
Step 1 Initial effect: prices rise. Since prices rise, $p > ATC$, each firm makes a profit in the short run. Leads to entry.

Step 2 Entry has two effects:

- i. Industry supply increases.
- ii. Individual firm's costs decrease.

In the new LR equilibrium:

- Price falls below the original price.
- Output increases.
- Number of firms increases.
- Average total costs are lower.



Long Run Supply Curve

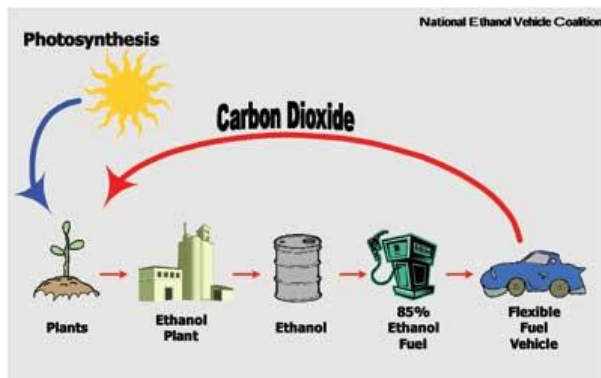
The **long run market supply curve** maps the quantity of output supplied for each given price. The supply of firms takes place after all long run adjustments of inputs, and entry or exit of firms.

Long Run Market Dynamics

1. In a **constant-cost** industry long run supply is horizontal.
2. In an **increasing-cost** industry long run supply **increases**.
3. In a **decreasing-cost** industry long run supply **decreases**.

Increasing cost industry: example

The US ethanol market



Ethanol is a liquid produced (mostly) from corn, and can be used to produce, amongst other things, bio-fuel.

In mid-2000s there was a sharp increase in demand, increasing prices.

As the industry grew, the price of corn rose sharply, increasing the production costs.

As a result, the construction of new plants fell sharply. The price of ethanol was more than twice as high in 2009 than in 2005.