1

FOUR CHARACTERISTICS OF PCM

1. **Fragmented industry** – an industry that consists of many small buyers and sellers.
2. **Undifferentiated products** – products that the consumers perceive as being identical.
3. **Perfect information about prices** – full awareness by consumers of the prices charged by all sellers in the market.
4. **Equal access to resources** – all firms currently in the industry as well as prospective entrants have access to the same technology and inputs.

→ Buyers and sellers act as **price takers** – they both take the price as given when making purchasing or production decisions.

→ **A law of one price** – transactions between buyers and sellers take place at a single price.

→ Industry is characterized by **free entry** – if it is profitable for new firms to enter an industry, then they will, and nothing prevents them from doing so.

2

WHAT WILL WE LEARN IN THIS CHAPTER?

- How price-taking firms maximize their profit.
- How market price is determined when the number of firms is fixed. (short-run equilibrium in a PCM)
- How market price is affected by free entry. (long-run equilibrium of PCM)

3

HOW DO FIRMS MAXIMIZE PROFIT?

4

WHICH PROFIT SHOULD FIRMS CARE ABOUT?

Accounting profit

= sales revenue – accounting costs

Economic profit

= sales revenue – economic costs

When we discuss profit maximization we are always talking about economic profit.
(includes all economic costs including all relevant opportunity costs.)

PROFIT MAXIMIZATION (foundational concepts)

Suppose that a firm's output is Q.

Total revenue: $TR(Q) = P \times Q$

Total cost: $TC(Q)$

Profit: $\pi(Q) = TR(Q) - TC(Q)$

Marginal Cost

- The rate at which total cost changes with respect to output.

$$MC = \frac{dTC(Q)}{dQ}$$

Marginal Revenue

- The rate at which total revenue changes with respect to output.

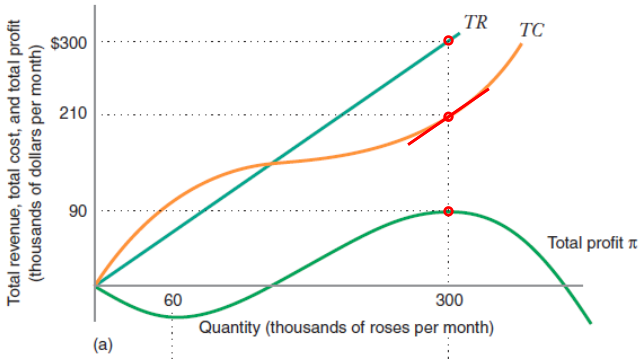
$$MR = \frac{dTR(Q)}{dQ}$$

PROFIT MAXIMIZATION (graphically)

Observe…

When the profit curve reaches its apex the **slopes** of the cost and revenue curves are equal…

$$MR(Q) = MC(Q)$$



PROFIT MAXIMIZATION (using calculus)

$$\pi(Q) = TR(Q) - TC(Q)$$

First order condition for a maximum

$\pi'(Q) = TR'(Q) - TC'(Q) = 0$

$MR(Q) - MC(Q) = 0$

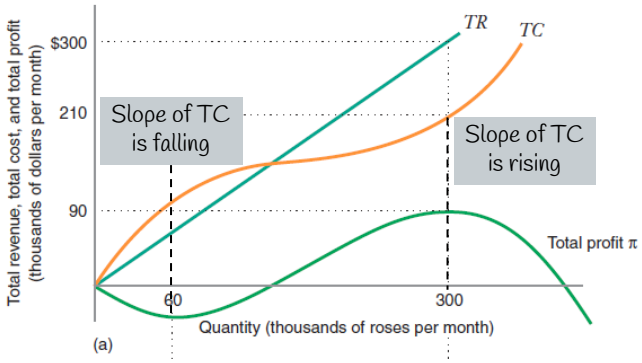
$MR(Q) = MC(Q)$

Second order condition for a maximum

$\pi''(Q) = MR'(Q) - MC'(Q) < 0$

$MR'(Q) < MC'(Q)$

…marginal cost must be rising faster than marginal revenue



ADAPTING PROFIT MAXIMIZATION FOR A PCM

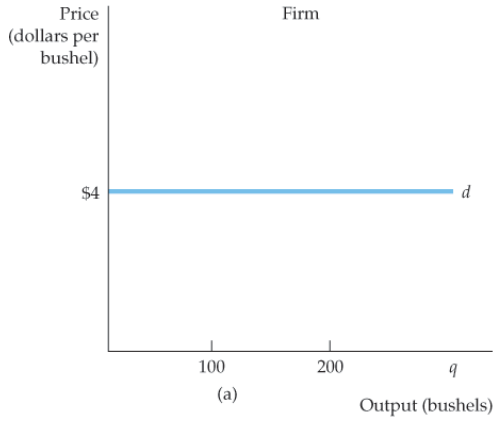
$TR(Q) = P \times Q$, where P is fixed at the market price.

Marginal revenue

$$MR(Q) = \frac{dTR}{dQ} = P$$

The demand curve faced by an individual firm in a competitive market is its marginal revenue curve.

MR=Price



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ADAPTING PROFIT MAXIMIZATION FOR A PCM

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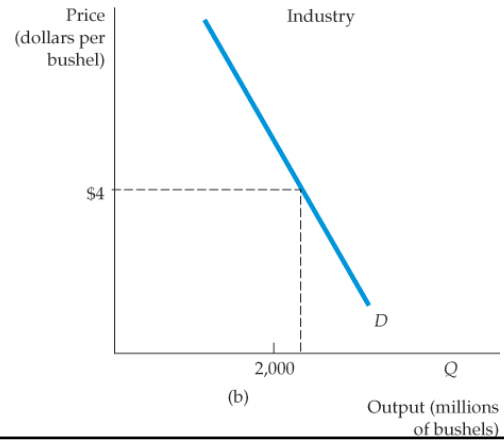

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ADAPTING PROFIT MAXIMIZATION FOR A PCM

We simplify the general rule, $MC(Q) = MR(Q)$, to the following:

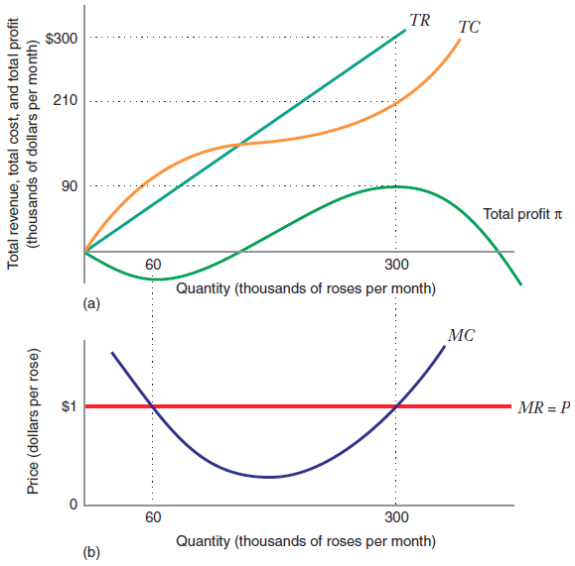
A perfectly competitive firm should **choose its output** so that

$$P - MC(Q) = 0 \rightarrow P = MC(Q)$$

Must also check second order conditions…

$$MR' - MC' < 0 \rightarrow MC' > 0$$

Marginal cost is rising



ADAPTING PROFIT MAXIMIZATION FOR A PCM

Important Conclusions…

If $P > MC$ then profit rises if output is increased

If $P < MC$ then profit falls if output is increased.

At profit maximizing point:

$P = MC = MR$

MC must be rising

MATHEMATICAL EXAMPLE

Ron's window washing service is a small business that operates in the perfectly competitive window washing industry in Evanston, Illinois.

They have a short-run total cost of $STC(Q) = 40 + 10Q + 0.1Q^2$, where $40 is fixed cost.

If the price is **$20** per window wash, how many windows should Ron wash to maximize profit?

Is marginal cost rising???

$$\frac{dSMC}{dQ} = 0.2 > 0$$

Yes, it is!

Goal: set $SMC = P$ and solve for Q

Step 1: Find $SMC = \frac{dSTC(Q)}{dQ}$

Step 2: Set $SMC = P$

DERIVING THE SHORT-RUN SUPPLY CURVE

SHORT-RUN COST STRUCTURE

$$STC(Q) = \begin{cases} SFC + NSFC + TVC(Q), & when\ Q > 0 \\ SFC, & when\ Q = 0 \end{cases}$$

- $TVC(Q)$ = total variable cost (output sensitive)
- SFC = sunk fixed costs (pay even if 0 units are produced)
- $NSFC$ = nonsunk fixed costs (avoidable cost)
- $TFC = SFC + NSFC$ (total fixed costs)

For simplicity, we will always assume that all fixed costs are sunk.

WHEN SHOULD A FIRM SHUT DOWN?
(all fixed costs are sunk)

What does shut down even mean?

Temporarily **producing 0 units** in the short-run to minimize losses…

…with the hope that market conditions will improve, and the firm can begin operating again in the future.

If the market price is too low…

How low is too low?

Market price is not high enough to cover the firm's average variable costs (AVC).

Formally, the **shutdown price** is the price below which a firm supplies zero output in the short run.

If all fixed costs are sunk, then

$$P_S = minimum\ AVC$$

WHERE DOES THIS SHUTDOWN PRICE COME FROM?

A firm will shut down if their profit from doing so is greater than the profit from continuing to operate where $MC(Q) = P$.

Since…

1. the firm always produces along its marginal cost curve, and
2. the marginal cost curve always intersects the $AVC(Q)$ at its minimum

This is updated to $P_S = minimum\ AVC(Q)$

Mathematically…

The firm will shut down if

$$\pi(Q^*) \leq \pi(0)$$

$$PQ^* - TVC(Q^*) - TFC \leq -TFC$$

$$PQ^* - TVC(Q^*) \leq 0$$

$$PQ^* \leq TVC(Q^*)$$

$$P \leq \frac{TVC(Q^*)}{Q^*}$$

$$P \leq AVC(Q^*)$$

SHORT-RUN SUPPLY (all fixed costs are sunk)

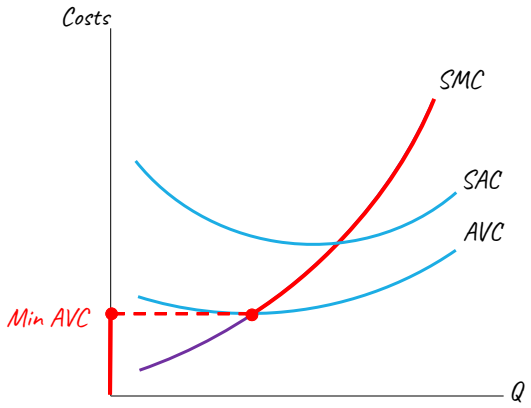
Short-run supply curve shows how the firm's profit maximizing output decision changes as the market price changes (assuming at least one of its inputs is fixed).

How does a price-taking firm maximize profit?

if $P > \min AVC$, then produce where $SMC(Q) = P$

if $P \leq \min AVC$, then produce $Q = 0$

The portion of the firm's marginal cost curve above the AVC curve is their supply curve!



SHORT-RUN SUPPLY (all fixed costs are sunk)

Short-run supply curve shows how the firm's profit maximizing output decision changes as the market price changes (assuming at least one of its inputs is fixed).

When does a price-taking firm earn positive profit?

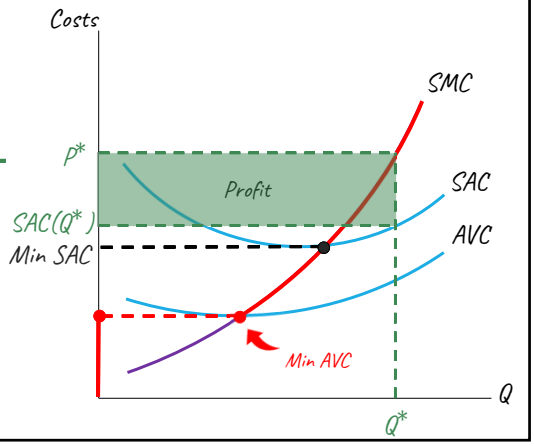
if $P > \min SAC$

At P^*, firm produces Q^*

Per-unit profit $= P^* - SAC(Q^*)$

Total profit $= Q^*(P^* - SAC(Q^*))$

Or… $= TR(Q^*) - TC(Q^*)$



SHORT-RUN SUPPLY (all fixed costs are sunk)

Short-run supply curve shows how the firm's profit maximizing output decision changes as the market price changes (assuming at least one of its inputs is fixed).

When does a price-taking firm operate at a loss?

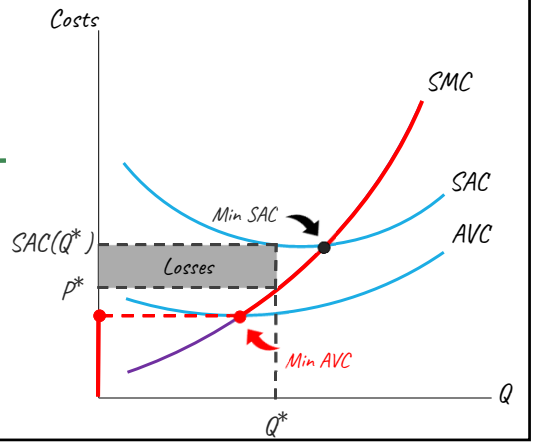
If $\min AVC < P < \min SAC$

At P^*, firm produces Q^*

Per-unit loss $= SAC(Q^*) - P^*$

Total loss $= Q^*(SAC(Q^*) - P^*)$

Or… $= TC(Q^*) - TR(Q^*)$

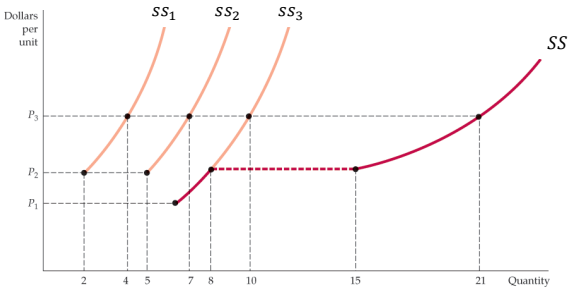


THE SHORT-RUN MARKET SUPPLY CURVE

Short-run market supply curve shows the quantity supplied in aggregate by all firms in the market for each possible market price when the number of firms in the industry is fixed.

Aggregate quantity supplied will equal to the sum of all quantities supplied by the individual firms.

Calculated by **horizontally summing** the individual firms' marginal cost curves.



BACK TO WINDOW WASHING...

Ron's window washing service is a small business that operates in the perfectly competitive window washing industry in Evanston, Illinois.

They have a short-run total cost of $STC(Q) = 40 + 10Q + 0.1Q^2$, where \$40 is (sunk) fixed cost.

We already know:

$$\boldsymbol{SMC(Q) = 10 + 0.2Q}$$

1. Determine the firm's shutdown price.
2. Determine the firm's supply curve.
3. Suppose there are 100 identical firms in the market, write down the equation for the market supply curve.

$P_S = Min\ AVC$

Step 1: Find $AVC = \frac{VC(Q)}{Q}$

$AVC = \frac{10Q + 0.1Q^2}{Q}$

$AVC = 10 + 0.1Q$

Step 2: Set $AVC = SMC$, find Q that minimizes AVC

$10 + 0.1Q = 10 + 0.2Q$

Step 3: Evaluate AVC at $Q = 0$

$P_S = 10 + 0.2(0) = 10$

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Produce where $SMC = P$

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1. Determine the firm's shutdown price.
2. Determine the firm's supply curve.
3. Suppose there are 100 identical firms in the market, write down the equation for the market supply curve.

$$\boldsymbol{SS(P) = 100 \times ss(P)}$$

$$SS(P) = 100 \times \begin{cases} 5P - 50, & if\ P > 10 \\ 0, & if P \leq 10 \end{cases}$$

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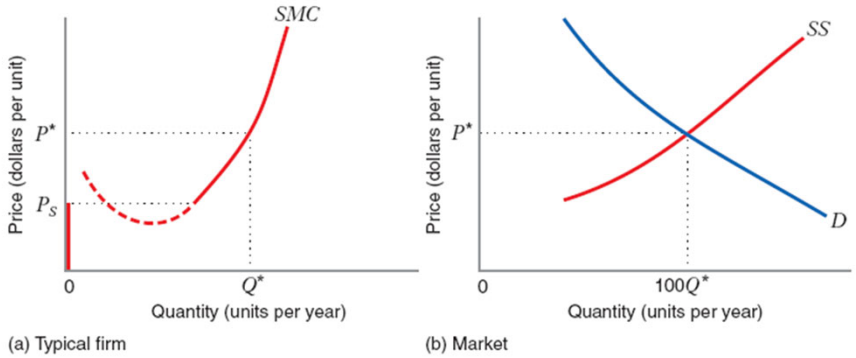
THE SHORT-RUN EQUILIBRIUM

The **short-run perfectly competitive equilibrium** occurs at the market price and quantity at which quantity demanded equals quantity supplied in the short run.

If there are 100 firms in the short-run all with the same cost structure, then…



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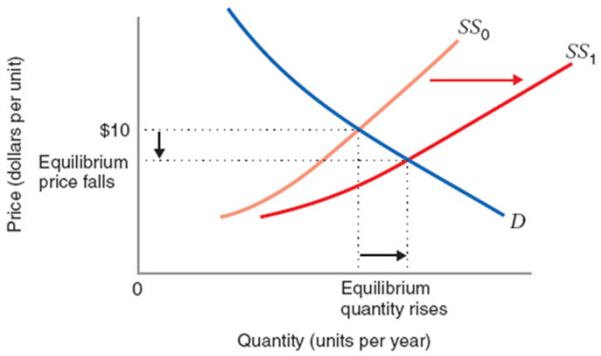
SOME COMPARATIVE STATICS

Several things can shift the short-run supply to the right.

1. An increase in the number of firms
2. A decrease in input prices

When this shift occurs…

The equilibrium price falls, and the equilibrium quantity rises.



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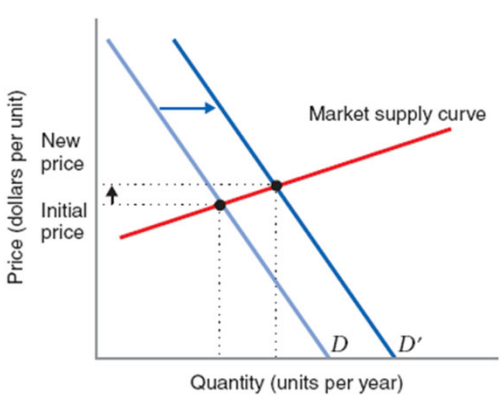
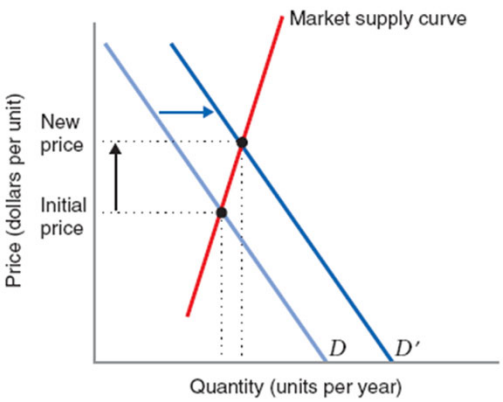
ELASTICITY OF SUPPLY MATTERS!



(a) Effect of shift in demand: Supply is relatively elastic



(b) Effect of shift in demand: Supply is relatively inelastic

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WHAT CHANGES IN THE LONG RUN?

A firm can now...

1. alter all its inputs including plant size
2. exit the industry entirely
3. begin producing a product for the first time (enter the industry)

The long-run profit maximizing output will depend on the long-run marginal cost…

Produce output such that

$$MC(Q) = P$$

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THE LONG-RUN COMPETITIVE EQUILIBRIUM

Occurs when firms have no incentive to exit or enter the industry…

Its all about economic profit!

$$\pi = TR - wL - rK$$

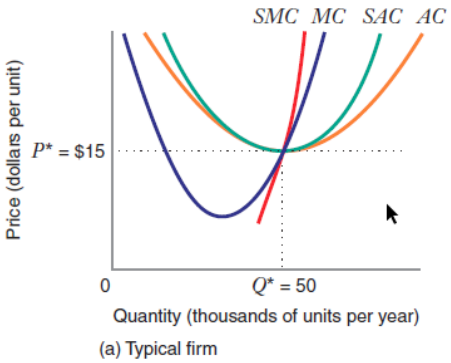
Zero economic profit
The firm is earning a normal (competitive) return on its investment

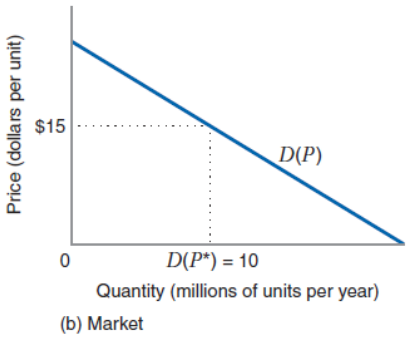
If economic profit is *positive*, then new firms will want to *enter*.

If economic profit is *negative*, then existing firms will want to *exit*.

If economic profit is *zero*, then there is *no incentive for entry or exit*.

GRAPHICAL DEPICTION OF LONG-RUN EQUILIBRIUM





3 Conditions must hold…

1. $MC(Q^*) = P^*$
2. $AC(Q^*) = P^*$
3. $n^* = \frac{D(P^*)}{Q^*}$

(n^* is the number of firms)

$P = Min\ AC$ in the long run equilibrium

LONG-RUN EQUILIBRIUM EXAMPLE

The propylene industry is perfectly competitive, and each producer has a long-run total cost:

$$TC = 40Q - 6Q^2 + \frac{1}{3}Q^3$$

The market demand curve for propylene is:

$$D(P) = 2200 - 100P$$

1. Determine the long-run equilibrium price in this industry.
2. How many units will each firm produce at this price?
3. How many firms are in the long-run competitive equilibrium?

Step 1: Find AC and MC

$$AC = \frac{TC}{Q} =$$

$$MC = \frac{dTC}{dQ} =$$

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LONG-RUN EQUILIBRIUM EXAMPLE

$$\boldsymbol{AC = 40 - 6Q + \frac{1}{3}Q^2}$$
$$\boldsymbol{MC = 40 - 12Q + q^2}$$

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Step 2: Find q that minimizes AC

$$\boldsymbol{AC = MC}$$

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LONG-RUN EQUILIBRIUM EXAMPLE

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1. Determine the long-run equilibrium price in this industry.
2. How many units will each firm produce at this price?
3. How many firms are in the long-run competitive equilibrium?

Step 3: Evaluate AC at $q = 9$ to find AC_{min}

$P = AC_{min} =$

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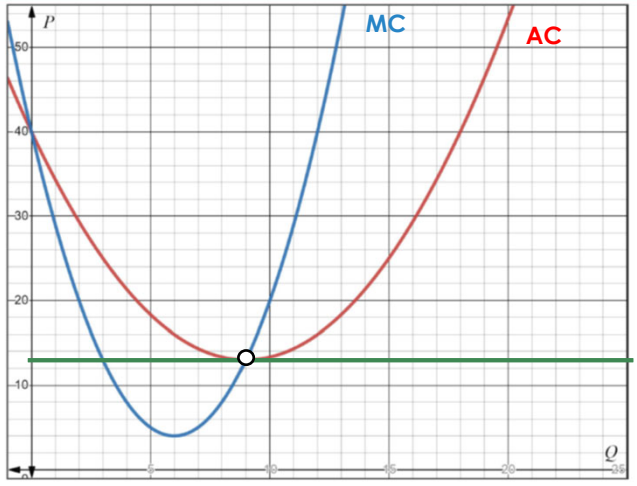
LONG-RUN EQUILIBRIUM EXAMPLE

$$AC = 40 - 6Q + \frac{1}{3}Q^2$$
$$MC = 40 - 12Q + Q^2$$



Each firm produces where $P = MC$ and MC is rising

$P = \$13$
$Q = 9\ units$

We solved for this before…
It is the output that minimizes AC

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LONG-RUN EQUILIBRIUM EXAMPLE

The propylene industry is perfectly competitive, and each producer has a long-run total cost:

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The market demand curve for propylene is:

$$D(P) = 2200 - 100P$$

1. Determine the long-run equilibrium price in this industry.
2. How many units will each firm produce at this price?
3. How many firms are in the long-run competitive equilibrium?

Step 1: Evaluate demand when $P = \$13$

Step 2: Divide $D(P)$ by the supply of each firm (9 *units*)

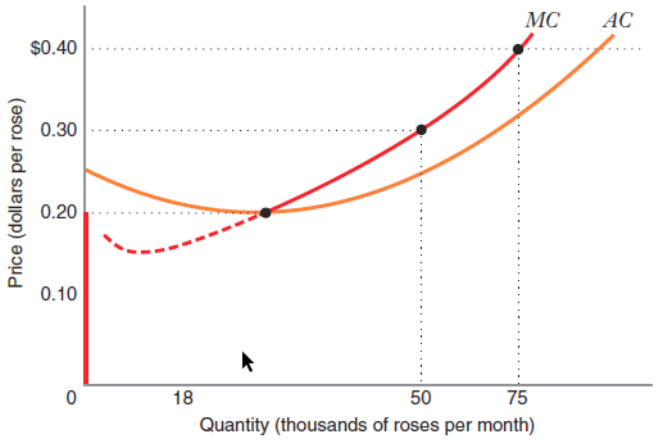
A FIRM'S LONG-RUN SUPPLY CURVE

if $P > \min AC$

produce where $MC(Q) = P$

if $P \leq \min AC$

exit the market



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LONG-RUN MARKET SUPPLY CURVE

In the long run firms enter and exit markets as the market price changes.

It is not possible to sum up supply curves to form the long-run market supply curve.

Instead…The shape of the long-run market supply curve depends on the structure of the costs in the industry.

There are three cases to consider

1. Constant-cost industry
2. Increasing-cost industry
3. Decreasing-cost industry

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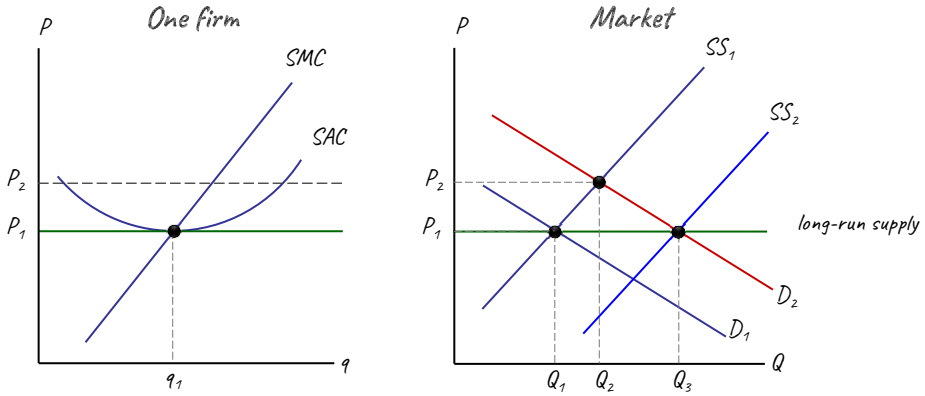
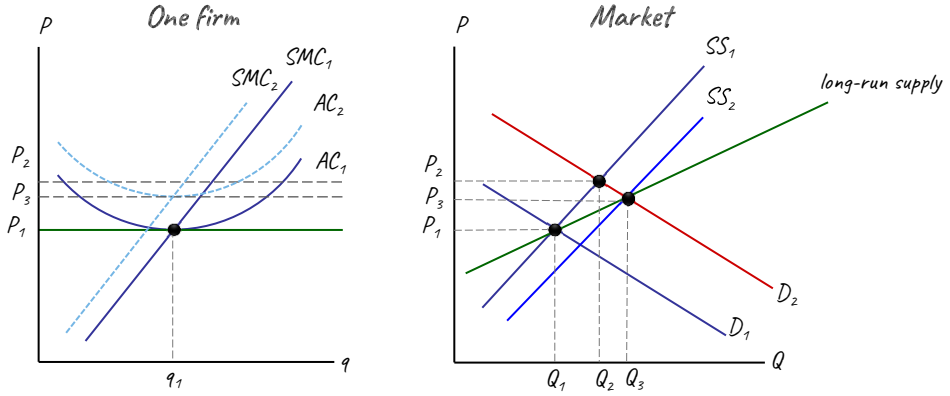
CONSTANT-COST INDUSTRY

Costs do not change as output and the associated demand for inputs change.



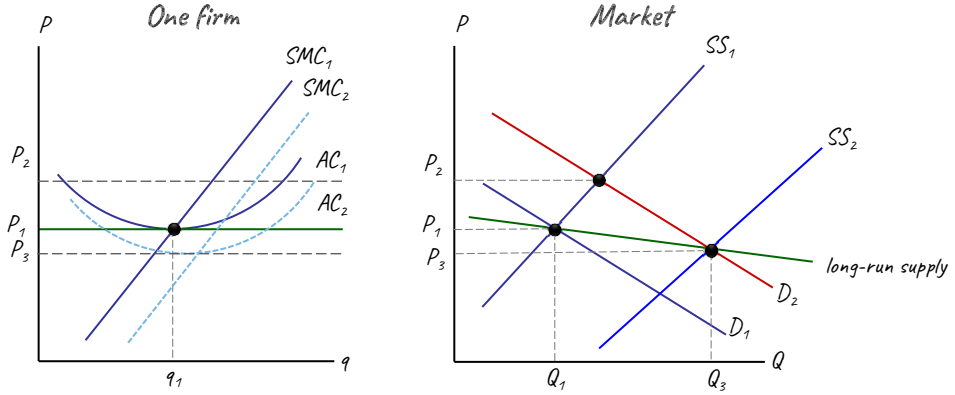
INCREASING-COST INDUSTRY

Costs increase as output and the associated demand for inputs increases.



DECREASING-COST INDUSTRY

Costs decrease as output and the associated demand for inputs increases.



ECONOMIC RENT

The economic return that is attributable to extraordinarily productive inputs whose supply is scarce.

It is the difference between the maximum amount a firm is willing to pay for the services of the input and the input's **reservation value**.

↓

The return that the owner of an input could get by deploying the inputs in its best alternative use outside the industry.

Whether the owner of the input, or the firm employing the input captures economic rent, depends on **resource mobility**.

↓

How easily the resource in question can be employed in other firms or industries.

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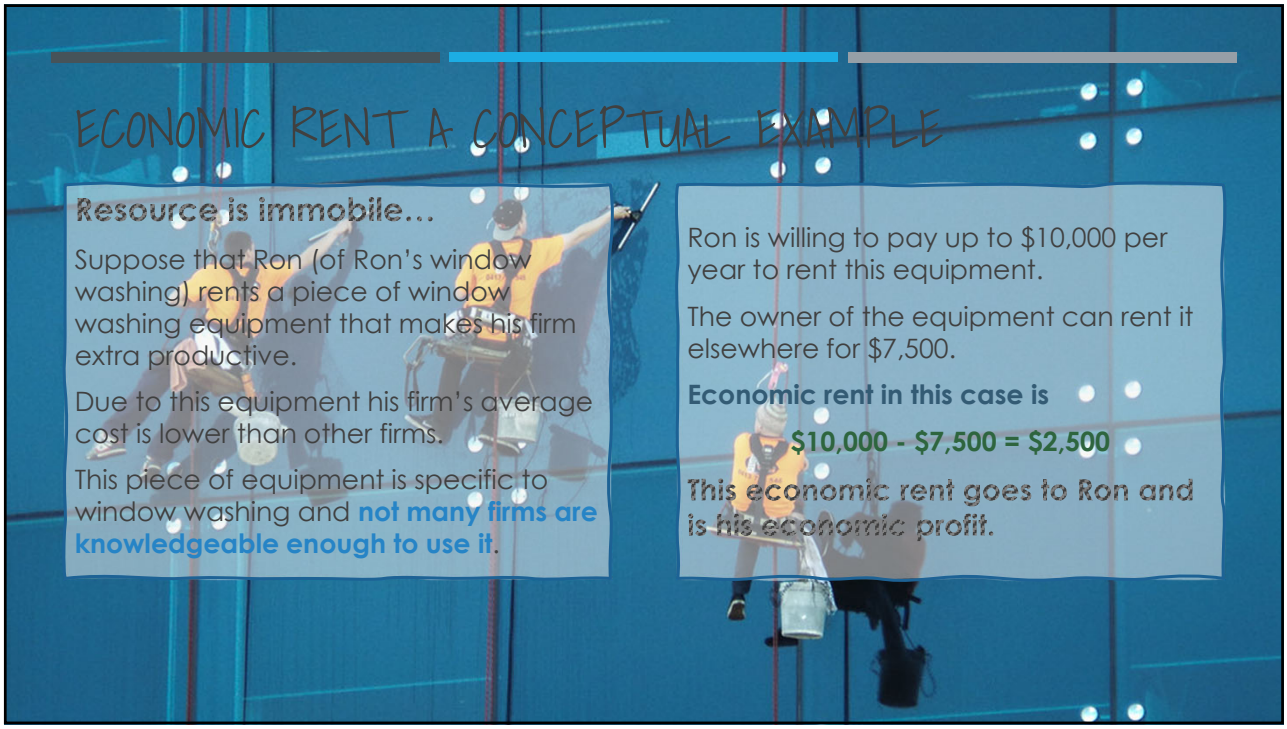

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ECONOMIC RENT A CONCEPTUAL EXAMPLE

Resource is mobile…

Suppose that Ron (of Ron's window washing) rents a piece of window washing equipment that makes his firm extra productive.

Due to this equipment his firm's average cost is lower than other firms.

This piece of equipment is specific to window washing but **any firm in this industry would be able to use it.**

Ron and many other window washers are willing to pay up to $10,000 per year to rent this equipment.

The owner of the equipment can rent it elsewhere for $7,500.

Economic rent in this case is

$10,000 - $7,500 = $2,500

This economic rent goes to the owner of the capital!

You can think of this as the input owner's "rent premium".

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PRODUCER SURPLUS FOR A FIRM

Sum from zero to q^*, of the differences between the market price of a good and the marginal cost of production.

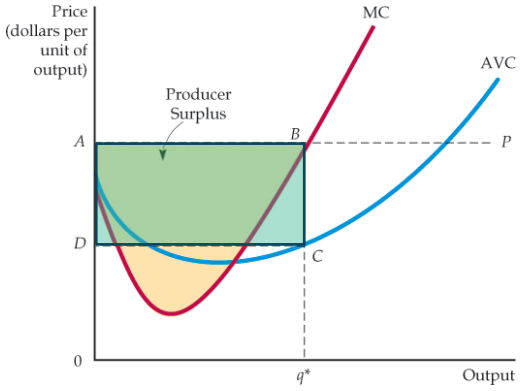
Area below price and above marginal cost (supply).

$$PS = \sum_{Q=0}^{Q^*} P - MC(Q) = orange\ shaded\ region$$

$$PS = TR(Q^*) - VC(Q^*)$$

$$PS = P \times Q^* - AVC(Q^*) \times Q^*$$

$$= \boldsymbol{ABCD}$$



This is not profit!

$$\pi = TR - VC - FC$$

$$PS = TR - VC$$

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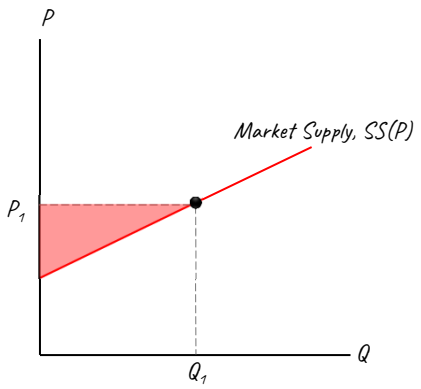
PRODUCER SURPLUS FOR A MARKET (short run)

Market producer surplus can be thought of as the **sum of all firms' producer surpluses**.

However, since the market supply curve is the horizontal sum of the individual firm supply curves…

…We can simplify the computation

Producer surplus in a market is the area below the market price and above the market supply curve from 0 to Q^*.



PRODUCER SURPLUS FOR A MARKET (long run)

Constant Cost industry

No producer surplus

Decreasing Cost industry

No producer surplus

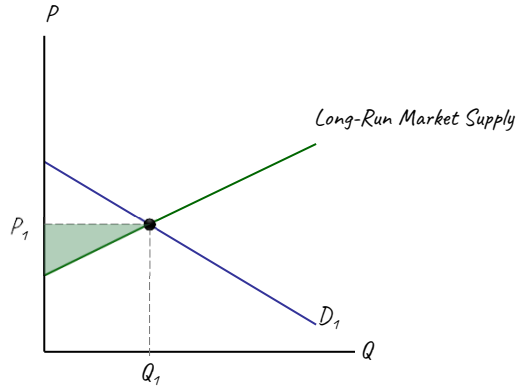
Increasing Cost Industry

Producer surplus ≠ economic profit

(because economic profit = 0 in the long run)

Instead…

Producer surplus = economic rent



PRODUCER SURPLUS EXAMPLE

Back to window washing again…

$TC(Q) = 40 + 10Q + 0.1Q^2$, where \$40 is fixed cost.

$$ss(P) = 5P - 50 \text{ if } P > 10$$

$$SS(P) = 500P - 5000 \text{ if } P > 10$$

Suppose the price is \$30 per window washing.

1. Find the firm's producer surplus.
2. Find the market producer surplus.

Step 1: Determine how many units are produced when $P = \$30$

$ss(30) = 5(30) - 50$

$= 100$

Step 2: Calculate $PS = TR(Q) - TVC(Q)$

$TR = P \times Q = 30 \times 100 = 3000$

$VC = 10 \times 30 + 0.1 \times 30^2 = 2000$

$PS = 3000 - 2000 = \$1000$

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PRODUCER SURPLUS EXAMPLE

Back to window washing again…

$TC(Q) = 40 + 10Q + 0.1Q^2$, where \$40 is fixed cost.

$$ss(P) = 5P - 50 \text{ if } P > 10$$

$$SS(P) = 500P - 5000 \text{ if } P > 10$$

Suppose the price is \$30 per window washing.

1. Find the firm's producer surplus.
2. Find the market producer surplus.

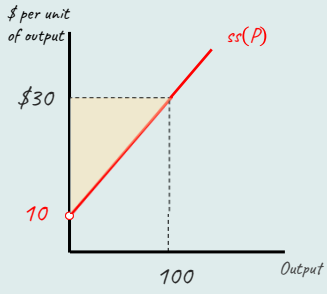
An Alternative Method

Step 1: Determine how many units are produced when $P = \$30$

$ss(30) = 5(30) - 50$

$= 100$

Step 2: Graph it!



Step 3: Calculate PS

$PS = \frac{1}{2}(30 - 10)(100)$

$= \$1000$

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PRODUCER SURPLUS EXAMPLE

Back to window washing again…

$TC(Q) = 40 + 10Q + 0.1Q^2$, where \$40 is fixed cost.

$$ss(P) = 5P - 50 \text{ if } P > 10$$

$$SS(P) = 500P - 5000 \text{ if } P > 10$$

Suppose the price is \$30 per window washing.

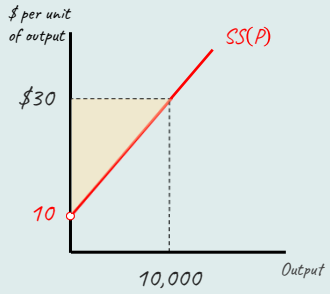
1. Find the firm's producer surplus.
2. Find the market producer surplus.

Step 1: Determine how many units are produced when $P = \$30$

$SS(30) = 500(30) - 5{,}000$

$= 10{,}000$

Step 2: Graph it!



Step 3: Calculate PS

$PS = \frac{1}{2}(30 - 10)(10{,}000)$

$= \$100{,}000$