1

Intermediate Microeconomics W3211

Lecture 16: Perfect Competition 6 Supply

Columbia University, Spring 2016
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Introduction

2

3

The Story So Far….

- We have now modeled the perfectly competitive firm in some detail

- Set up and solved the firm's problem

- Talked about the difference between the short run and the long run
  - Short run: some inputs are fixed
  - Long run: all inputs are variable

- Drawn the various cost functions associated with a firm

4

Today

- Think about **firm supply**: how much an individual firm will supply at different prices

- Define the concept of **producer surplus and consumer surplus**

Firm Supply Decisions in the Short and the Long Run

5

6

Firm Supply

- Previously we calculated the firm' supply function
  - i.e. how much they will supply based on prices of inputs and outputs
  - For example, for Cobb Douglas technology, we decided that
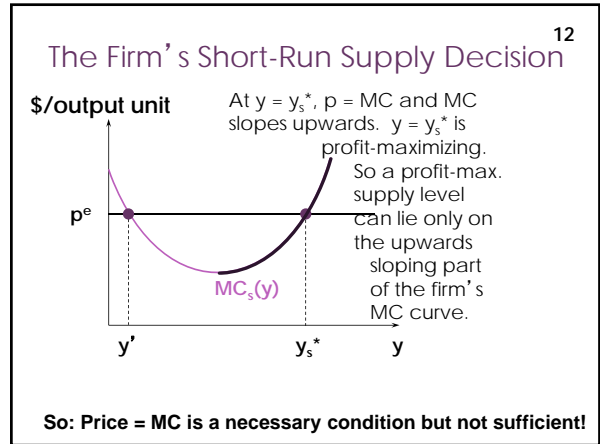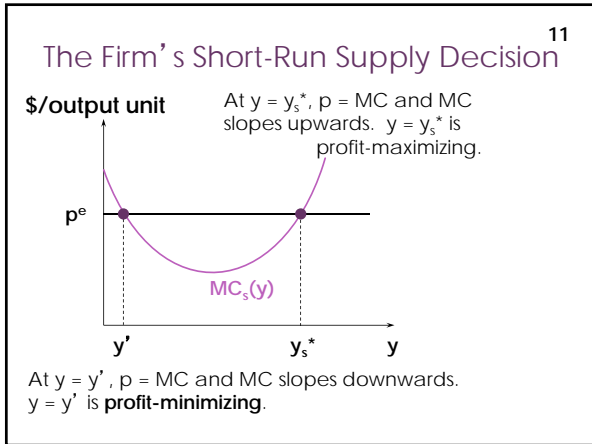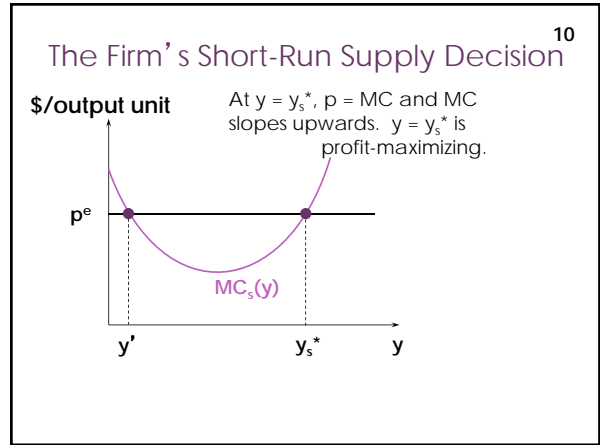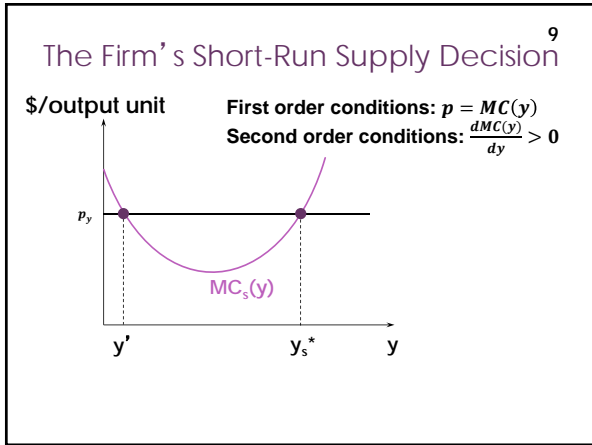
$$y = \left[\frac{p_y(a_1 + a_2)}{p_1^{\frac{a_1}{a_1+a_2}} p_2^{\frac{a_2}{a_1+a_2}} A} \right]^{\frac{a_1+a_2}{1-a_1-a_2}}$$

- Now we are going to think a little harder about the firm's supply decisions in the short and the long run.

The Firm's Short-Run Supply Decision

- In the short run, the firm's profits are given by
$$p_y y - c_s(y) = p_y y - c_v(y) - F$$

- As we discussed before, the first order conditions tell us to pick output to set price equal to the short run marginal cost
$$p_y = MC_s(y)$$

- However, we know that this is neither a necessary, nor a sufficient condition

- For example, what about a production function with increasing, then decreasing returns to scale?

A Non-Concave Production Function

The Firm's Short-Run Supply Decision

$/output unit

First order conditions: $p = MC(y)$
Second order conditions: $\frac{dMC(y)}{dy} > 0$

The Firm's Short-Run Supply Decision

$/output unit

At $y = y_s^*$, p = MC and MC slopes upwards. $y = y_s^*$ is profit-maximizing.

The Firm's Short-Run Supply Decision

$/output unit

At $y = y_s^*$, p = MC and MC slopes upwards. $y = y_s^*$ is profit-maximizing.

At $y = y'$, p = MC and MC slopes downwards. $y = y'$ is **profit-minimizing**.

The Firm's Short-Run Supply Decision

$/output unit

At $y = y_s^*$, p = MC and MC slopes upwards. $y = y_s^*$ is profit-maximizing. So a profit-max. supply level can lie only on the upwards sloping part of the firm's MC curve.

So: Price = MC is a necessary condition but not sufficient!

The Firm's Short-Run Supply Decision

- But not every point on the upward-sloping part of the firm's MC curve represents a profit-maximum.
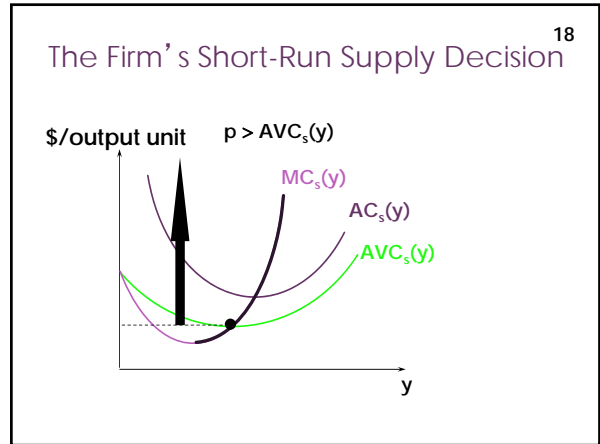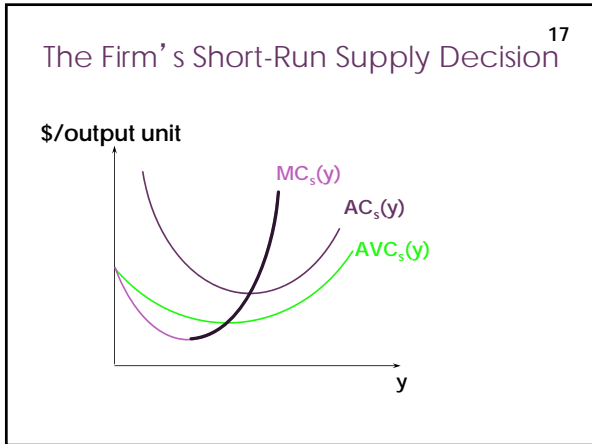
The Firm's Short-Run Supply Decision

- But not every point on the upward-sloping part of the firm's MC curve represents a profit-maximum.
- The firm's profit function is

$$\Pi_S(y) = py - c_S(y) = py - F - c_v(y).$$
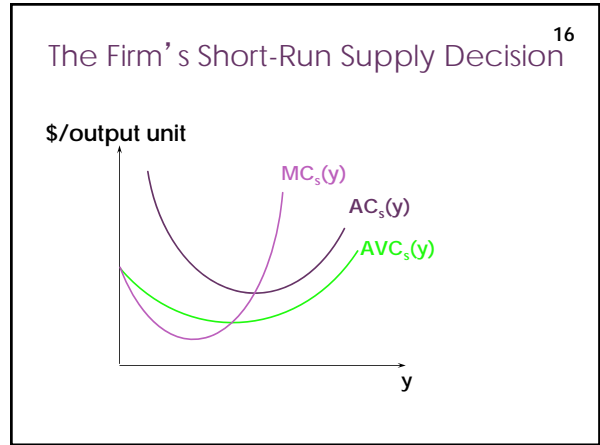
- If the firm chooses y = 0 then its profit is

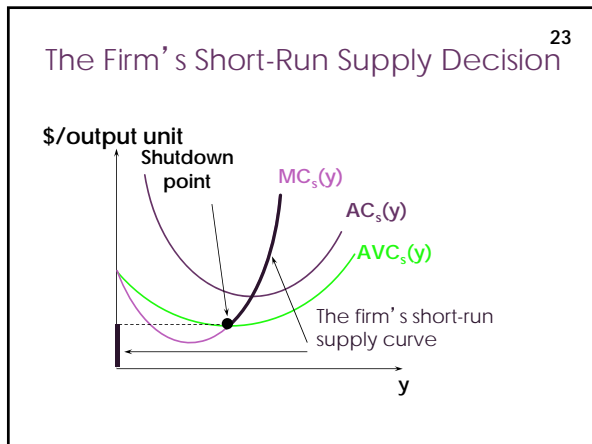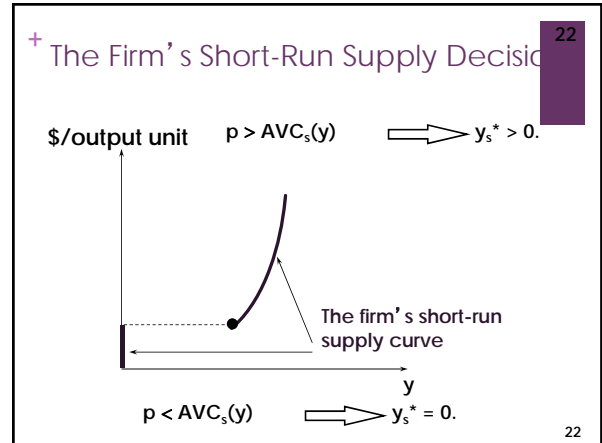$$\Pi_S(y) = 0 - F - c_v(0) = -F.$$
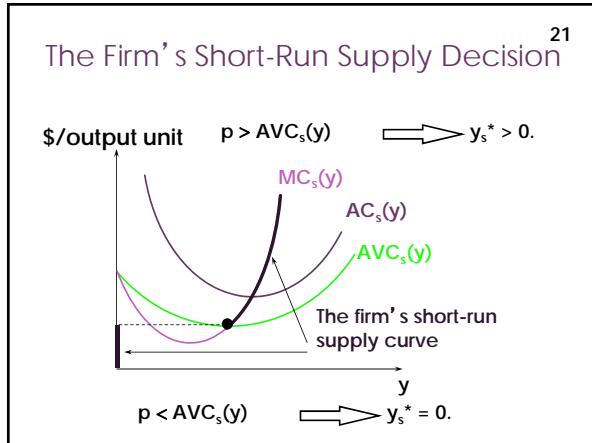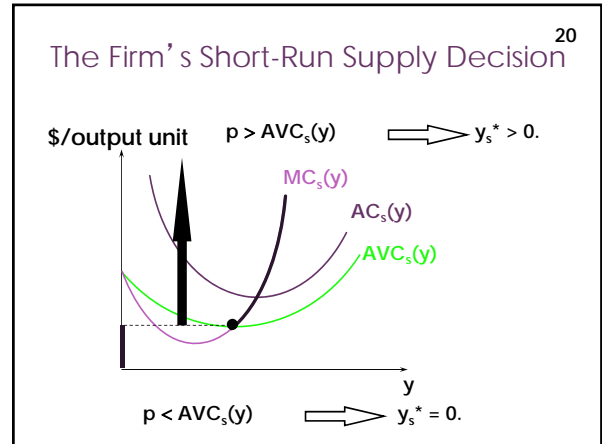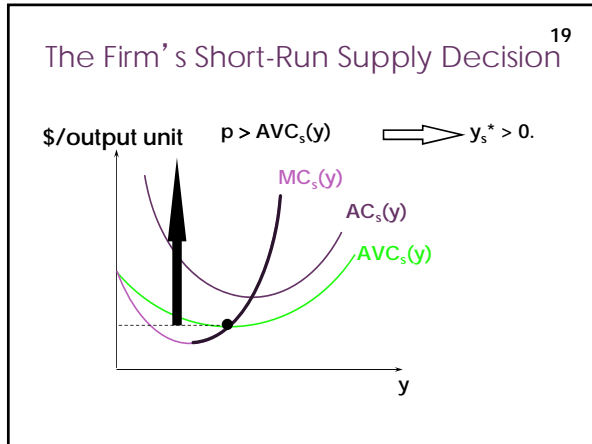
The Firm's Short-Run Supply Decision

- So the firm will choose an output level y > 0 only if

$$\Pi_S(y) = py - F - c_v(y) \geq -F.$$

- I.e., only if $py - c_v(y) \geq 0$

Equivalently, only if

$$p \geq \frac{c_v(y)}{y} = AVC_S(y).$$

The Firm's Short-Run Supply Decision

The Firm's Short-Run Supply Decision

The Firm's Short-Run Supply Decision

Slide 19

The Firm's Short-Run Supply Decision [19]

$/output unit

$p > AVC_s(y)$ ⟹ $y_s^* > 0$.

$MC_s(y)$
$AC_s(y)$
$AVC_s(y)$

y

Slide 20

The Firm's Short-Run Supply Decision [20]

$/output unit

$p > AVC_s(y)$ ⟹ $y_s^* > 0$.

$MC_s(y)$
$AC_s(y)$
$AVC_s(y)$

y

$p < AVC_s(y)$ ⟹ $y_s^* = 0$.

Slide 21

The Firm's Short-Run Supply Decision [21]

$/output unit

$p > AVC_s(y)$ ⟹ $y_s^* > 0$.

$MC_s(y)$
$AC_s(y)$
$AVC_s(y)$

The firm's short-run
supply curve

y

$p < AVC_s(y)$ ⟹ $y_s^* = 0$.

Slide 22

+ **The Firm's Short-Run Supply Decision** [22]

$/output unit

$p > AVC_s(y)$ ⟹ $y_s^* > 0$.

The firm's short-run
supply curve

y

$p < AVC_s(y)$ ⟹ $y_s^* = 0$.

22

Slide 23

The Firm's Short-Run Supply Decision [23]

$/output unit

Shutdown point

$MC_s(y)$
$AC_s(y)$
$AVC_s(y)$

The firm's short-run
supply curve

y

Slide 24

The Firm's Short-Run Supply Decision [24]

- Shut-down is not the same as exit.
- Shutting-down means producing no output, but the firm is still in the industry and suffers its **fixed cost**.
- Exiting means leaving the industry and not paying even the fixed cost, **which the firm can do only in the long-run**.
- So note: we now have two differences between the short and long run
1. In the long run, all inputs can be varied
2. In the long run firms can leave (and enter) the industry

4

The Firm's Long-Run Supply Decision [25]

- The long-run is the circumstance in which the firm can choose amongst all of its short-run circumstances.

- How does the firm's long-run supply decision compare to its short-run supply decisions?

The Firm's Long-Run Supply Decision [26]

- A competitive firm's long-run profit function is

$$\Pi(y) = py - c(y).$$

- The long-run cost c(y) of producing y units of output consists only of variable costs since all inputs are variable in the long-run.

The Firm's Long-Run Supply Decision [27]

- The firm's long-run supply level decision is to

$$\max_{y \geq 0} \Pi(y) = py - c(y).$$

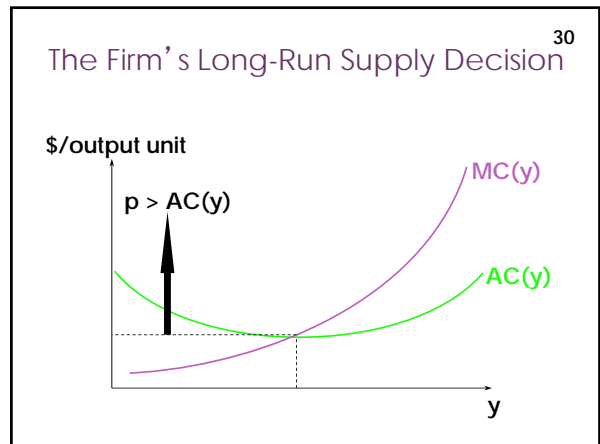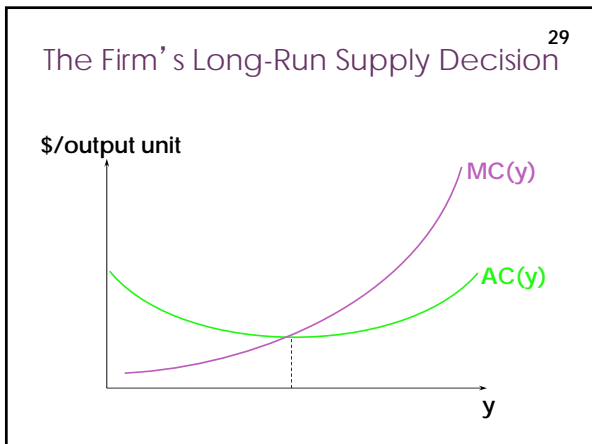- The 1st and 2nd-order maximization conditions are, for y* > 0,

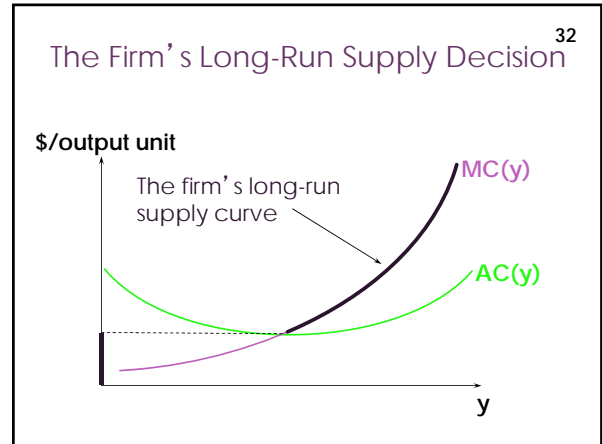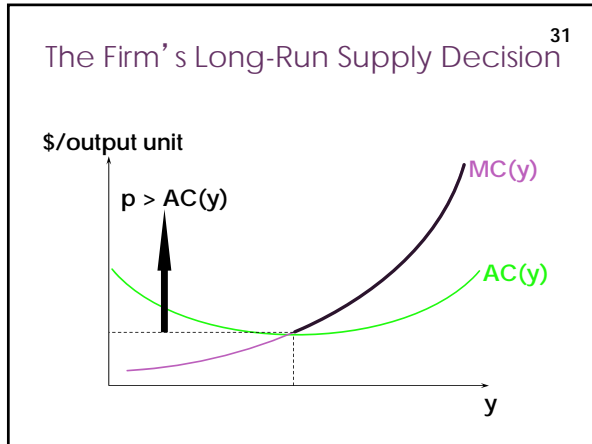$$p = MC(y) \text{ and}$$
$$\frac{dMC(y)}{dy} > 0.$$

The Firm's Long-Run Supply Decision [28]

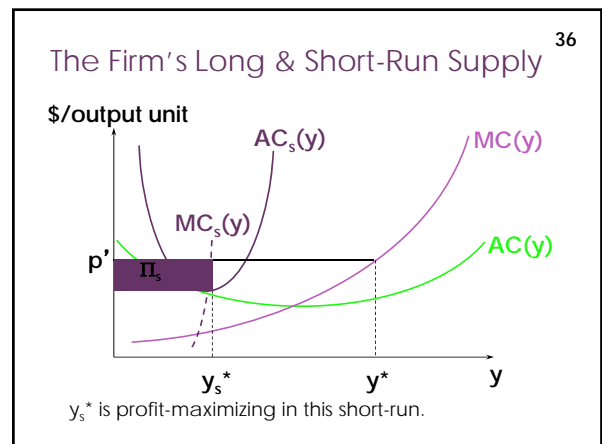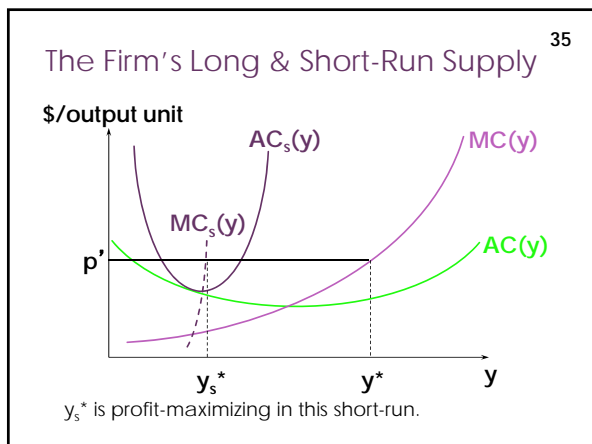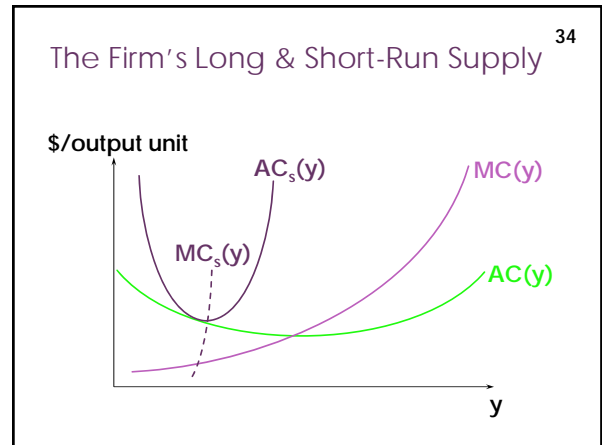- Additionally, the firm's economic profit level must not be negative since then the firm would exit the industry. So,
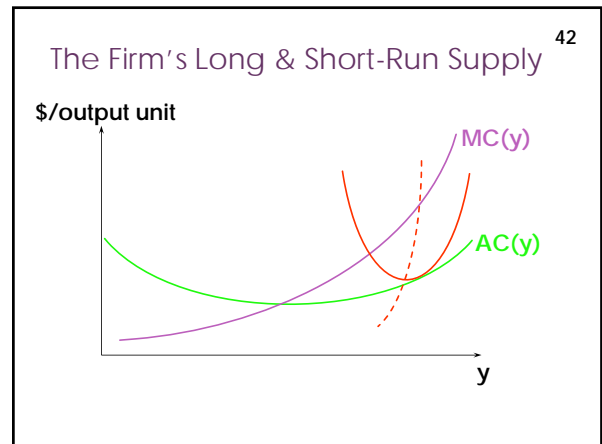
$$\Pi(y) = py - c(y) \geq 0$$
$$\Rightarrow \quad p \geq \frac{c(y)}{y} = AC(y).$$

The Firm's Long-Run Supply Decision [29]

$/output unit

MC(y)

AC(y)

y

The Firm's Long-Run Supply Decision [30]

$/output unit

p > AC(y)

MC(y)

AC(y)

y

The Firm's Long-Run Supply Decision
31

$/output unit

$p > AC(y)$

MC(y)

AC(y)

y

The Firm's Long-Run Supply Decision
32

$/output unit

The firm's long-run supply curve

MC(y)

AC(y)

y

The Firm's Long-Run Supply Decision
33

- How is the firm's long-run supply curve related to all of its short-run supply curves?

The Firm's Long & Short-Run Supply
34

$/output unit

$AC_s(y)$

MC(y)

$MC_s(y)$

AC(y)

y

The Firm's Long & Short-Run Supply
35

$/output unit

$AC_s(y)$

MC(y)

$MC_s(y)$

AC(y)

p'

y_s^* y^* y

y_s^* is profit-maximizing in this short-run.

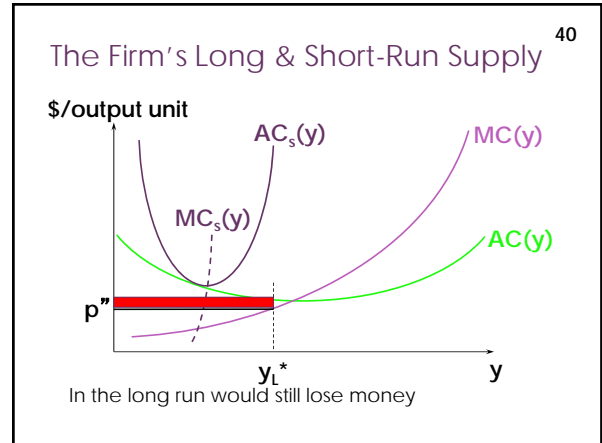## The Firm's Long & Short-Run Supply
36

$/output unit

$AC_s(y)$

MC(y)

$MC_s(y)$

AC(y)

p' Π_s

y_s^* y^* y

y_s^* is profit-maximizing in this short-run.

The Firm's Long & Short-Run Supply [37]

$/output unit

$AC_s(y)$ $MC(y)$

$MC_s(y)$

$AC(y)$

p' Π_s Π

y_s^* y^* y

The firm can increase profit by increasing x_2 and producing y^* output units.

The Firm's Long & Short-Run Supply [38]

$/output unit

$AC_s(y)$ $MC(y)$

$MC_s(y)$

$AC(y)$

p''

y_s^* y

y_s^* is loss-minimizing in this short-run.

The Firm's Long & Short-Run Supply [39]

$/output unit

$AC_s(y)$ $MC(y)$

$MC_s(y)$

$AC(y)$

p'' Loss

y_s^* y

y_s^* is loss-minimizing in this short-run.

The Firm's Long & Short-Run Supply [40]

$/output unit

$AC_s(y)$ $MC(y)$

$MC_s(y)$

$AC(y)$

p''

y_L^* y

In the long run would still lose money

The Firm's Long & Short-Run Supply [41]

$/output unit

$AC_s(y)$ $MC(y)$

$MC_s(y)$

$AC(y)$

p''

y_L^* y

Will therefore exit the industry in the long run

The Firm's Long & Short-Run Supply [42]

$/output unit

$MC(y)$

$AC(y)$

y

The Firm's Long & Short-Run Supply 43

$/output unit

MC(y)

AC(y)

p'

y_s^* y

y_s^* is profit-maximizing in this short-run.

The Firm's Long & Short-Run Supply 44

$/output unit

MC(y)

AC(y)

p'

y_s^* y

Firm will lose money in the short run

The Firm's Long & Short-Run Supply 45

$/output unit

MC(y)

AC(y)

p'

y_L^* y

Firm will make money in the long run
Will stay in the market

The Firm's Long & Short-Run Supply 46

$/output unit

MC(y)

AC(y)

y

The Firm's Long & Short-Run Supply 47

$/output unit

MC(y)

AC(y)

y

The Firm's Long & Short-Run Supply 48

$/output unit

MC(y)

AC(y)

y

The Firm's Long & Short-Run Supply
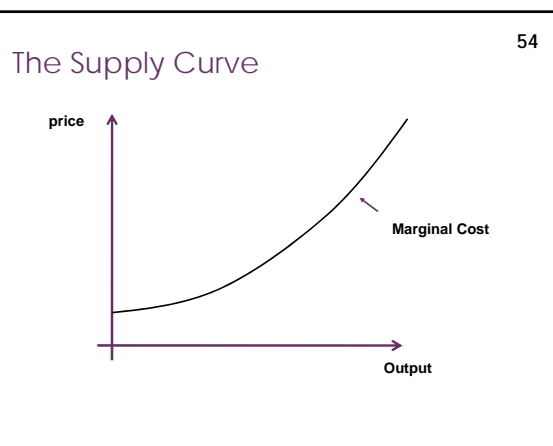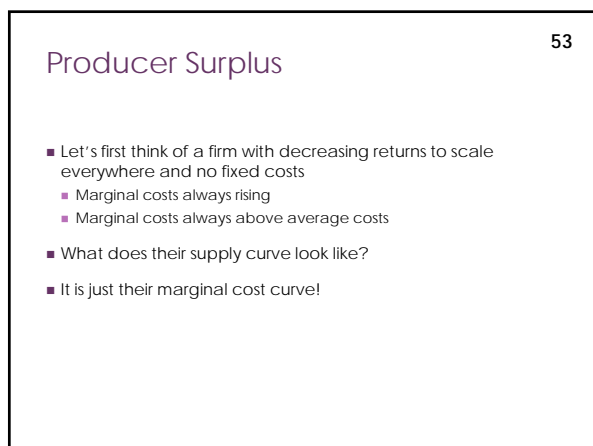
$/output unit

49

So..

- In the **long run**, quantity supplied by a firm in a competitive market is the part of **the long run marginal cost** curve **above** the **long run average cost**
- For prices below that point, the firm exits the marked
- In the **short run**, quantity supplied by a firm in a competitive market is the part of **the short run marginal cost** curve **above** the **short run average VARIABLE cost**
- For prices below that point, the firm produces zero, but still has to pay the fixed costs (it cannot exit)

50

Producer and Consumer Surplus

51
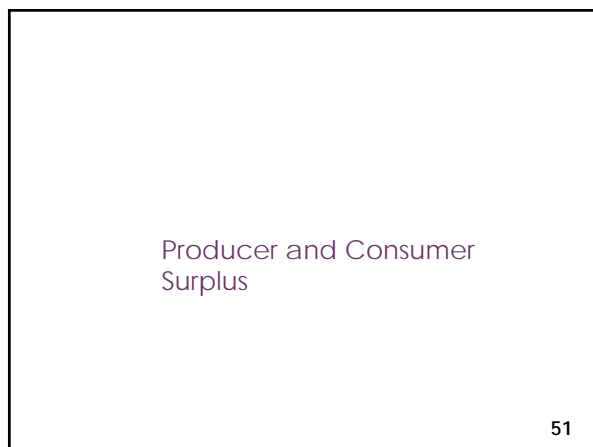
Producer and Consumer Surplus

- We are now in a position where we can draw supply curves for producers
- And demand curves for consumers
- From next lecture, we will work with these graphs to figure out the effect of certain types of policies
- When doing so, it will be useful to read these graphs to understand the benefit that both sides get from trading
  - i.e. how much better off they would have been if no trade had taken place
- For the firm this is the **producer surplus**
- For the consumer, this is the **consumer surplus**

52

Producer Surplus

- Let's first think of a firm with decreasing returns to scale everywhere and no fixed costs
  - Marginal costs always rising
  - Marginal costs always above average costs
- What does their supply curve look like?
- It is just their marginal cost curve!

53

The Supply Curve

54

The Supply Curve

55

price

Marginal Cost

Output

This is the amount that will be supplied at any price

+ Producer Surplus

56

- Also, if they sell an amount y, how much better off does this make them than if they sold nothing?
- It is just the profit they get from selling y
- How can I see this from the graph?

The Supply Curve

57

price

Marginal Cost

P^*

y^*

Output

At price P^* firm will supply y^*

The Supply Curve

58

price

Marginal Cost

P^*

B

A

y^*

Output

Where is profit on this graph?

The Supply Curve

59

price

Revenue

P^*

B

A

y^*

Output

Revenue is just A+B: P^* times y^*

The Supply Curve

60

price

Marginal Cost

P^*

B

A

y^*

Output

What about costs?

The Supply Curve

price

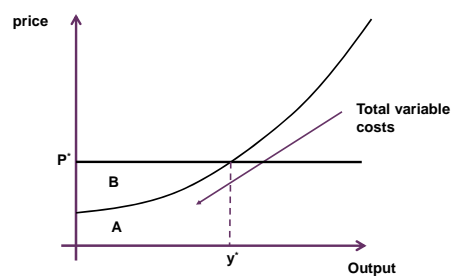Total variable costs

P*

B

A

y*

Output
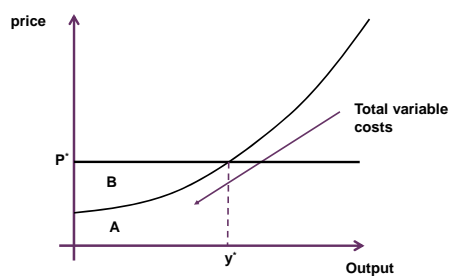
Remember, from last lecture, area under the marginal cost line is equal to total variable costs (i.e. A)
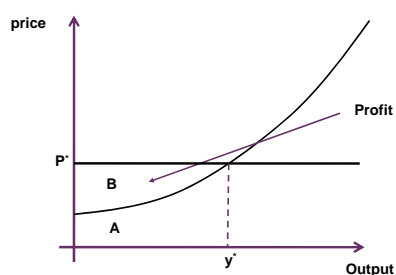
The Supply Curve

price

Total variable costs

P*

B

A

y*

Output

Here, variable costs are the same as total costs

The Supply Curve

price

Profit

P*

B

A

y*

Output

Profit is area B: the area above the supply curve below the price

Producer Surplus

- For this firm we have

  Profit equals producer surplus

  Producer surplus is the area above the supply curve

- What about if we added fixed costs?

- What is the producer surplus?

- Remember producer surplus is **how much better the firm is than if no trade had taken place**
 - Is producer surplus still equal to profit?

Producer Surplus

- If the firm sells nothing then their 'profit' is –F

- If they sell an amount y it is $py - c_v(y) - F$

- So producer surplus is $py - c_v(y)$
  - Price minus variable costs

- So producer surplus is **not** the same thing as profit

- However, it turns out producer surplus **is** always the area above the firm's supply curve and below the price

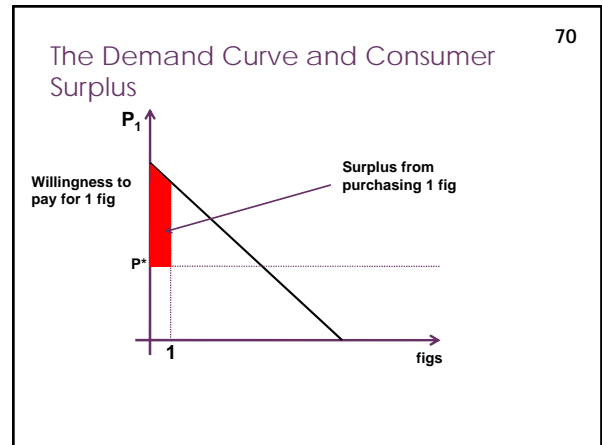- You will see why this is in the homework!
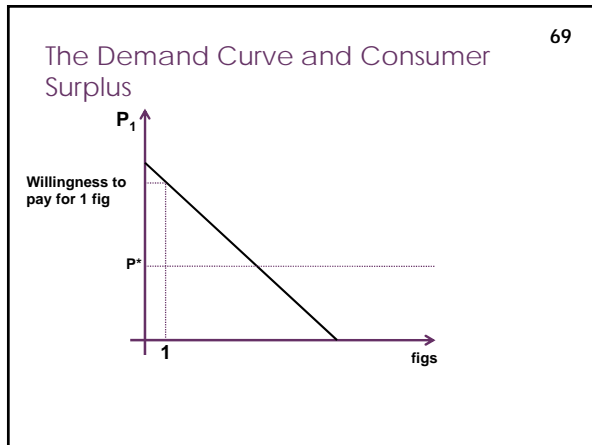
Consumer Surplus

- What about consumer surplus?

- We have shown that producer surplus is the area above the supply curve below the price

- It would be nice if we could say that the consumer surplus were the area under the demand curve above the price

Total Surplus

67

price

Consumer Surplus

P*

Producer Surplus

y*

Amount
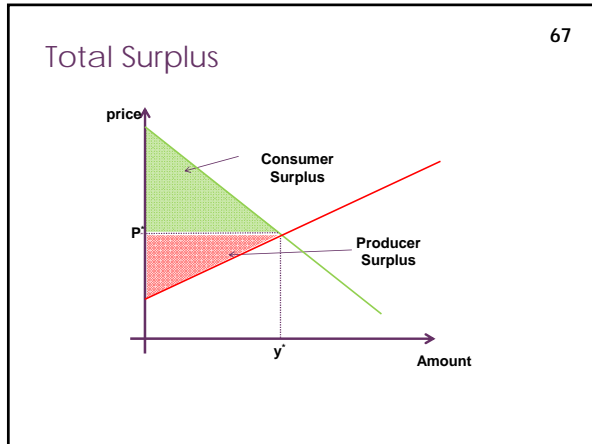
Consumer Surplus

68

- In fact, this is exactly how we are going to define 'consumer surplus'
- What is the justification for doing so?
- Well, informally, think of the following
  - Imagine that the consumer was not allowed to buy any of the good (let's say they are figs)
  - How much would they pay to buy one fig?
  - This is exactly what the demand curve tells us

The Demand Curve and Consumer Surplus

69

P_1

Willingness to pay for 1 fig

P*

1

figs

The Demand Curve and Consumer Surplus

70

P_1

Willingness to pay for 1 fig

Surplus from purchasing 1 fig

P*

1

figs

Consumer Surplus

71

- Demand curve tells us willingness to pay for each good
- Price is what we actually pay
- Difference between the two is the consumer surplus
- Can we make this precise given our earlier work on consumer choice?
- Yes, in the case of quasi-linear preferences
- As you will see for homework

Summary

72

Summary

- Today we have discussed firm supply in more detail
- Defined the concept of consumer and producer surplus