Competitive Firms and Markets

Lecture 6

Reading: Perloff Chapter 8

August 2015

Introduction

- We learned last lecture what input combination a firm will use for a given level of output.
- But exactly how much should a firm produce?
- Depends on their cost structure, what other firms will do and how consumers behave.

Introduction

- In this lecture, we see how the supply curve we saw on the first day is derived.
- We look in more detail how the equilibrium quantity and price is determined in a perfectly competitive market.

Outline

- **Perfect Competition** - A perfectly competitive firm is a price taker and faces a horizontal demand curve.
- **Profit Maximization** - How much should a firm produce to maximize profits?
- **Competition in the Short Run** - What is the market equilibrium when the number of firms in the market is fixed?
- **Competition in the Long Run** - What is the market equilibrium when firms are free to enter and exit?

Perfect Competition

- One of the simplest market structures is **perfect competition.**
- A market is perfectly competitive if each firm in the market is a **price taker**.
- A firm is a price taker if it cannot alter the market price or the price at which they buy inputs.
- Everything the firm needs to know is captured by the market price.

Perfect Competition

- Firms are likely to be price takers if the market has some or all of the properties
  - Huge number of firms
  - Homogenous products
  - Everybody knows everything
  - Low transaction costs
  - Free entry and exit

- Obviously these conditions are never fully met, but many markets are highly competitive.

Perfect Competition

Large Number of Buyers and Sellers

- If there are enough sellers, no firm can raise or lower the market price.
- An individual firm is a tiny percent of the entire market.
- The firm's demand curve is a horizontal line at the market price.

Perfect Competition

Identical Products

- Firms sell **homogenous** products.
- A good produced by firm A is perfectly substitutable with a good produced by firm B.
- A firm cannot sell anything if it raises its price by 1P more than its competitors.
- An example of this would be Granny Smith apples or plain white t-shirts.

Perfect Competition

Full Information

- Buyers know the prices set by all firms.
- Firms cannot get away with raising their price because consumers know the prices of all firms.

Perfect Competition

Negligible Transaction Costs

- Buyers and sellers don't have to spend much time or money to interact with each other.
- If this were not the case, buyers might absorb a higher price charged by firms who have a lower transaction cost.
- Think of all firms as being in the same room.

Perfect Competition

Free Entry and Exit

- If all firms raise their prices and there is profit to be made, firms will keep entering until the price is driven back down.
- If there were no free exit, firms might be hesitant to enter the market in case of a bad shock.

Perfect Competition

- Many markets do not posses all these features, but are for practical purposes still price takers.
- In these markets, firms do not deviate significantly from price taking.
- We still call these markets competitive in practice.

Perfect Competition

- The most important thing to take away from all this is that a perfectly competitive firm faces a horizontal demand curve.
- Lets see how this can occur.

Perfect Competition

- An individual firm faces a **residual demand curve.**
- This is the market demand not met by other sellers.
- It is equal to the market demand minus the supply of all other firms.

$$D^r(p) = D(p) - S^o(p)$$

- For example, buyers want to purchase 10,000 bananas and all the other banana firms sell 9,990 bananas. Residual demand is 10 bananas.

(a) Firm

p, \$ per metal chair

100

66
63

D^r

0   93

q, Thousand metal
chairs per year

(b) Market

p, \$ per metal chair

100

S^o

66
63

D

0   434 500 527

Q, Thousand metal
chairs per year
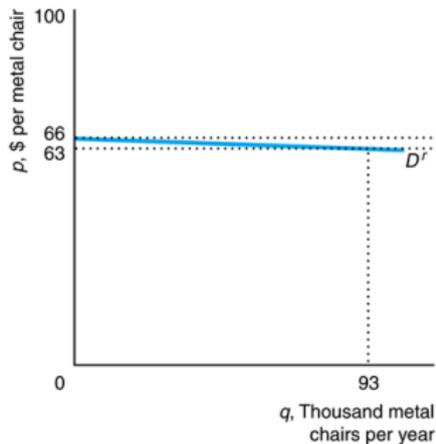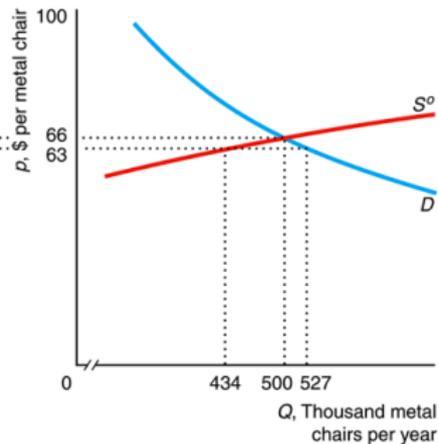
Perfect Competition

- Because the residual demand curve is much flatter than the market demand curve, the elasticity of residual demand is much higher than market elasticity

- If there are n identical firms, the elasticity of demand facing firm i is

$$\varepsilon_i = n\varepsilon - (n-1)\eta_o$$

- ε_i is the elasticity facing firm i. ε is the market elasticity and η_o is the elasticity of supply of the other firms

EXAMPLE

- Suppose the market elasticity of demand is -1.5
- There are 10 firms in the market and the elasticity of supply is 4.
- What is the elasticity of demand facing firm i?
- What is the interpretation behind this?
- What happens when we increase the number of firms in the market?

Perfect Competition

- As the number of firms in the market increases, we approach a perfectly competitive market.
- As we approach a perfectly competitive market, the demand curve facing a single firm gets flatter and flatter.
- The key point is that an individual firm is insignificant to what happens in the market.

Perfect Competition

- Why do we study perfect competition?
  - Many markets are reasonably described as competitive.
  - Easy to model.
  - Once we understand it, we can easily add imperfections to make it more realistic.

Profit Maximization

- To derive the market supply curve, we must know how much each firm wants to produce.
- We will first look at this in the short-run.
- The firm produces an amount such that its profits are maximized.
- Profit is just the difference between total revenue and total cost $\pi = TR - TC$.
- Total revenue is the number of units you sell times the price of each unit $p * q$.

Profit Maximization

- Cost is a bit less straightforward.
- We always refer to **economic costs.**
- Economic costs includes opportunity cost, *accounting cost* do not.
- It might seem like your business is making money, but working somewhere else might be more profitable.

Profit Maximization

- There are two steps a firm must make when finding its profit maximizing level of output.
- The first step is the **output decision**
- What level of output, q^*, maximizes profit?

Profit Maximization

- The next step is the **shutdown decision**
- Is it more profitable to produce q^* or to shut down and produce nothing?

Profit Maximization

- A firm can use any of the following three *equivalent* rules to choose how much to produce.

RULE 1 Maximize profit function

- Find your profit function and find the maximum.

Profit Maximization
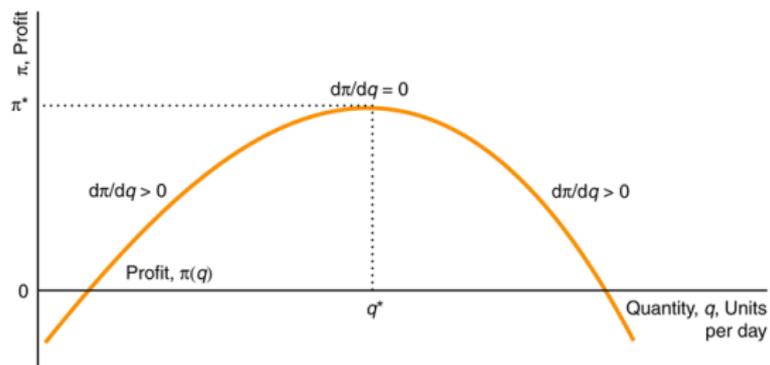
RULE 2 Set marginal profit to zero

- Marginal profit is the extra profit you get from selling one more unit.
- When marginal profit is zero, we will lose profit by increasing or decreasing output (must check second order condition).

$$\frac{d\pi(q)}{dq} = 0$$

Two Steps to Maximizing Profit-Step One

RULE 3 Set marginal revenue to equal to marginal cost

- **Marginal revenue** is the additional revenue you get from increasing output.
- **Marginal cost** is the addition cost you incur from increasing output.
- At the optimum, $MC(q) = MR(q)$.

Profit Maximization

- These are all exactly the same thing

$$
\begin{aligned}
\max \pi(q) &= R(q) - C(q) \\
\frac{d\pi(q)}{dq} &= \frac{dR(q)}{dq} - \frac{dC(q)}{dq} = 0 \\
\frac{dR(q)}{dq} &= \frac{dC(q)}{dq}
\end{aligned}
$$

EXAMPLE

- Suppose the market price is $p = 100$.
- Our cost function is

$$C(q) = 20q + 10q^2$$

- What is the profit maximizing level of output?

Profit Maximization

- After you know what q^* is, all we have to know whether or not we should shut down.
- Remember that in the **short run**, we can have *sunk* fixed costs.
- If a firm shuts down in the short run, it still has to pay sunk fixed costs.
- A firm might stay in business if it is making a loss if it is covering its sunk fixed costs.

Profit Maximization

- The sunk cost should not play a role in the firm's shut down decision.
- The firm only needs to make sure its costs are less than the avoidable costs.

Profit Maximization

- Suppose

$$
\begin{aligned}
\textit{Total Revenue} &= 5000 \\
\textit{Variable Cost} &= 2000 \\
\textit{Sunk Fixed Cost} &= 6000
\end{aligned}
$$

- Should the firm shut down?

- We just need to compare the profit from staying in business versus not (π^O is profit from staying in business and π^{SD} is profit from shutting down).

$$
\begin{aligned}
\pi^O &= 5000 - 2000 - 6000 = -3000 \\
\pi^{SD} &= -6000
\end{aligned}
$$

- The firm minimizes its losses by staying in business

- Okay, we know how much an individual firm decides its production level.
- We can use this information to find out what total market production and the market price is.
- First, we need to find the supply curve of each individual firm.

Competition in the Short Run

- **REMEMBER**, firms in competitive markets face a *horizontal demand curve*.
- No matter how much an individual firm sells, the price will not change.
- The price they get from each unit is constant $\Rightarrow R(q) = p * q$.
- The market price is independent of how much an *individual* firm produces.

- Because the price is the same no matter how much one firm produces, marginal revenue is simply $MR(q) = \frac{dR(q)}{dq} = p$.
- The profit maximizing level of output occurs where $MR(q) = MC(q)$
- Therefore the profit maximizing level of output occurs where

$$MC(q) = p$$

- The firm's supply curve is the marginal cost curve above the shut-down price.
- That is, the firm sees the market price and decides how much to produce according to its marginal cost curve.

EXAMPLE

- Suppose the shutdown price for a firm is $p = 0$.
- What is the firms supply curve if the cost function is

$$C(q) = 2q^2 + q + 12$$

Competition in the Short Run

- How do we find the shut-down price?
- At q^*, we can find the firm's average profit as follows

$$\frac{\pi}{q} = \frac{R}{q} - \frac{C}{q} = \frac{pq}{q} - \frac{C}{q} = p - AC$$

- For example, If the price is \$10 and the average cost of producing each unit is \$3, your average profit is \$7.

Competition in the Short Run
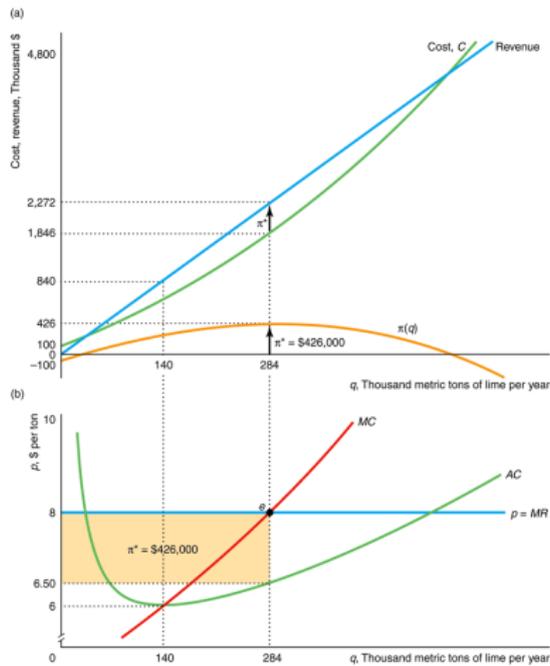
- Remember firms in the short run only care about covering their variable costs.
- The firm can only gain from shutting down if its revenue is less than its short-run variable cost $pq < VC(q)$
- Divide both sides by q to show the firm shuts down if the market price is less than the minimum of its short-run average variable cost curve

$$p < \frac{VC(q)}{q} = AVC$$
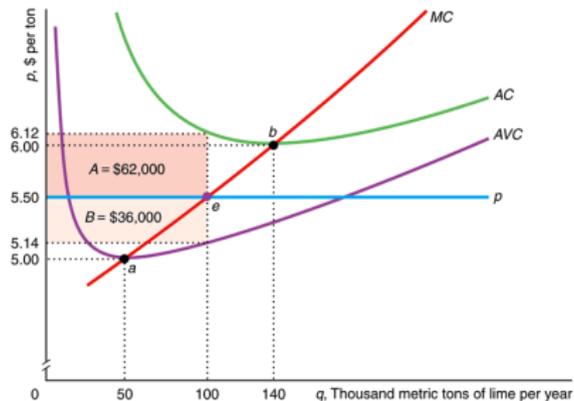
Competition in the Short Run

- We know that firms will shut down if price is $p < AVC$
- We also know that to maximize profit the firm will produce where $p = MC(q)$
- The firm will shutdown when $MC < AVC$
- **This occurs at the minimum of the average variable cost curve**
- $\Rightarrow$ The firm's shut down price in the short-run is the minimum of the average variable cost curve.

- There are two ways we can find the shut-down price in the short-run.

1. Minimize the AVC function and find the corresponding price.
2. Find the price where $AVC = MC$

- The supply curve is just the marginal cost curve above the minimum of the average cost curve

$$S(p) = \left\{ \begin{array}{c} MC(q) \text{ if } p \geq p_{shutdown} \\ 0 \text{ if } p < p_{shutdown} \end{array} \right.$$
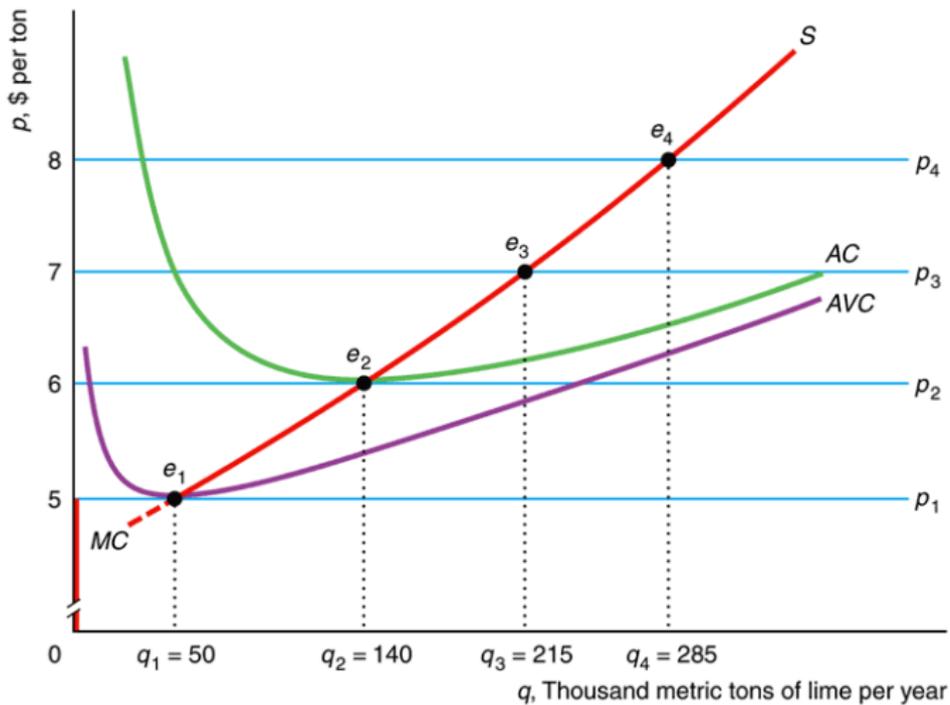
EXAMPLE

- Suppose the firm's cost curve is

$$C(q) = 100 + 10q - q^2 + \frac{1}{3}q^3$$

- What is the firm's marginal cost and average variable cost.
- What is the firm's supply curve?
- What is the shut down price?
- Will the firm produce if $p = 10$? if $p = 5$?

Competition in the Short Run

- We saw how to get one firm's supply curve
- The market supply curve is the horizontal sum of all the firm's in the markets supply curve
- In the short run, the number of firms is fixed at n

- Suppose an individual firm has a supply curve

$$q = 10 + P$$

- If there are 10 identical firms, just multiply q by 10 to get the market supply curve

$$Q = 100 + 10P$$

- The more firms we have, the flatter is the market supply curve
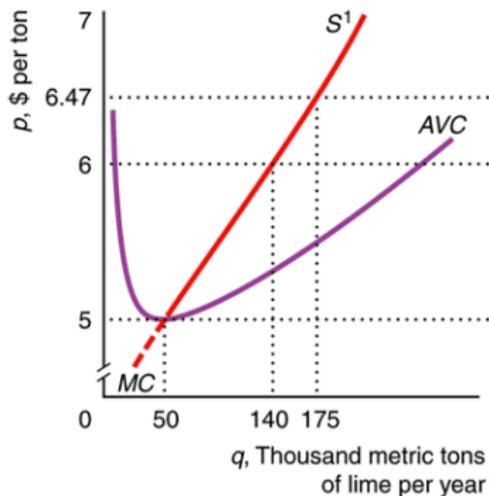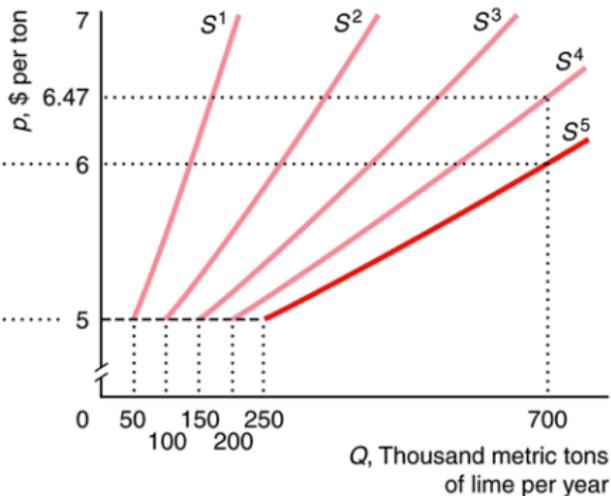
Competition in the Short Run

- If firms differ, the marginal cost curves will not be identical.
- The shut down prices of firms will not be the same either.
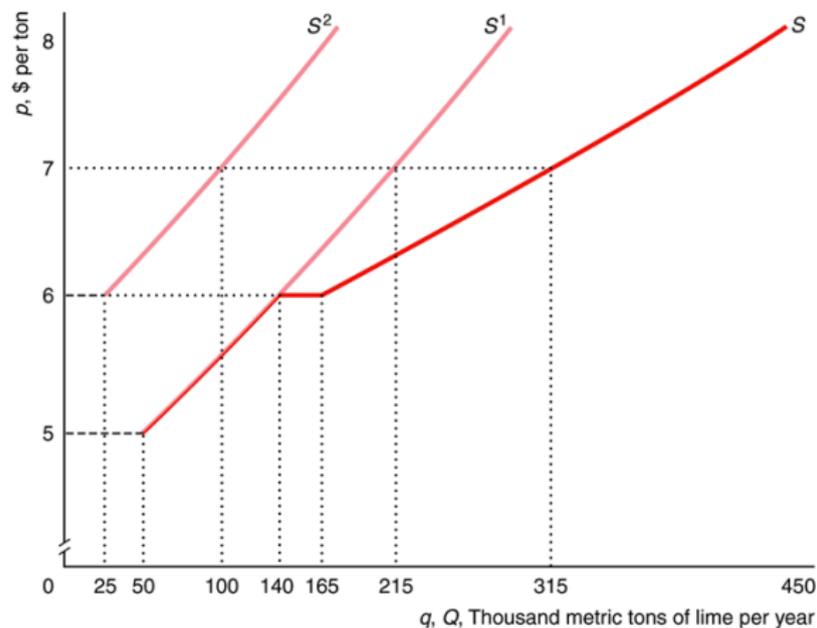
- By combining the short-run market supply curve and the market demand curve, we can find the short-run equilibrium

(a) Firm
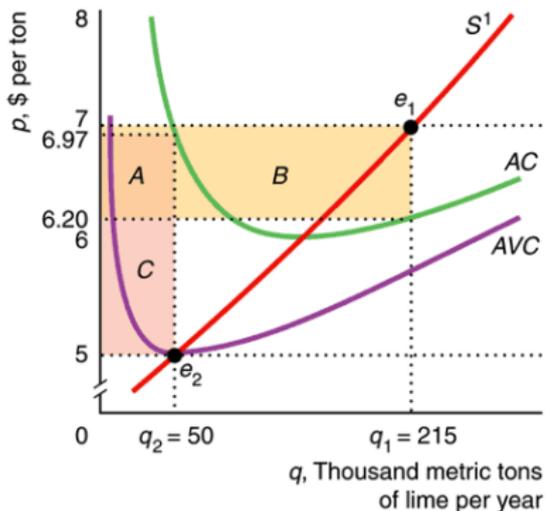
(b) Market
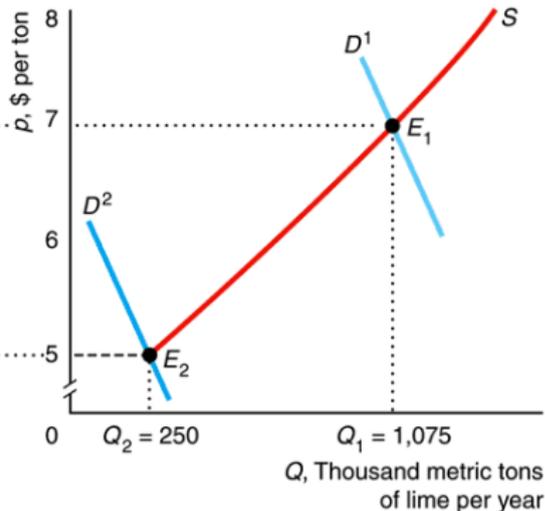
Competition in the Short Run

- In summary...
- Each firm will produce the level of output where $MC = p$.
- We add up the individual firm supply curves to get the market supply curve.
- The market price is determined by the intersection of the market supply curve and the market demand curve.

EXAMPLE

- Each firm has a cost function of

$$C(q) = 10q^2 + q + 100$$

- The market demand curve is

$$D(P) = 145 - 10P$$

- When there are 100 firms, what is the equilibrium price?

Competition in the Long Run

- There are two key differences in between the short and long run

1. There are no sunk fixed costs
2. The number of firms in the market is not fixed

- How much will each firm produce in the long-run?
- Once again, firms select the level of output which maximizes their profit.
- The profit maximizing level of output occurs where $p = MC$.

Competition in the Long Run

- After determining the profit maximizing level of output q^*, the firm must decide whether or not to shutdown.
- In the long run, all costs are variable.
- Unlike in the short-run, the firm will shut down if it incurs any losses at all.
- The firm will shut down when $p < AC$.
- The shut-down price occurs at the minimum of the average cost curve.

- There are two ways we can find the shut-down price in the long-run.

1. Minimize the AC function and find the corresponding price.
2. Find the price where $AC = MC$

- Therefore, the supply curve of an individual firm in the long-run is the marginal cost curve above the minimum of the average curve.

$$S(p) = \left\{ \begin{array}{c} MC(q) \text{ if } p \geq p_{shutdown} \\ 0 \text{ if } p < p_{shutdown} \end{array} \right.$$

EXAMPLE

- What is the supply curve for a firm in the long-run with the cost function:
$$C(q) = 40q - q^2 + .01q^3$$

Competition in the Long Run

- The market supply curve is once again the horizontal sum of all firms' supply curves.
- In the short-run, the number of firms is fixed, but firms can enter or leave the market in the long run.

Competition in the Long Run

- If there are profits to be made, firms will enter the market as there are no barriers in perfect competition.
- This will cause the market supply curve to shift and the market price to fall.
- If there is negative profit, firms will exit.
- The number of firms is determined by $\pi = 0$.

Competition in the Long Run

- Firms make zero profit when $p = p^{SD}$ where p^{SD} is the shutdown price.
- The shutdown price occurs at the minimum of the average cost curve.

- Therefore, the market price will always occur at the minimum of the average cost curve.

EXAMPLE

- Draw the market supply and demand curves in one graph next to a graph showing an individual firms's average/marginal cost curves.
- Identify two market prices, p_1 and p_2. At price p_1, firms will enter the market and at price p_2, firms will exit the market.

- Suppose all firms have an identical cost curve

$$C(q) = 40q - q^2 + .01q^3$$

- Market demand is

$$D(P) = 25,000 - 1000P$$

Competition in the Long Run

- We have three equilibrium conditions in the long run. P^* is the market price and n^* is the number of firms.

1. Profit Maximization

$$P^* = MC \ \rightarrow \ P^* = 40 - 2q + .03q^2$$

2. Zero Profit

$$P^* = AC \rightarrow P^* = 40 - q + .01q^2$$

3. Supply equals demand

$$nq = 25,000 - 1000P$$

Competition in the Long Run

- Combine equation 1 and equation 2 to find how much each firm will produce.

$$40 - 2q + .03q^2 = 40 - q + .01q^2$$
$$q = 50$$

- Plug 50 into the average cost curve to find the market price will be $15.
- Plug 15 into the demand curve to see that 10,000 units will be produced.
- There will be 10,000 / 50 = 200 firms in the market.

- The long run market supply curve is flat at the minimum long run average cost curve iff
  - input prices are constant.
  - firms have identical costs.

Competition in the Long Run

(a) Firm

p, $ per unit

S^1

LRAC

10

LRMC

0   150

q, Hundred metric tons of oil per year

(b) Market

p, $ per unit

Long-run market supply

10

0

Q, Hundred metric tons of oil per year
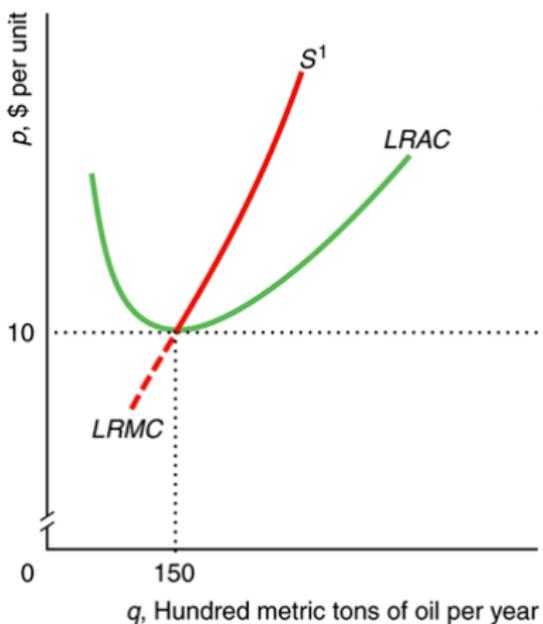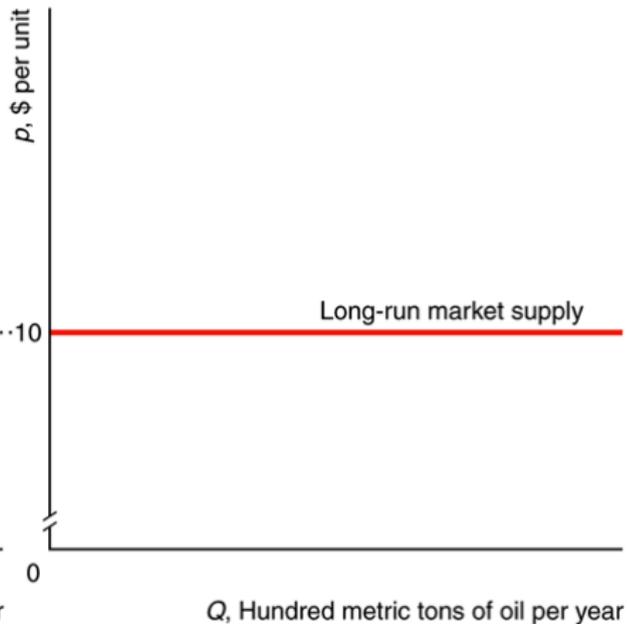
Competition in the Long Run

- Remember how we said there is no such thing as the law of supply?
- The supply curve can slope upwards or downwards if the previous two conditions are not met.

Competition in the Long Run

- If entry is limited, the market supply curve will slop upward.
  - Individual firms have upward sloping supply curves.
  - The only way to increase output is for existing firms to produce more.

- If firms differ in their costs, the market supply curve will also slope upwards.
  - Some firms will enter the market at lower prices than others.

Competition in the Long Run

- If the number of coffee shops increases, we could expect the price of coffee beans to increase.
    - This will also cause the market supply curve to be upward sloping.
- It is also possible for input prices to decrease with output (economies of scale).
    - This will cause the supply curve to be downward sloping.

Summary

- What are the conditions under which firms are price takers?
- What is the residual demand curve?
- The firm will shut down so long as the price is greater than what?
- The supply curve is the _ _ _ _ _ above _ _ _ _ _.

- How do you determine the market price in the long-run?
- How do you determine the number of firms in the long-run?
- When will the long-run market supply curve slope upwards?
- When will the long-run market supply curve slope upwards?