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Intermediate Microeconomics W3211

Lecture 17: Equilibrium with Firms

Columbia University, Spring 2016
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Introduction

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The Story So Far....

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- We have now thought a lot about what a single firm will do in a perfectly competitive market
- We know how to maximize profits
- In the short and long run

Today

4

- Think about what happens when firms are not on their own
- How many firms combine to make an industry
- What happens when firms and consumers interact
- This second point will take us back to the study of **equilibrium**
- Equilibrium will now come in two flavors
  - Partial Equilibrium
  - General Equilibrium

Industry Supply

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Supply From A Competitive Industry

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- So far we have thought about the behavior of a single firm
- But typically an industry will consist of many firms
- In fact, we pretty much assumed that when we started talking about perfect competition
- How are the supply decisions of the many individual firms in a competitive industry combined to discover the market supply curve for the entire industry?

Supply From A Competitive Industry

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- Since every firm in the industry is a price-taker, total quantity supplied at a given price is the sum of quantities supplied at that price by the individual firms.

Short-Run Supply

8

- In a short-run the number of firms in the industry is, temporarily, fixed.
- Let n be the number of firms; i = 1, … ,n.
- $S_i(p)$ is firm i's supply function.

Short-Run Supply

9

- In a short-run the number of firms in the industry is, temporarily, **fixed**
- Let n be the number of firms; i = 1, … ,n.
- $S_i(p)$ is firm i's supply function.
- The industry's short-run supply function is

$$S(p) = \sum_{i=1}^{n} S_i(p).$$

Supply From A Competitive Industry

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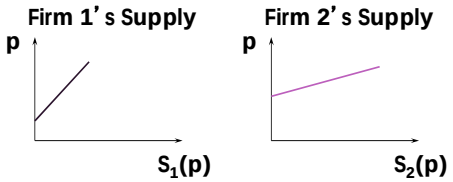

Supply From A Competitive Industry

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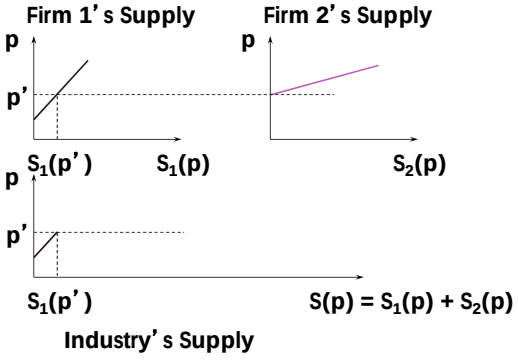

Supply From A Competitive Industry

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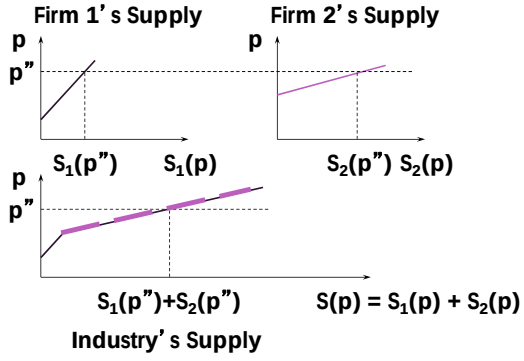

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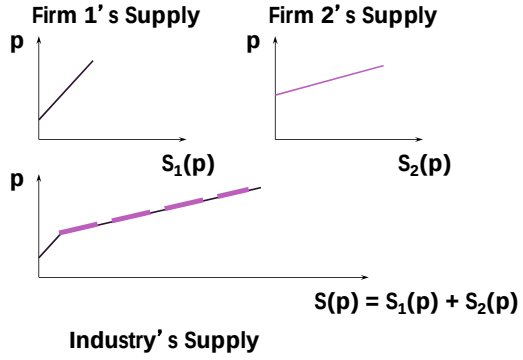
Supply From A Competitive Industry



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Short-Run Industry Equilibrium

- In a short-run, neither entry nor exit can occur.
- Consequently, in a short-run equilibrium, some firms may earn positive economics profits, others may suffer economic losses, and still others may earn zero economic profit.

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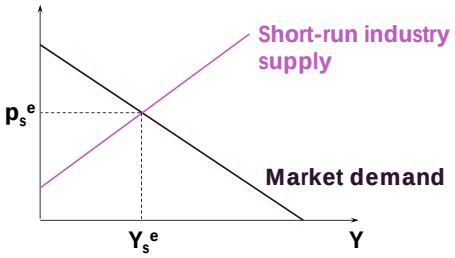
Short-Run Industry Equilibrium



Short-run equilibrium price clears the market and is taken as given by each firm. (We will talk more about this in a minute)

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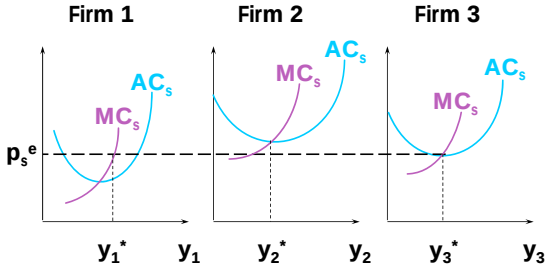
Short-Run Industry Equilibrium



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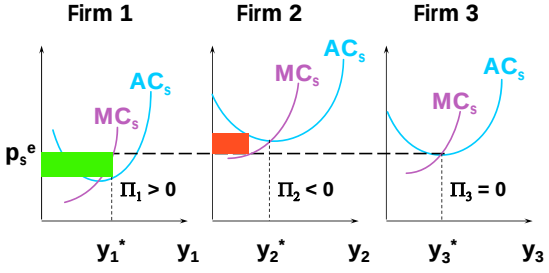
Short-Run Industry Equilibrium



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Long-Run Industry Supply

- In the long-run every firm now in the industry is **free to exit** and firms now outside the industry **are free to enter**
- (Notice: not true in all markets. There are cases in which firms are not free to enter. Examples?)
- The industry's long-run supply function must account for entry and exit as well as for the supply choices of firms that choose to be in the industry.
- How is this done?

Long-Run Industry Supply

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- Positive economic profit induces entry.
- Economic profit is positive when the market price p_s^e is higher than a firm's minimum av. total cost;
  p_s^e > min AC(y).
- Entry increases industry supply, causing p_s^e to fall.
- When does entry cease?
- For simplicity, let's assume that all firms have identical costs

Long-Run Industry Supply

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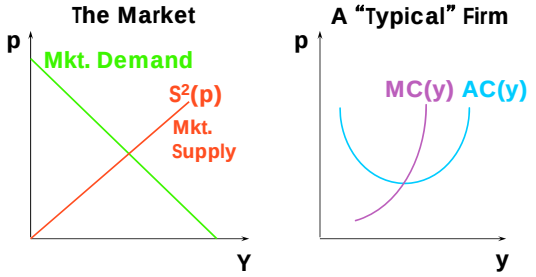

Suppose the industry initially contains only two firms.

Long-Run Industry Supply

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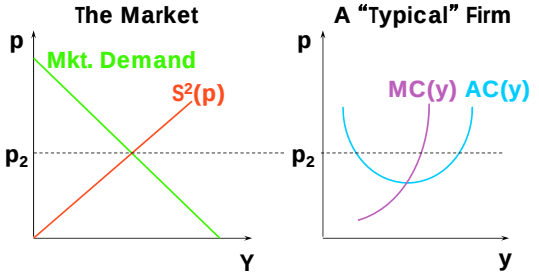

Then the market-clearing price is p_2.

Long-Run Industry Supply

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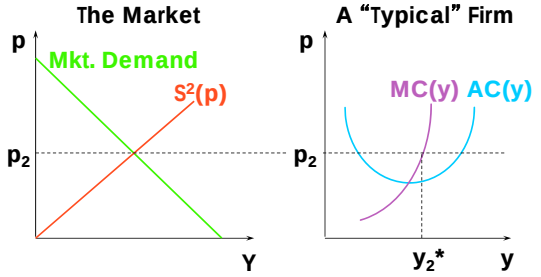

Then the market-clearing price is p_2.
Each firm produces y_2* units of output.

Long-Run Industry Supply

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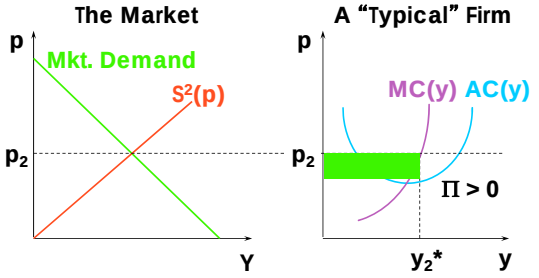

Each firm makes a positive economic profit, inducing entry by another firm.

Long-Run Industry Supply

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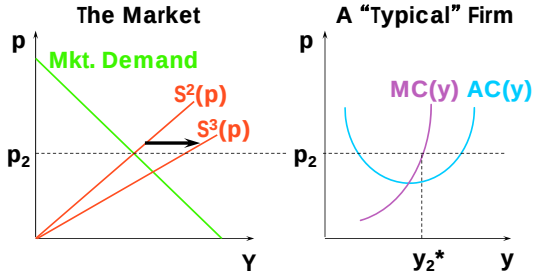

Market supply shifts outwards.

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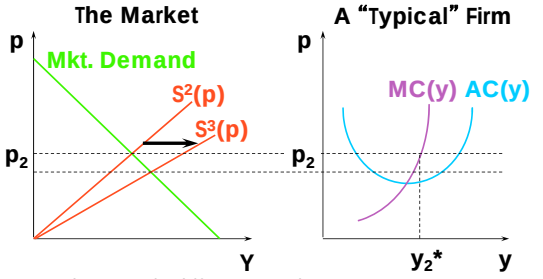
Long-Run Industry Supply



Market supply shifts outwards.
Market price falls.

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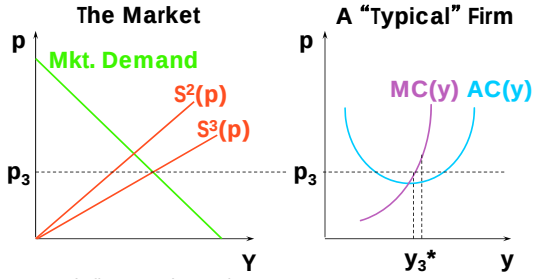
Long-Run Industry Supply



Each firm produces less.

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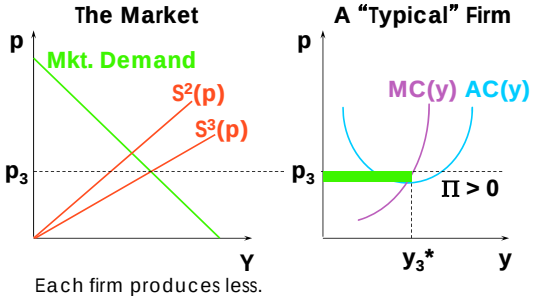
Long-Run Industry Supply



Each firm produces less.
Each firm's economic profit is reduced.

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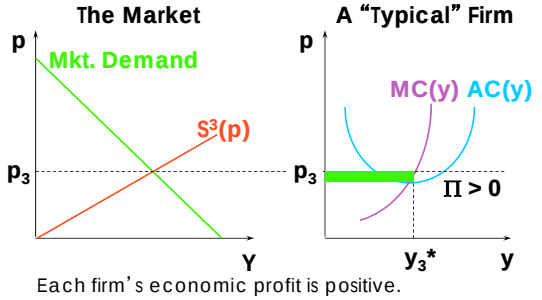
Long-Run Industry Supply



Each firm's economic profit is positive.
Will another firm enter?

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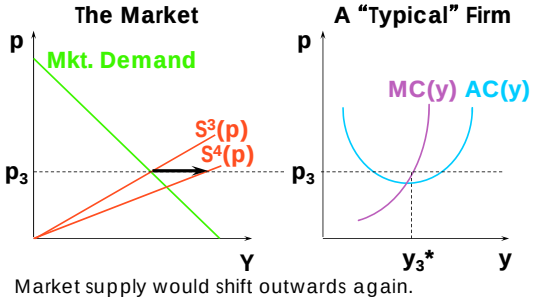
Long-Run Industry Supply



Market supply would shift outwards again.

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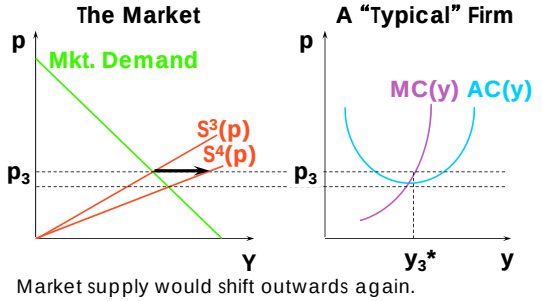
Long-Run Industry Supply



Market supply would shift outwards again.
Market price would fall again.

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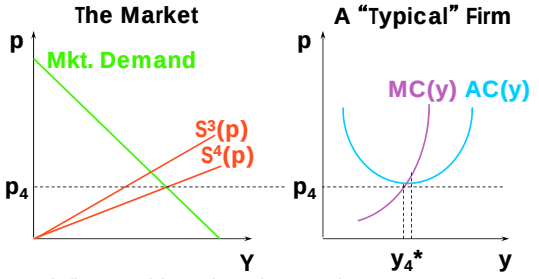
Long-Run Industry Supply



Each firm would produce less again.

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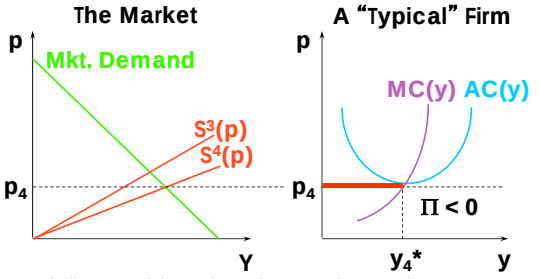
Long-Run Industry Supply



Each firm would produce less again. Each firm's economic profit would be negative.

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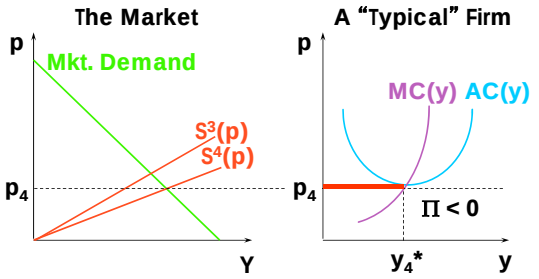
Long-Run Industry Supply



Each firm would produce less again. Each firm's economic profit would be negative. So the fourth firm would not enter.

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Long-Run Industry Supply

- The **long-run number of firms in the industry is the largest number for which the market price is at least as large as the minimum of the AC(y)**.
- Now we can construct the industry's long-run supply curve
- Remember, this measures how industry supply changes with price
  - For example because demand changes

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Long-Run Industry Supply

- Suppose that market demand is large enough to sustain only two firms in the industry.

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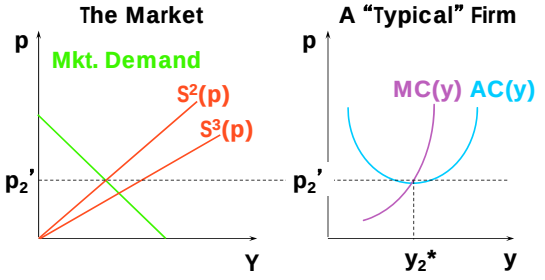
Long-Run Industry Supply



Long-Run Industry Supply

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- Suppose that market demand is large enough to sustain only two firms in the industry.
- Then if market demand increases, the market price rises, each firm produces more, and earns a higher economic profit.

Long-Run Industry Supply

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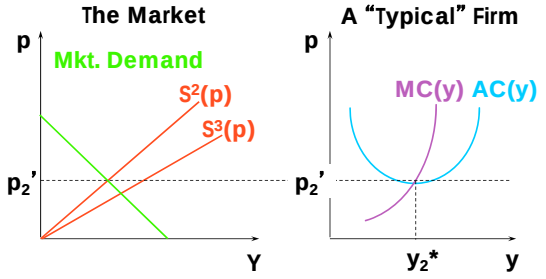

Long-Run Industry Supply

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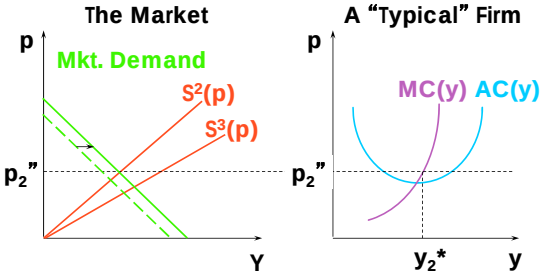

Long-Run Industry Supply

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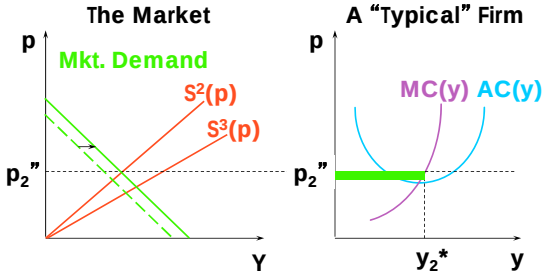

Long-Run Industry Supply

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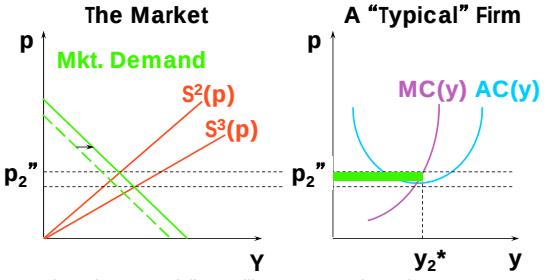

Notice that a 3rd firm will not enter since it would earn negative economic profits.

Long-Run Industry Supply

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- As market demand increases further, the market price rises further, the two incumbent firms each produce more and earn still higher economic profits -- until a 3rd firm becomes indifferent between entering and staying out.

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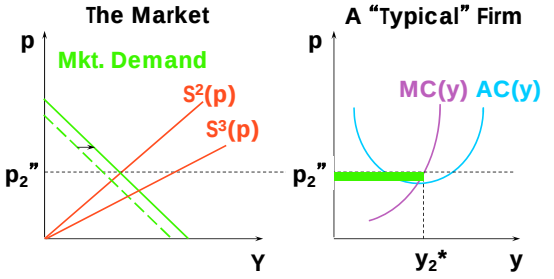
Long-Run Industry Supply



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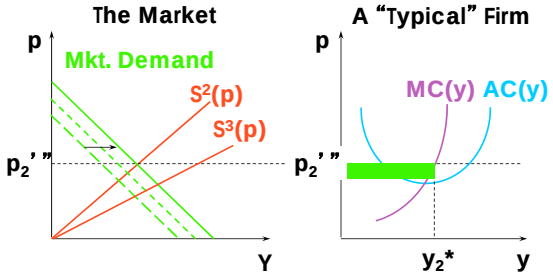
Long-Run Industry Supply



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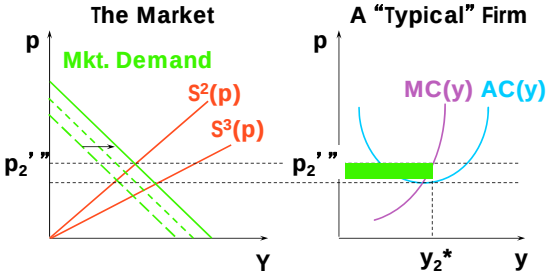
Long-Run Industry Supply



A third firm can now enter, causing all firms to earn zero economic profits.

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Long-Run Industry Supply

- So any further increase in market demand will cause the number of firms in the industry to rise to three.

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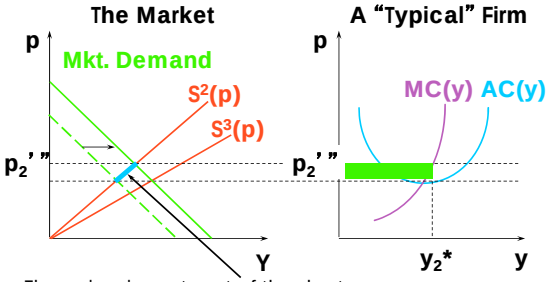
Long-Run Industry Supply



The only relevant part of the short-run supply curve for n = 2 firms in the industry.

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Long-Run Industry Supply

- How much further can market demand increase before a fourth firm enters the industry?

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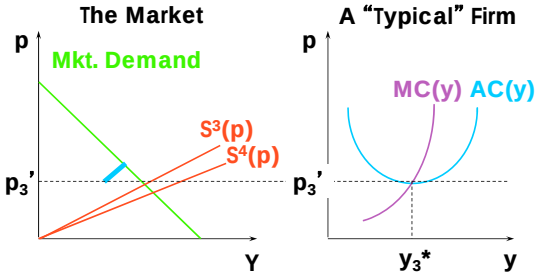
Long-Run Industry Supply



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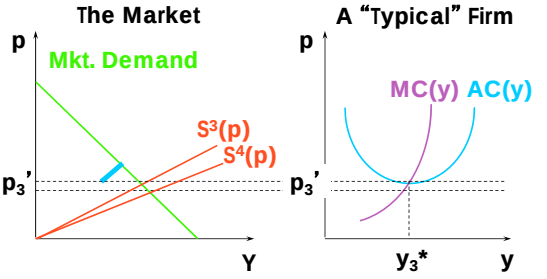
Long-Run Industry Supply



A 4th firm would now earn negative economic profits if it entered the industry.

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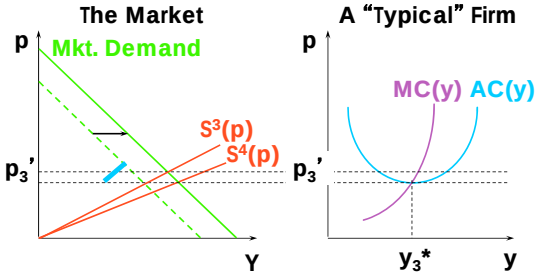
Long-Run Industry Supply



But now a 4th firm would earn zero economic profit if it entered the industry.

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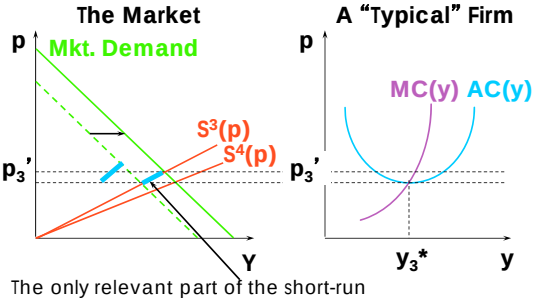
Long-Run Industry Supply



The only relevant part of the short-run supply curve for n = 3 firms in the industry.

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Long-Run Industry Supply

- Continuing in this manner builds the industry's long-run supply curve, one section at-a-time from successive short-run industry supply curves.

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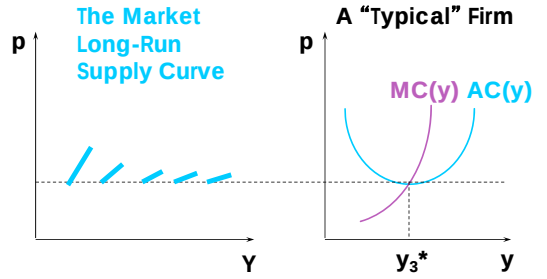
Long-Run Industry Supply



Long-Run Industry Supply

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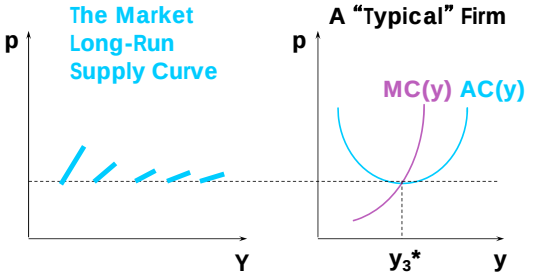

Notice that the bottom of each segment of the supply curve is min AC(y).

Long-Run Industry Supply

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- As each firm gets "smaller" relative to the industry, the long-run industry supply curve approaches a horizontal line at the height of min AC(y).

Long-Run Industry Supply

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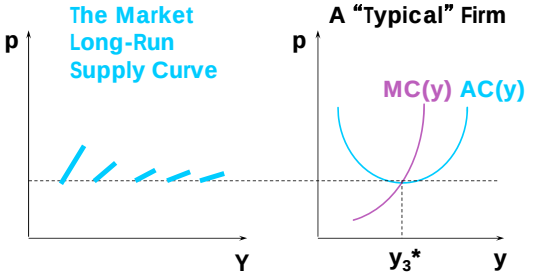

Notice that the bottom of each segment of the supply curve is min AC(y).

Long-Run Industry Supply

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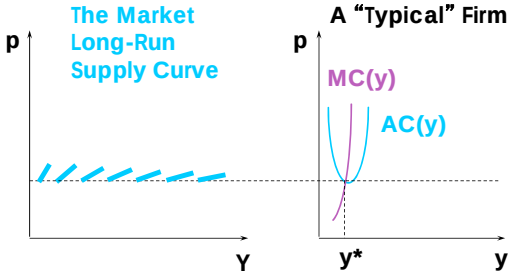

The bottom of each segment of the supply curve is min AC(y). As firms get "smaller" the segments get shorter.

Long-Run Industry Supply

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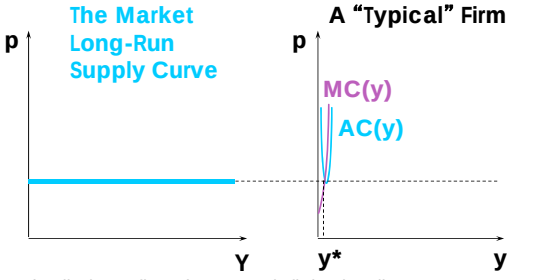

In the limit, as firms become infinitesimally small, the industry's long-run supply curve is horizontal at min AC(y).

Long-Run Market Equilibrium Price

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- If there are a large number of small firms, the long-run market equilibrium, **the market price is determined solely by the long-run minimum average production cost**.

Long-run market price is

$$p^e = \min_{y>0} AC(y).$$

Partial Equilibrium

Finding Equilibrium

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Market Equilibrium

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- We now have all the tools to understand what a firm will do given prices
- However, as with the case of consumers, we want to know where these prices come from
- What prices will emerge from the interaction of firms and consumers?
- This is again the study of equilibrium

Market Equilibrium

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- It turns out that we can answer this question in two different ways
  - Partial Equilibrium
  - General Equilibrium
- What is the difference between them?
- Partial equilibrium thinks about what happens **one market at a time**
  - Take a particular market (e.g. cantaloupes)
  - Figures out the price that creates an equilibrium in this market
- Is this the right thing to do?

Partial Equilibrium vs General Equilibrium

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- Arguably not
- Why?
- Because what happens in one market will affect what happens in other markets!
- As we saw from consumer theory, the price of cantaloupes will also affect demand for bananas (and vise versa)
- Also, as demand for cantaloupes changes, this will affect how many workers cantaloupe makers hire
  - Affects the income of these workers
  - Affects the demand for cantaloupes!
- In short, the economy is one massive connected system, and what happens in one part of it affects all the others, creating feedback
- This is one of the things that makes economics so bloody difficult!

Partial Equilibrium vs General Equilibrium

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- General equilibrium is the way of trying to sort out this mess
  - Solve for equilibrium in all markets at the same time
- This is, understandably, complicated.
- We will begin with partial equilibrium
  - This may give us a good approximation of what will happen if a particular market is 'small'
  - And is also a lot easier
- Then we will move on to general equilibrium

Partial Equilibrium

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- What is an equilibrium?
- Remember from consumer theory
  - An allocation (i.e. an amount that each person gets)
  - A set of prices
  - Such that
    - The allocation is feasible
    - The allocation is optimal for everyone given prices
- We showed that we could identify the correct prices by finding the point at which supply equals demand

Partial Equilibrium

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- We are going to do the same thing here
- Find the prices such that **supply** of firms equals **demand** of consumers
- Remember –
  - **Supply** is the profit maximizing output of firms at each price
  - **Demand** is the utility maximizing consumption of consumers at each price
- So the price at which demand equals supply will give rise to a feasible output, and at which everyone is optimizing

Market Equilibrium

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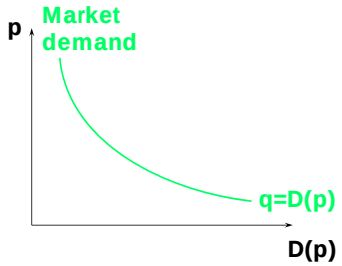

Market Equilibrium

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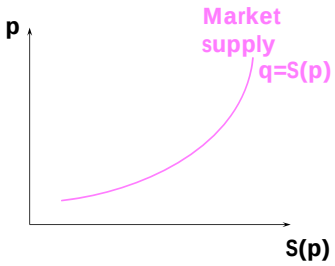

Market Equilibrium

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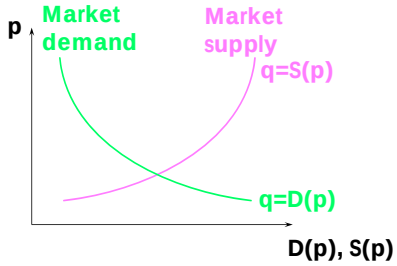
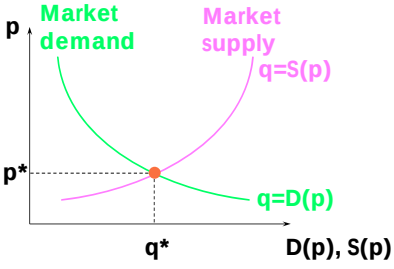


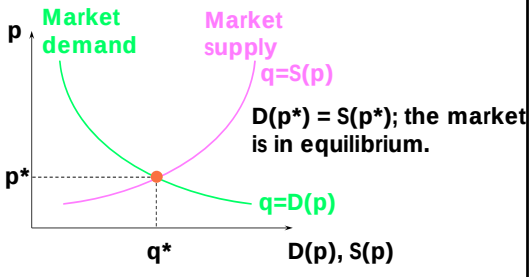
Market Equilibrium

71



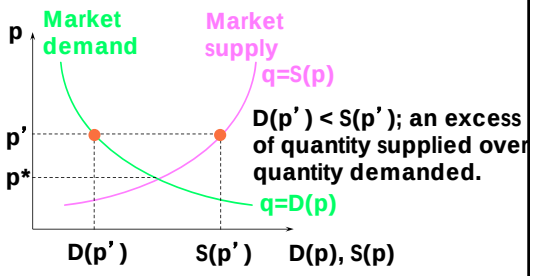
Market Equilibrium

72



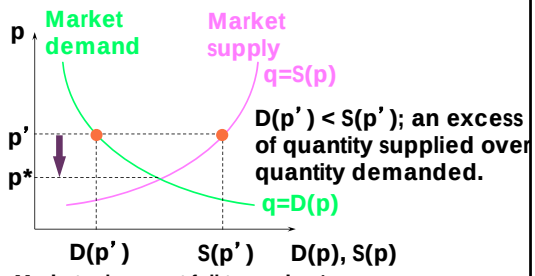
Market Equilibrium

73



Market Equilibrium

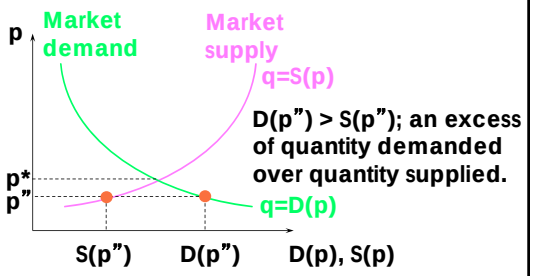
74



Market price must fall towards p*.

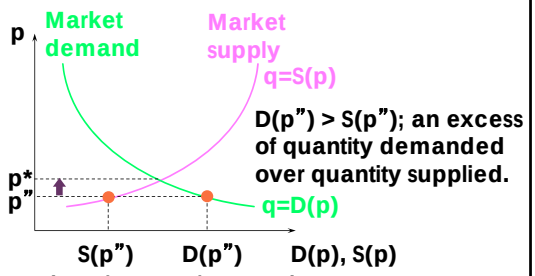
Market Equilibrium

75



Market Equilibrium

76



Market price must rise towards p*.

Market Equilibrium

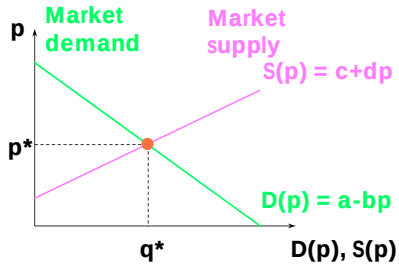
77

- An example of calculating a market equilibrium when the market demand and supply curves are linear.

$$D(p) = a - bp$$
$$S(p) = c + dp$$

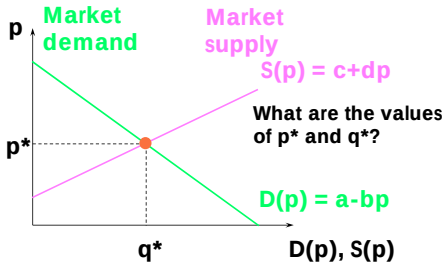
Market Equilibrium

78



79

Market Equilibrium



80

Market Equilibrium

$$D(p) = a - bp$$
$$S(p) = c + dp$$

At the equilibrium price p*, D(p*) = S(p*).

81

Market Equilibrium

$$D(p) = a - bp$$
$$S(p) = c + dp$$

At the equilibrium price p*, D(p*) = S(p*).
That is,

$$a - bp^* = c + dp^*$$

82

Market Equilibrium

$$D(p) = a - bp$$
$$S(p) = c + dp$$

At the equilibrium price p*, D(p*) = S(p*).
That is,

$$a - bp^* = c + dp^*$$

which gives

$$p^* = \frac{a - c}{b + d}$$

83

Market Equilibrium

$$D(p) = a - bp$$
$$S(p) = c + dp$$

At the equilibrium price p*, D(p*) = S(p*).
That is,

$$a - bp^* = c + dp^*$$

which gives

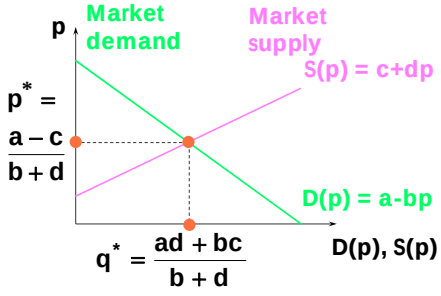
$$p^* = \frac{a - c}{b + d}$$

and

$$q^* = D(p^*) = S(p^*) = \frac{ad + bc}{b + d}.$$

84

Market Equilibrium



Market Equilibrium

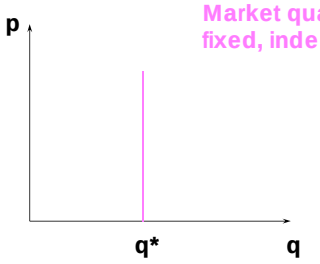
85

- Two special cases:
  - quantity supplied is fixed, independent of the market price, and
  - quantity supplied is extremely sensitive to the market price.

Market Equilibrium

86

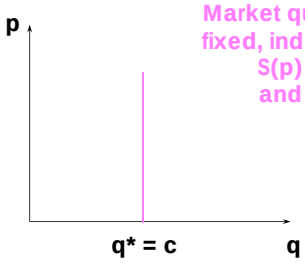
Market quantity supplied is fixed, independent of price.



Market Equilibrium

87

Market quantity supplied is fixed, independent of price.
S(p) = c+dp, so d=0 and S(p) ≡ c.

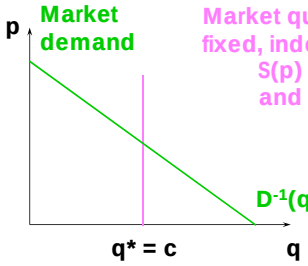


Market Equilibrium

88

Market quantity supplied is fixed, independent of price.
S(p) = c+dp, so d=0 and S(p) ≡ c.

$D^{-1}(q) = (a-q)/b$

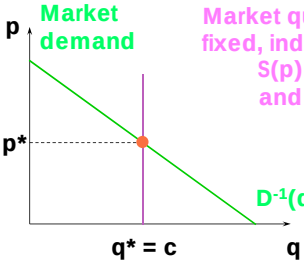


Market Equilibrium

89

Market quantity supplied is fixed, independent of price.
S(p) = c+dp, so d=0 and S(p) ≡ c.

$D^{-1}(q) = (a-q)/b$



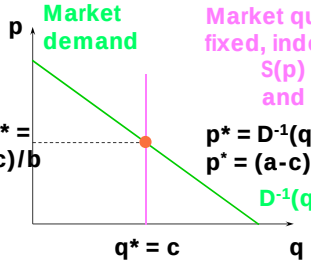
Market Equilibrium

90

Market quantity supplied is fixed, independent of price.
S(p) = c+dp, so d=0 and S(p) ≡ c.

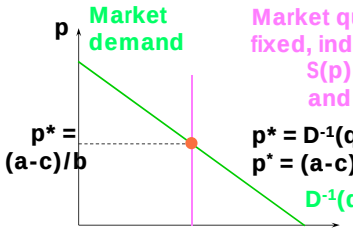
$p^* = D^{-1}(q^*)$; that is, $p^* = (a-c)/b$.

$D^{-1}(q) = (a-q)/b$



Market Equilibrium

91



Market quantity supplied is fixed, independent of price.
S(p) = c+dp, so d=0 and S(p) ≡ c.

p* = D^{-1}(q*); that is, p* = (a-c)/b.

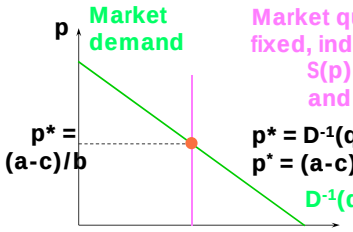
D^{-1}(q) = (a-q)/b

$$p^* = \frac{a-c}{b+d}$$

$$q^* = \frac{ad+bc}{b+d}$$

Market Equilibrium

92



Market quantity supplied is fixed, independent of price.
S(p) = c+dp, so d=0 and S(p) ≡ c.

p* = D^{-1}(q*); that is, p* = (a-c)/b.

D^{-1}(q) = (a-q)/b

$$p^* = \frac{a-c}{b+d}$$

$$q^* = \frac{ad+bc}{b+d}$$

with d = 0 give

$$p^* = \frac{a-c}{b}$$

$$q^* = c.$$

Market Equilibrium

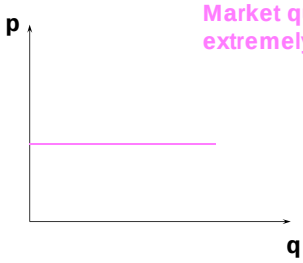
93

- Two special cases are
  - when quantity supplied is fixed, independent of the market price, and
  - when quantity supplied is extremely sensitive to the market price.

Market Equilibrium

94

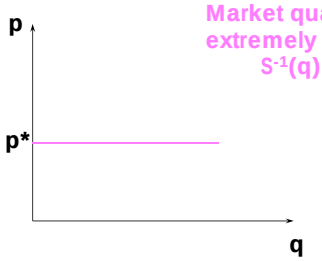
Market quantity supplied is extremely sensitive to price.



Market Equilibrium

95

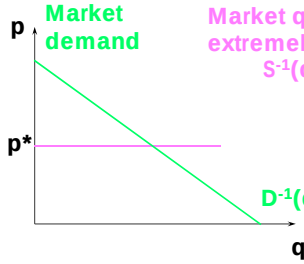
Market quantity supplied is extremely sensitive to price.
S^{-1}(q) = p*.



Market Equilibrium

96

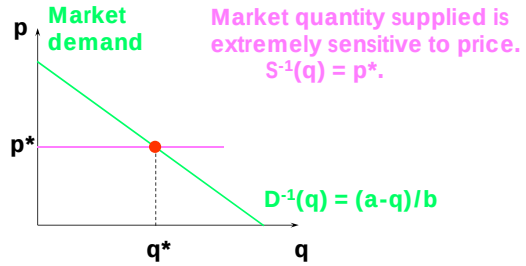
Market quantity supplied is extremely sensitive to price.
S^{-1}(q) = p*.



D^{-1}(q) = (a-q)/b

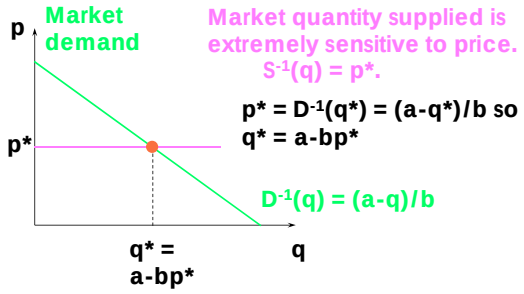
Market Equilibrium

97



Market Equilibrium

98



Market Equilibrium

99

- Two special cases are
  - when quantity supplied is fixed, independent of the market price, and
  - when quantity supplied is extremely sensitive to the market price.
- Question: can you think of examples for each of these special cases?

Partial Equilibrium

Policy Analysis

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Policy Analysis

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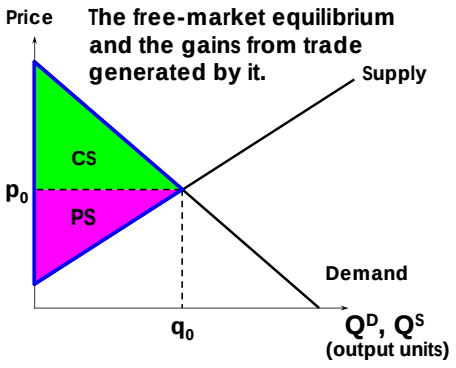
- As we discussed last lecture, we can use supply and demand graphs to do policy analysis
- Using the concept of consumer and producer surplus

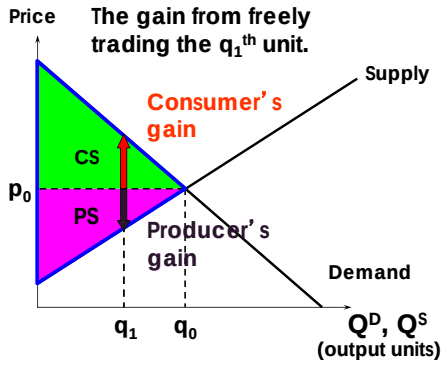
Benefit-Cost Analysis

102



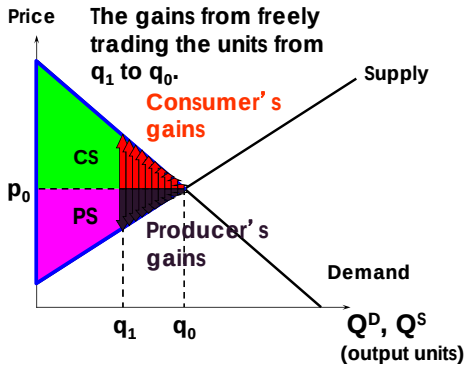
Benefit-Cost Analysis

103



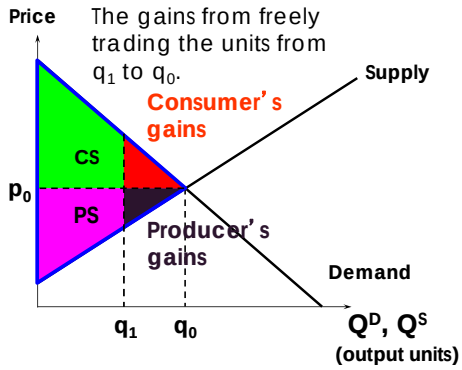
Benefit-Cost Analysis

104



Benefit-Cost Analysis

105



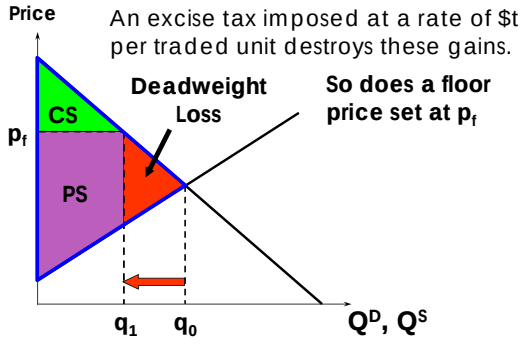
Policy Analysis

106

- Policies that prevent trade up to this point will destroy these gains from trade
- For example, consider a price floor, so that prices cannot go below p_f
  - Consumers choose how much to buy at this price
  - Firms supply that amount

Benefit-Cost Analysis

107



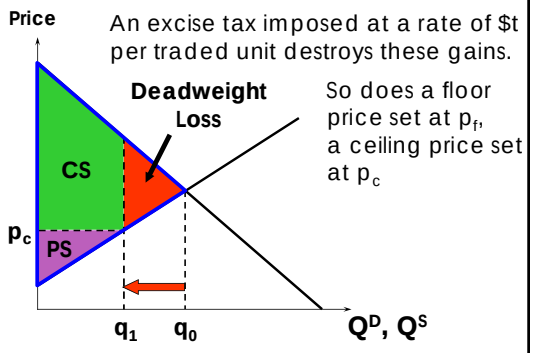
Policy Analysis

108

- Policies that prevent trade up to this point will destroy these gains from trade
- For example, consider a price floor, so that prices cannot go below p_f
  - Consumers choose how much to buy at this price
  - Firms supply that amount
- For example, consider a price ceiling, so that prices cannot go above p_c
  - Firms decide how much to supply at this price
  - Consumers can only buy that amount

Benefit-Cost Analysis

109



Policy Analysis

110

- This is (again) basically the argument behind most free market economics
- Moving the market away from its equilibrium destroys the gains from trade
  - In the price floor case, there are firms that want to supply at a lower price, consumers that want to buy at a lower price, but they are not allowed
  - In the price ceiling case there are consumers that want to buy at a higher price, firms that want to supply at a higher price, but they are not allowed
- Both situations lead to rationing
  - In the first case, there are more firms that want to supply than buyers who want to buy at the price
  - In the second case there are more consumers who want to buy than firms that want to supply at that price

Policy Analysis

111

- As with everything else in this course, this lesson should be taken **with caution**
- What is it that the model is missing out?

1. Everybody is a **price taker** – as we will see in the next lecture, if one side gets to choose the price, things can get nasty
2. No **externalities**
3. Ignoring general equilibrium effects
4. Ignores the fact (as you will see in the homework) that increasing trade can create winners and losers

Summary

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Summary

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- Today we have dealt with

1. Industry supply
2. Partial Equilibrium