MGRECON - Class 5 (after class)

Fixed Costs and Variable Costs

Costs are either **fixed** or **variable**:

$$TC(Q) \quad = \quad FC \quad + \quad TVC(Q)$$

Fixed Costs (FC)
do not change
in the "**short run**"

Examples:

Rent, Utilities
Insurance, Security
Property taxes

Variable Costs (TVC)
change with
the level of output Q

Examples:

Materials
Piece-rate Labor, Sales Commissions
Energy

In the "**long run**" all costs are variable.

Average Costs and Marginal Cost

Average Costs: ATC, AFC, AVC

$$ATC(Q) = \frac{TC(Q)}{Q} = \frac{FC + TVC(Q)}{Q}$$

$$= \frac{FC}{Q} + \frac{TVC(Q)}{Q}$$

$$= AFC(Q) + AVC(Q)$$

Marginal Cost (MC) = cost of the last unit

$$MC(Q) = \frac{d\,TC(Q)}{d\,Q} = \frac{d\,TVC(Q)}{d\,Q} \qquad \left(\frac{d\,FC}{d\,Q} = 0\right)$$

Opportunity Cost

Choosing an alternative means forgoing other alternatives:

- a team of scientists working on an R&D project cannot work on other projects
- a product sold to a customer cannot be sold to anybody else
- if a plant is built on a site, the site cannot be used for any other purpose

The **opportunity cost** of a decision is **the value of the best forgone alternative**

Question 1 A construction company has 1,000 tons of steel in inventory. The steel was purchased for \$250 per ton. Its current price is \$500 per ton.
What is the cost per ton of using the steel today?
Answer to Question 1 \$500

Question 2 A restaurant owns equipment (ovens, grills) that has fully depreciated (accounting book value of zero). The equipment can be sold for \$1 000 today, and for \$200 next year.
What is the cost to the restaurant of using the equipment for 1 more year?
Answer to Question 2 \$1000 - \$200 = \$800

Question 3 A construction firm is asked to install AC ducts for \$16,000. Operating expenses (including labor) are estimated at \$9,000. All necessary materials are already held in inventory. Sheet metal (needed for the installation and part of the inventory) originally cost \$10,000, but its current market value is \$3,000. Should the construction firm accept the job?
Answer to Question 3
Net payoff from Accepting: \$16,000 - \$9,000 = \$7,000 (using the sheet metal)
Net payoff from Declining: \$3,000 (can sell the sheet metal)

Sunk Cost

A cost is sunk if it cannot be recovered ("spilled milk"),
e.g. R&D money spent on a project that has failed.

Sunk costs should have no effect on any current decision.

The "sunk cost fallacy" or "throwing good money after bad":
continuing investing in a project because so much has been invested in it already, even though we have better use for our money.

Question A real-estate developer has paid $15,000 for the option to purchase land at a price of $250,000. Recently, an equally usable site has been offered for sale at $240,000. Should the new land be purchased or should the original?

Answer

Payoff from exercising the option: -$15 000 - $250 000 = -$265 000

Payoff from not exercising the option: -$15 000 - $240 000 = -$255 000

A "Sudoku" Exercise

Complete the following table:

Units	TC	FC	TVC	MC	ATC	AFC	AVC
0		**60**		-	-	-	-
1			**10**				
2	**90**						
3				**20**			
4			**80**				
5	**180**						
6					**40**		

A "Sudoku" Exercise: Answers

Complete the following table:

Units	TC	FC	TVC	MC	ATC	AFC	AVC
0	60	**60**	0	-	-	-	-
1	70	60	**10**	10	70	60	10
2	**90**	60	30	20	45	30	15
3	110	60	50	**20**	36.7	20	16.7
4	140	60	**80**	30	35	15	20
5	**180**	60	120	40	36	12	24
6	240	60	180	60	**40**	10	30

fill the FC column

fill row Q = 0: TVC(0) = 0, TC(0) = FC

fill row Q = 1: TC(1) = TVC(1) + FC, MC(1) = TVC(1), ATC(1) = TC(1), ...

fill row Q = 2: TVC(2) = TC(2) - FC, MC(2) = TC(2) - TC(1), ATC(2) = TC(2)/2, ...

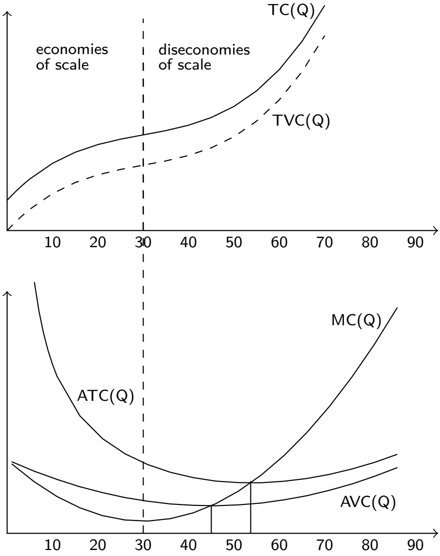
fill row Q = 3: TC(3) = TC(2) + MC(3), TVC(3) = TVC(2) + MC(3), ATC(3) = TC(3)/3, ...

fill row Q = 4: TC(4) = TVC(4) + FC, MC(4) = TVC(4) - TVC(3), ATC(4) = TC(4)/4, ...

fill row Q = 5: TVC(5) = TC(5) - FC, MC(5) = TC(5) - TC(4), ATC(5) = TC(5)/5, ...

fill row Q = 6: TC(6) = ATC(6)·6, TVC(6) = TC(6) - FC, MC(6) = TC(6) - TC(5), ...

Typical Cost Curves



The TC curve and the TVC curve are *vertically parallel*

TC(Q) - TVC(Q) = FC

Typically, the TC and TVC curves are S-shaped

low Q $\rightarrow$ “economies of scale”
TC increases at a decreasing rate $\leftrightarrow$ MC is decreasing

high Q $\rightarrow$ “diseconomies of scale”
TC increases at an increasing rate $\leftrightarrow$ MC is increasing

AFC = vertical distance between ATC and AVC

gets smaller as Q increases

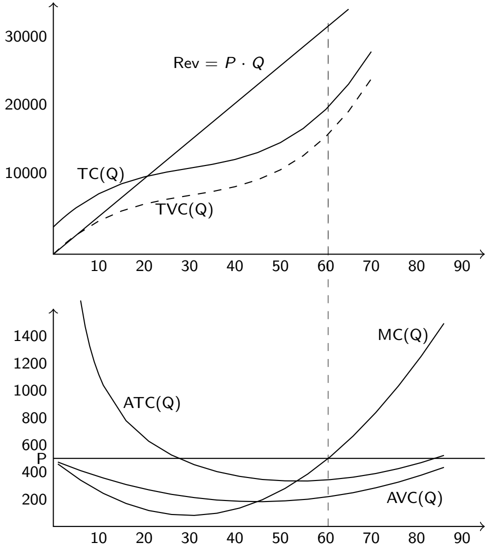
$\text{AFC}(Q) = \text{ATC}(Q) - \text{AVC}(Q) = \frac{FC}{Q}$

If MC $<$ AVC, then AVC is decreasing
If MC $>$ AVC, then AVC is increasing
$\rightarrow$ at min AVC(Q) we have AVC(Q) = MC(Q)

If MC $<$ ATC, then ATC is decreasing
If MC $>$ ATC, then ATC is increasing
$\rightarrow$ at min ATC(Q) we have ATC(Q) = MC(Q)

Profit Maximization for a Price-Taking Firm

A price taking firm cannot influence the market price, faces a horizontal demand curve



$$\max_{Q} \ \Pi = P \cdot Q - TC(Q)$$

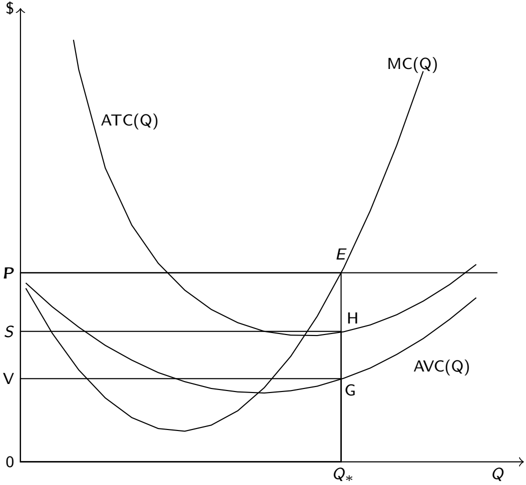
$$\frac{d\Pi}{dQ} = P - MC(Q) = 0 \qquad \text{(P = MR)}$$

$$\boxed{P = MC(Q)}$$

A price-taking firm has no market power

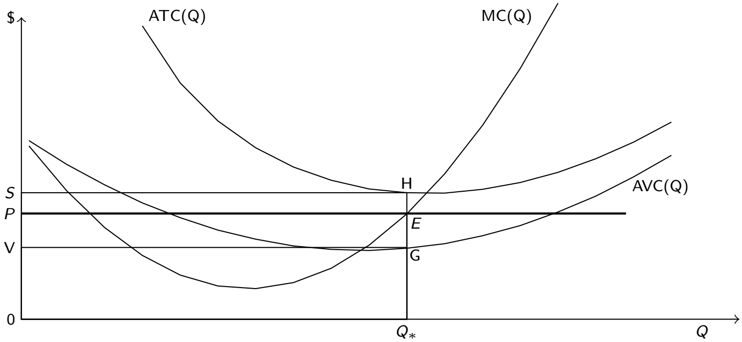
its demand is horizontal → P = MR

Profit Maximization when $P > ATC \to \Pi > 0$



$$
\begin{aligned}
\text{Revenue} &= \text{OPE}Q_* = P \cdot Q_* \\
\text{TC} &= \text{OSH}Q_* = \text{ATC}(Q_*) \cdot Q_* \\
\text{TVC} &= \text{OVG}Q_* = \text{AVC}(Q_*) \cdot Q_* \\
\text{FC} &= \text{VSHG} = \text{AFC}(Q_*) \cdot Q_* \\
\text{Profit} &= \text{SPEH} = P \cdot Q - ATC(Q_*) \cdot Q_* > 0
\end{aligned}
$$

Profit Maximization when $AVC < P < ATC \rightarrow \Pi < 0$



Revenue	=	OPEQ_*
TC	=	OSHQ_*
TVC	=	OVGQ_*
FC	=	VSHG
Profit	=	SPEH < 0

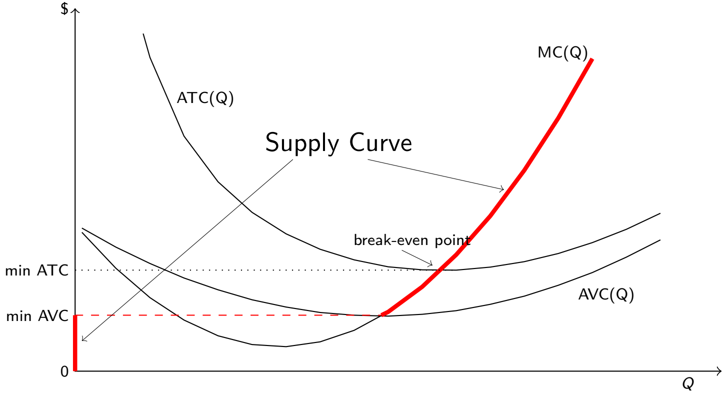
In the <u>short run</u>, must pay FC

$\rightarrow$ sell Q_* $\rightarrow \Pi_* = P \cdot Q_* - TVC\,(Q_*) - FC$

$$\boxed{-FC < \Pi_* < 0}$$

In the <u>long run</u>, shut down $\rightarrow$ $\boxed{\Pi_* = 0}$

The Firm's Supply Curve



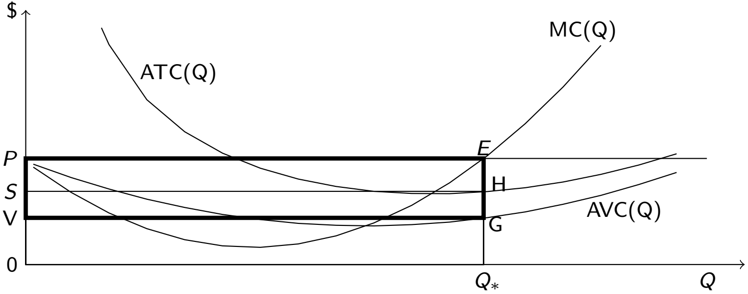
At any price below *min* AVC, the firm supplies zero units.

At any price above *min* AVC, the firm supplies Q units, such that $MC(Q) = P$.

The firm's **supply curve** is the part of the MC curve which is:

upward-sloping and above the AVC curve

Producer Surplus vs. Profit



$$
\begin{aligned}
\text{Revenue} &= \text{OPE}Q_* &&= P \cdot Q_* \\
\text{TC} &= \text{OSH}Q_* &&= \text{ATC}(Q_*) \cdot Q_* \\
\text{TVC} &= \text{OVG}Q_* &&= \text{AVC}(Q_*) \cdot Q_* && = \text{area below MC} \\
\text{FC} &= \text{VSHG} &&= \text{AFC}(Q_*) \cdot Q_* \\
\text{Profit} &= \text{SPEH} &&= (P - \text{ATC}(Q_*)) \cdot Q_* \\
\text{Producer Surplus} &= \text{VPEG} &&= (P - \text{AVC}(Q_*)) \cdot Q_* && = \text{“Variable” Profit}
\end{aligned}
$$

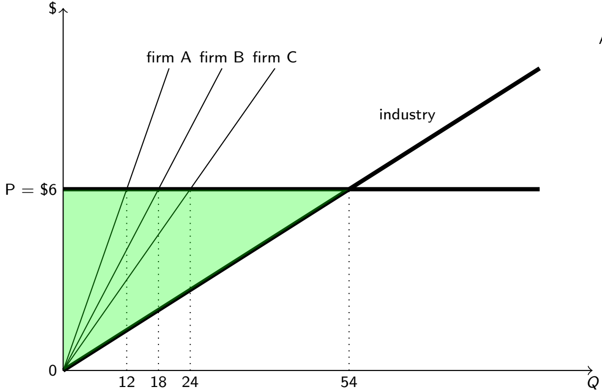
Produce Surplus = “Variable” Profit = Rev - TVC = **Area below price line & above MC curve**

Profit = Producer Surplus - Fixed Costs

Market Supply and Aggregate Producer Surplus

The **market supply** is the ***horizontal*** sum of the supply curves of all firms in the market

The **aggregate producer surplus** is *the area below the price line & above the market supply curve*



At P = $6:

firm A supplies 12 units, $PS_A = \frac{6 \cdot 12}{2} = \$36$

firm B supplies 18 units, $PS_B = \frac{6 \cdot 18}{2} = \$54$

firm C supplies 24 units, $PS_C = \frac{6 \cdot 24}{2} = \$72$

industry supply $= 12 + 18 + 24 = 54$ units

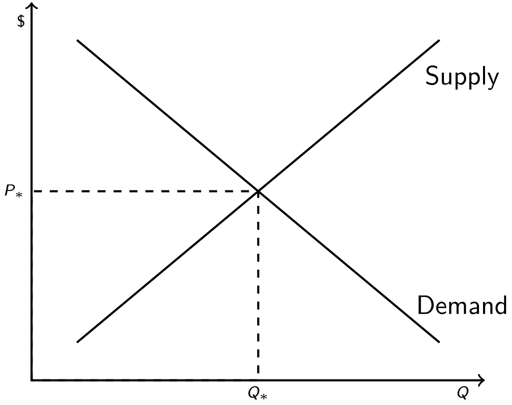
$$PS = PS_A + PS_B + PS_C$$
$$= \$36 + \$54 + \$72 = \$162$$

PS = area below price line & Mkt supply

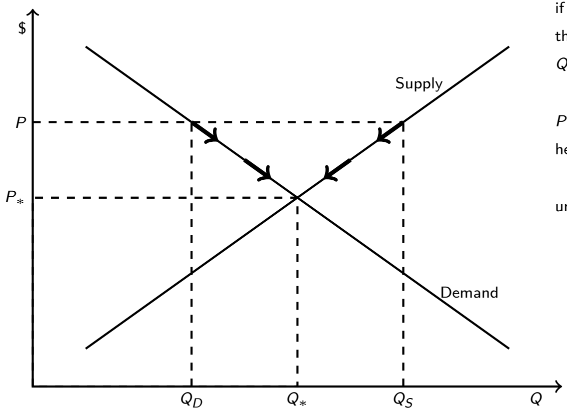
$$= \frac{1}{2} \cdot \$6 \cdot 54 = \$162$$

Perfectly Competitive Markets

At price P*, the market clears: Demand = Supply



Adjustment from Excess Supply



if $P > P_*$, then

there is **excess supply**

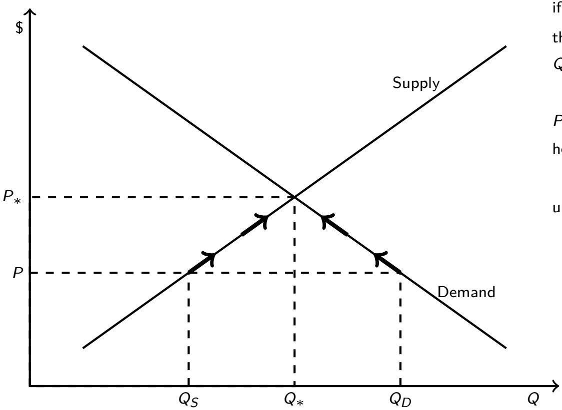
$Q_S - Q_D > 0$

P is pushed down,

hence $Q_S \downarrow$ and $Q_D \uparrow$

until the excess supply shrinks to zero

Adjustment from Excess Demand



if $P < P_*$, then

there is **excess demand**

$Q_D - Q_S > 0$

P is pushed up,

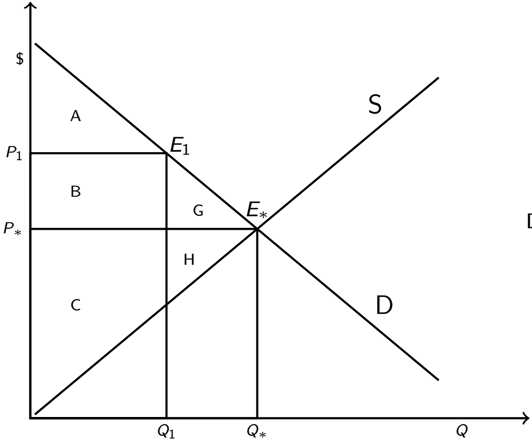
hence $Q_S \uparrow$ and $Q_D \downarrow$

until the excess demand shrinks to zero

The Efficiency of Perfectly Competitive Markets

At price P*, all gains from trade are realized – no deadweight loss

Social Surplus (= Consumer Surplus + Producer Surplus) is maximized



	at P_1	at P_*
CS	A	A+B+G
PS	B+C	C+H
TS	A+B+C	A+B+C+G+H
DWL	G+H	0

Adam Smith's quote

"Every individual . . . neither intends to promote the public interest, nor knows how much he is promoting it . . .

He intends only his own gain, and he is in this, as in many other cases, ***led by an invisible hand*** *to promote an end which was no part of his intention.*

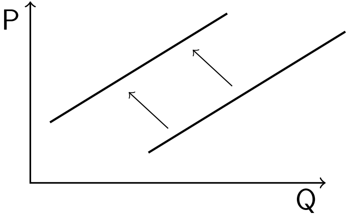
Nor is it always the worse for the society that it was no part of it.

By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it."

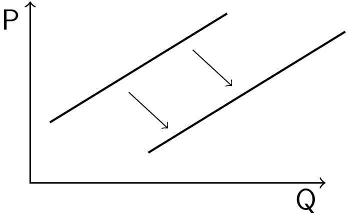
Adam Smith, passages from "The Wealth of Nations", 1776

Demand and Supply Shifts

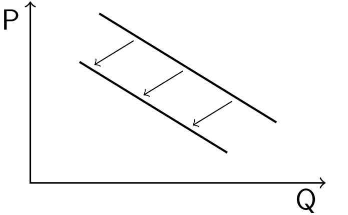
Supply shifts inward,
if inputs prices increase



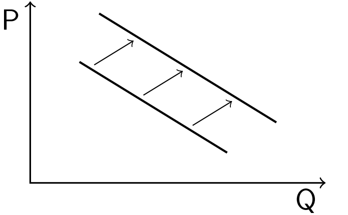
Supply shifts outward,
if inputs prices decrease



Demand shift <u>inward</u>,
due to $P_S \downarrow$, $P_C \uparrow$, $I \downarrow$, and/or $U \downarrow$,



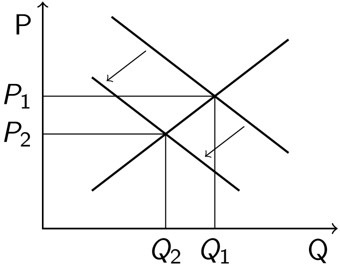
Demand shift <u>outward</u>,
due to $P_S \uparrow$, $P_C \downarrow$, $I \uparrow$, and/or $U \uparrow$,



How Demand Shifts Affect the Equilibrium P and Q

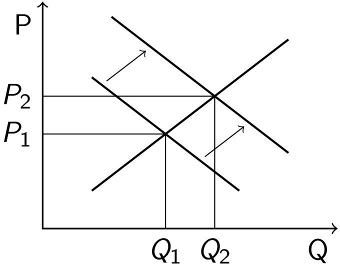
If demand shifts <u>inward</u>,

both P and Q go down



If demand shifts <u>outward</u>,

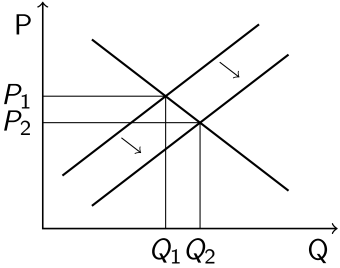
both P and Q go up



How Supply Shifts Affect the Equilibrium P and Q

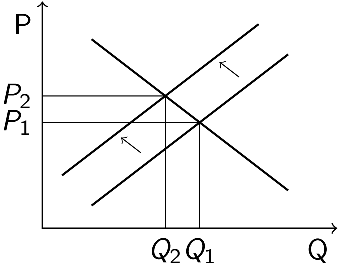
If supply shifts <u>outward</u>,

P goes down and Q goes up



If supply shifts <u>inward</u>,

P goes up and Q goes down



Exercises

1. Both the equilibrium price and equilibrium quantity of beef increase if:

   a. herd sizes fall following a severe drought
   b. consumers increasingly view beef as unhealthy
   c. the price of cattle feed decreases
   d. **consumer income increases** $\leftarrow$

   If the demand shifts outward, and the equilibrium point moves along the supply curve toward "north-east", hence both P and Q increases

2. If demand and supply both shift inward:

   a. the equilibrium price will increase while the quantity produced and sold could increase, decrease, or remain constant
   b. the equilibrium price will decrease while the quantity produced and sold could increase, decrease, or remain constant
   c. the quantity produced and sold will increase, while the equilibrium price could increase, decrease, or remain constant
   d. **the quantity produced and sold will decrease, while the equilibrium market price could increase, decrease, or remain constant** $\leftarrow$