Introduction (Microeconomics)

Micro- and Macroeconomics

Miscellaneous information

- Course: Micro- and Macroeconomics (BMEGT30A001)
- Lecturers: Micro: Zoltán Bánhidi (banhidi.zoltan@gtk.bme.hu), Macroeconomics: Zsolt Gilányi (gilanyi.zsolt@gtk.bme.hu)
- Assessment: Compulsory midterm exam AND an optional midterm exam OR final exam. Final grades are determined by the overall score, provided that a student scores at least 40% in all exams (otherwise an F grade is assigned).

WHEN?

- Compulsory midterm (7th week)
- Optional midterm (14th week)
- Final exam (Exam period)

% achieved	Hungarian grade	ECTS equivalent	Explanation for the Hungarian grade
86-100	5	A	Excellent
71-85	4	B	Good
56-70	3	C	Satisfactory
40-55	2	D	Pass
0-39	1	F	Fail

Attendance, grading

- Attendance is not compulsory, but may result in extra points being awarded (e.g. tasks)

% achieved	Hungarian grade	ECTS equivalent	Explanation for the Hungarian grade
86-100	5	A	Excellent
71-85	4	B	Good
56-70	3	C	Satisfactory
40-55	2	D	Pass
0-39	1	F	Unfulfilled/Fail

Textbook and student workbook

- Micro textbook: Begg, D. – Fischer, S. – Dornbush, R.: Economics. McGraw-Hill.
- Student workbook: Ward D. – Begg, D.: Student Workbook for Economics. McGraw-Hill.
- The textbook is available in limited quantities in the library.

Web site: https://edu.gtk.bme.hu/?lang=en

Microeconomics and Macroeconomics

- **Microeconomics** offers a detailed analysis of particular activities in the economy. For simplicity, it may neglect some interactions with the rest of the economy. TODAY
- **Macroeconomics** emphasizes these interactions at the cost of simplifying the individual building blocks.
- **Macroeconomics** is the study of the economy as a system. ON WEDNESDAYS

Topics (Microeconomics)

Topics	Corresponding chapter in the textbook
Economics and the economy	1
Demand, supply and the market	3
Elasticities of demand and supply	4
Consumer choice and demand decisions	5
Introducing supply decisions	6
Costs and supply	7
Perfect competition and pure monopoly	8

Fundamental questions

- Economics analyses **what**, **how**, and **for whom** society produces.
- The **key economic problem** is to reconcile the conflict between **people's virtually unlimited demands** with **society's limited ability** to produce goods and services to fulfil these demands.

Economics: studying Choice in a World of Scarcity

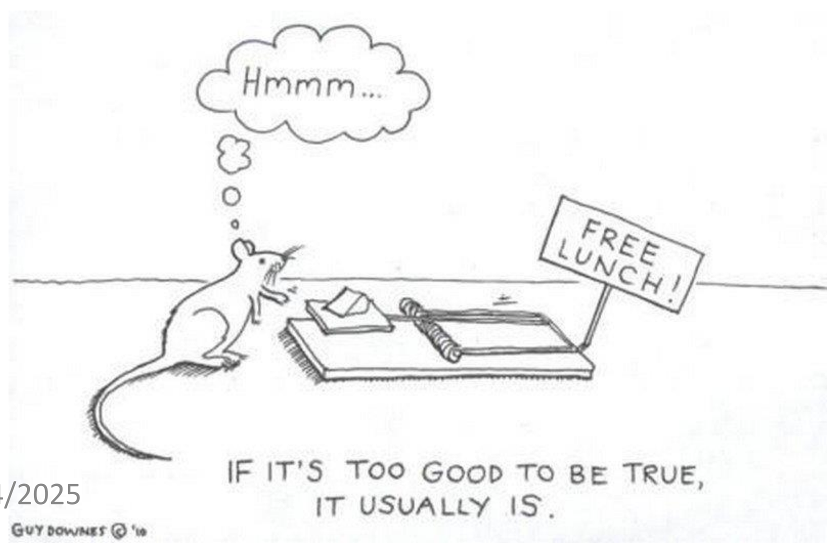
The Scarcity Principle
("No free lunch" principle)

– Boundless wants cannot be satisfied with limited resources.

– Therefore, having more of one thing usually means having less of another.

– Because of scarcity we must make choices.

There is No Such Thing as a Free Lunch



The Scarcity Principle: Examples

Scarcity is involved in

- **Global warming**
- **Political elections**
- **Career choices**
- **Buying bottled water**

The Scarcity Principle: Examples

Scarcity: Time is a valuable asset, too

Should Elon Musk pick up a $100 bill while hurrying to a business meeting?

Should a famous divorce lawyer write his own will?

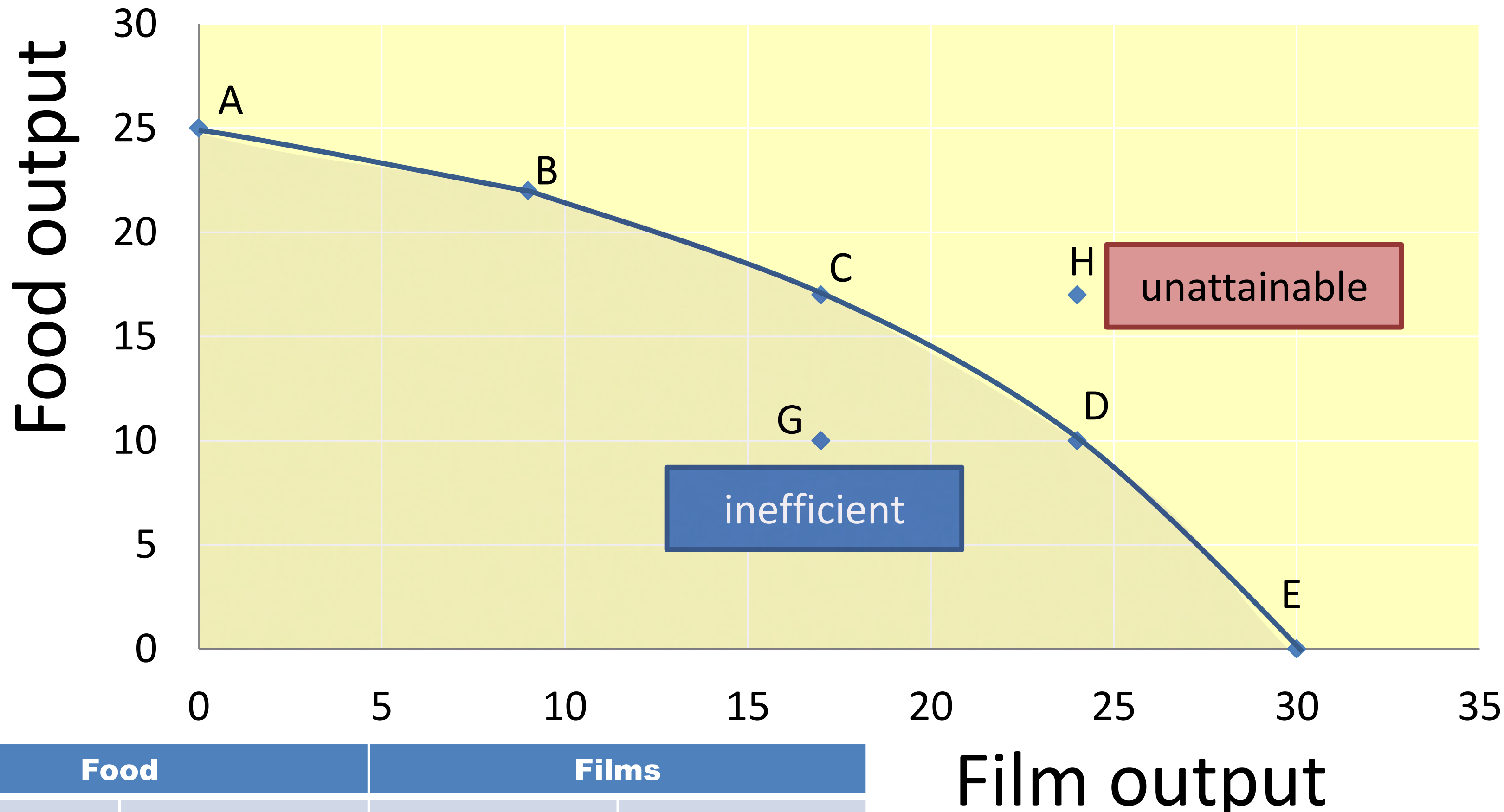
Production possibility frontier (PPF)

- The **production possibility frontier** shows the maximum amount of one good that can be produced given the output of the other good.
- It depicts the **trade-off** or menu of choices for society in deciding what to produce.

Production possibilities

Food		Films	
Workers	Output	Workers	Output
4	25	0	0
3	22	1	9
2	17	2	17
1	10	3	24
0	0	4	30

Production possibility frontier



Food		Films	
Workers	**Output**	**Workers**	**Output**
4	**25**	**0**	**0**
3	**22**	**1**	**9**
2	**17**	**2**	**17**
1	**10**	**3**	**24**
0	**0**	**4**	**30**

Resources are scarce and points outside the frontier are **unattainable**. It is **inefficient** to produce within the frontier

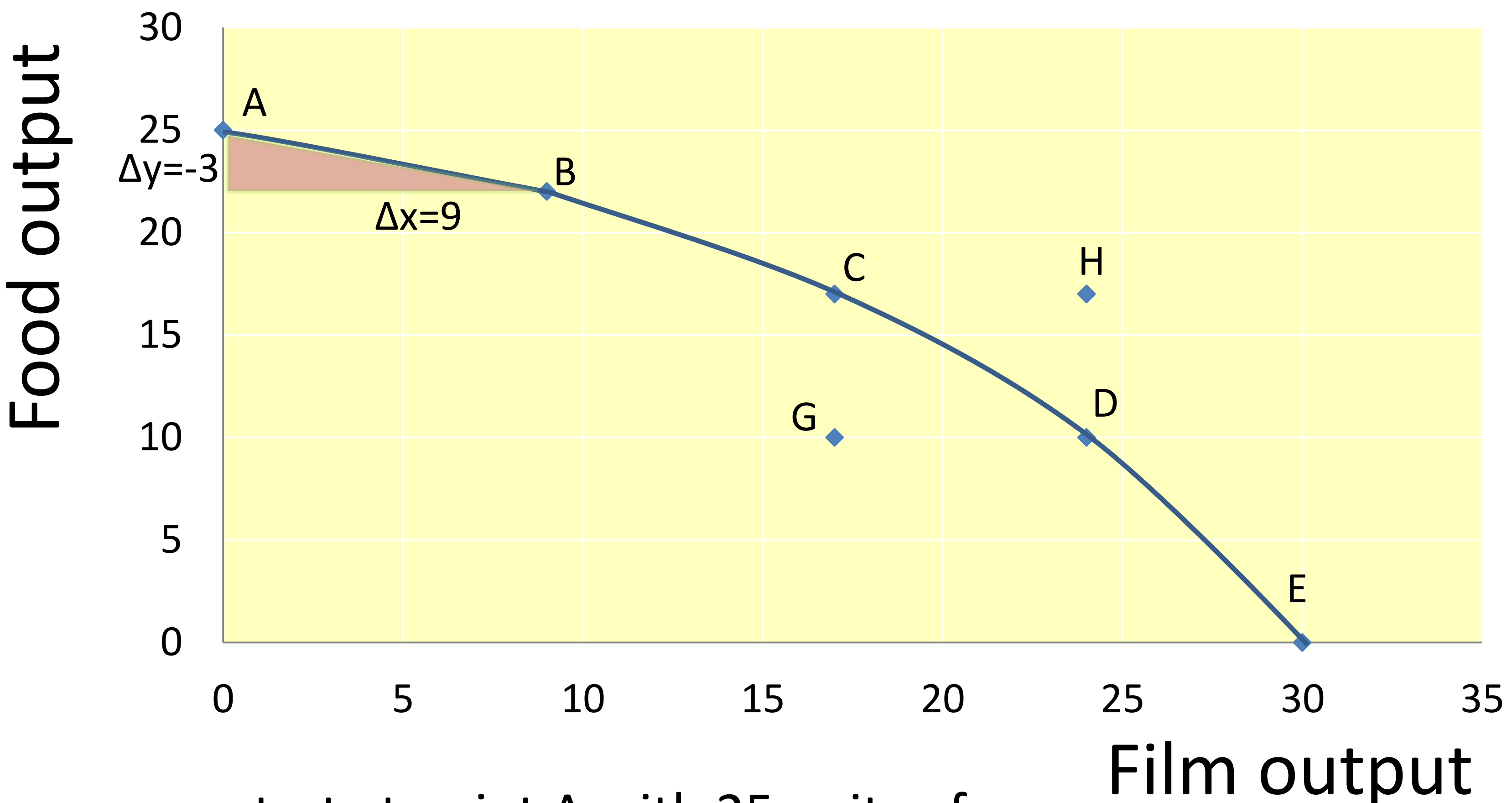
Opportunity cost

- The **opportunity cost** of a good is the quantity of other goods sacrificed to make an additional unit of the good. It is the slope of the production possibility frontier.

-?

+1

Opportunity cost (trade-off)



Suppose we start at point A with 25 units of food but no films. Moving from A to B, we gain 9 films but lose 3 units of food. Thus, 3 units of food is the opportunity cost of producing the first nine films.

Note that the curve becomes <u>steeper</u> as we move from point *A* to point *E*.

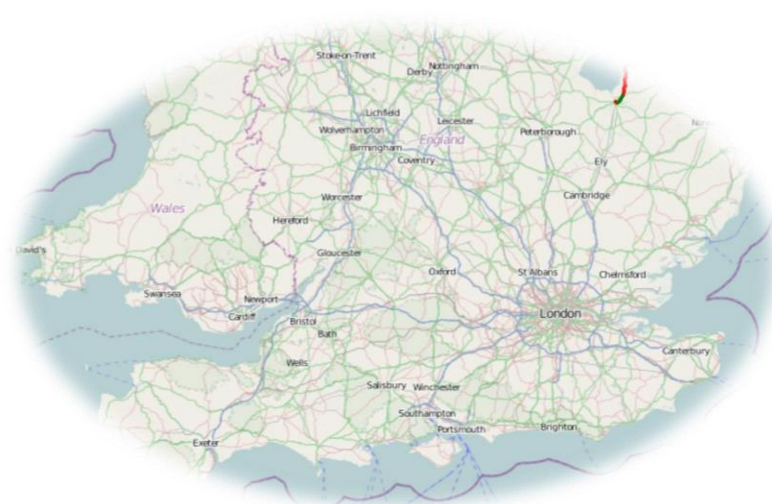
Opportunity cost (example)

- In a broader sense, opportunity cost refers to the value of the next-best alternative that must be forgone to undertake an activity.
- Joe Jamail, a highly successful divorce lawyer, employs another attorney to write his will. Why?
  - Writing his own will: ***2 hours***
  - Opportunity cost of 2 hours of Joe's time: ***$10,000+***
  - Hiring a junior lawyer to spend 4 hours on his will: ***$3,200***
  - Making the right economic choice: ***priceless***
- He should have done it himself only when:

Opportunity cost < hired cost

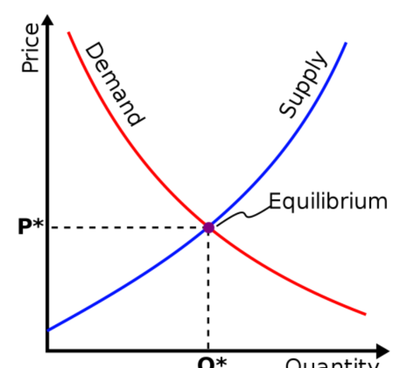
The role of economic models

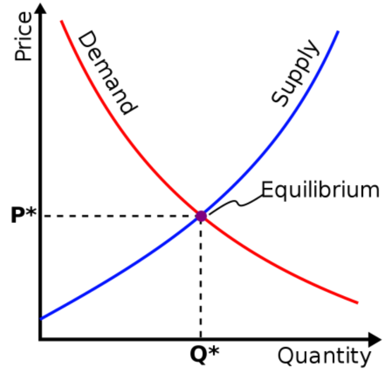
- Economic models are abstract constructs (simplified descriptions) that allow us to analyze situations in a logical way
- Other examples of abstract models
  - ➢A computer model of climate change
  - ➢A road map



The role of markets
(in a free market economy)

- Modern economies rely heavily on markets and prices to allocate resources between competing uses.
- The interplay of demand (the behaviour of buyers) and supply (the behaviour of sellers) determines the quantity of the good produced and the price at which it is bought and sold.





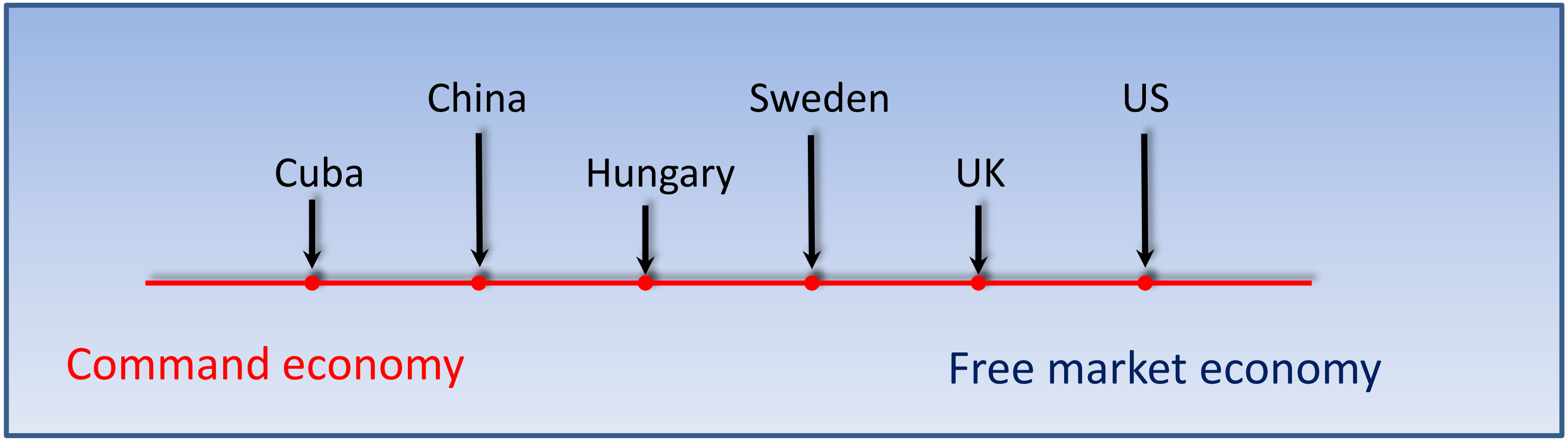
Markets

- A **market** is a set of arrangements by which buyers and sellers exchange goods and services.
- Markets determine prices that ensure that the quantity people wish to buy equals the quantity people wish to sell.
- Examples of markets:
  - Market for used cars
  - Market for gasoline
  - Stock market
  - Goods market
  - Labour market
  - Financial market

Microeconomics

Macroeconomics

Market orientation



In the **command economy** resources are allocated by central government planning. In the **free market economy** there is virtually no government regulation of the consumption, production, and exchange of goods. In between lies the **mixed economy**, where market forces play a large role but the government intervenes extensively.

Normative and Positive Economics

- **Normative economic principle** says how people *should* behave

Examples: opinion pieces in newspapers (even those written by economists).

Gas prices are too high

Building a space base on the moon will cost too much

- **Positive economic principle** explains causal relationships between economic variables and predicts how people *will* behave

The average price of gasoline in May 2010 was higher than in May 2009

Building a space base on the moon will cost more than the shuttle program

Increasing the duty on alcoholic beverages decreases their consumption

Normative and Positive Economics

- **Positive economics** studies how the economy actually behaves. **Normative economics** recommends what should be done.
- The two should be kept separate. Given sufficient research, economists could agree on issues in positive economics. Normative economics involves subjective value judgements. There is no reason why people should agree on normative statements!

Microeconomics and Macroeconomics

Microeconomics studies choice and its implications for price and quantity in individual markets

- Sugar
- Carpets
- House cleaning services

Microeconomics considers topics such as

- Costs of production
- Demand for a product
- Competition between firms

Macroeconomics studies the performance of national economies and the policies that governments use to try to improve that performance

- Inflation
- Unemployment
- Economic growth

Macroeconomics considers

- Monetary policy
- Deficits
- Tax policy

Supply and Demand

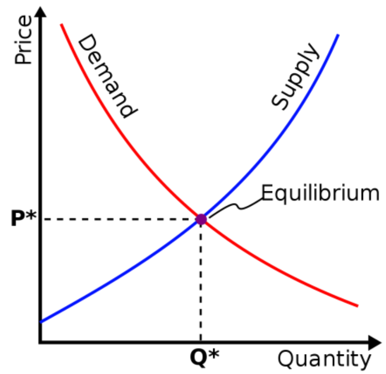
Demand and supply curves

Equilibrium price and quantity

Markets

Reminder

- A **market** is a set of arrangements by which buyers (🡐 demand) and sellers (🡐 supply) exchange goods and services.
- Markets determine prices (🡐 equilibrium p.) that ensure that the quantity people wish to buy equals the quantity people wish to sell.



Demand

- **Demand** is the quantity that buyers wish to purchase at each conceivable price.
- Demand is not a *particular* quantity, such as forty bars of chocolate (which might be the *quantity demanded* at a price of €2), but rather a full description of the quantity of chocolate buyers would purchase at each and every price that might be charged.

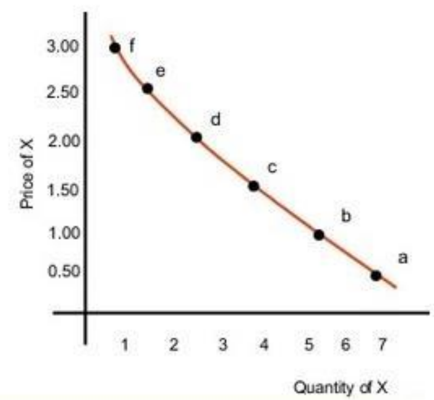
$$Q_D = f(P)$$

$$D(P): P \to Q_D$$

Demand Schedule

Point	Price [Rs per unit]	Quantity demanded of X [kg. per month]
a	0.50	7.0
b	1.00	5.0
c	1.50	3.5
d	2.00	2.5
e	2.50	1.5
f	3.00	1.0

Demand Curve



Supply

- **Supply** is the quantity of a good sellers wish to sell at each possible price.
- Supply is not a particular quantity but a complete description of the quantity that sellers want to sell at each possible price.

$$Q_S = f(P)$$

$$S(P): P \to Q_S$$

Note the distinction between *demand/supply* and *quantity demanded/supplied*:

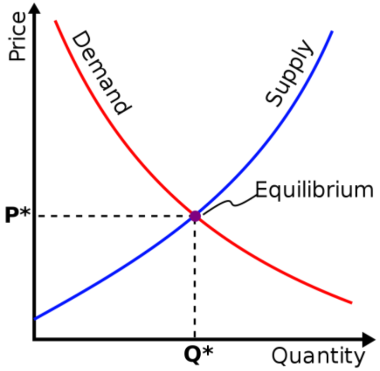
- Demand/supply describe the behaviour of buyers/sellers at *every price*.
- At a *particular price* there is a particular quantity demanded/supplied.

Example: demand and supply of chocolate

(1) Price (€/bar)	(2) Quantity demanded (no. of bars)	(3) Quantity supplied (no. of bars)
0	200	0
0.5	160	0
1	120	40
1.5	80	80
2	40	120
2.5	0	160
3	0	200

Ceteris paribus (other things equal)

- The demand and supply schedules are each constructed on the assumption of ***ceteris paribus*** (Latin for *'[all] other things [being] equal*')
- E.g. if the prices of candies change, the demand for chocolate might also change.
- *Other things equal*, the lower the price of chocolate, the higher the quantity demanded.
- *Other things equal*, the higher the price of chocolate, the higher the quantity supplied.



Equilibrium price

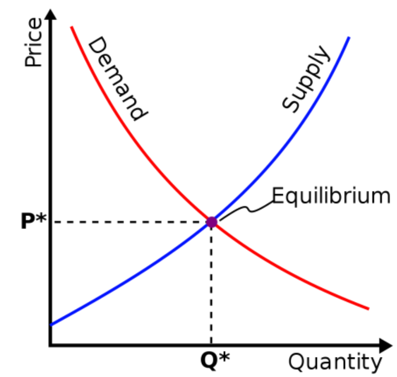
$$P^*: Q_S(P^*) = Q_D(P^*)$$

- We combine the behaviour of buyers and sellers to model the market for chocolate bars.
- At low prices, the quantity demanded exceeds the quantity supplied but the reverse is true at high prices.
- At some intermediate price, which we call the **equilibrium price**, the quantity demanded equals the quantity supplied.

The equilibrium quantity

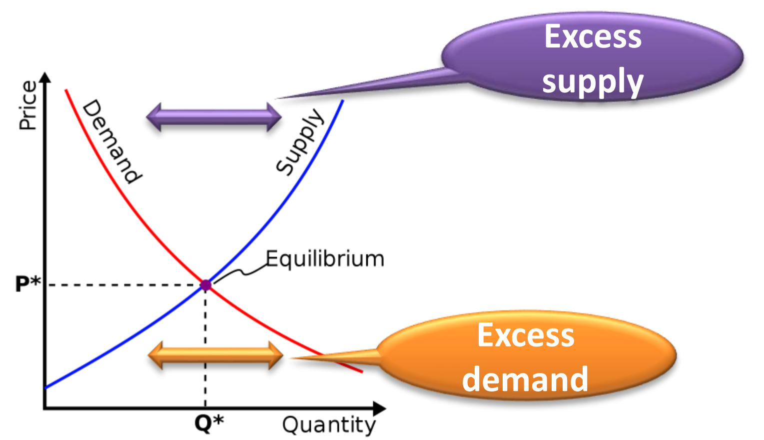
- The **equilibrium price** clears the market for chocolate. It is the price at which the quantity supplied equals the quantity demanded.
- In our previous example, the equilibrium price was €1.5, at which 80 bars is the **equilibrium quantity**, the quantity buyers wish to buy and sellers wish to sell.

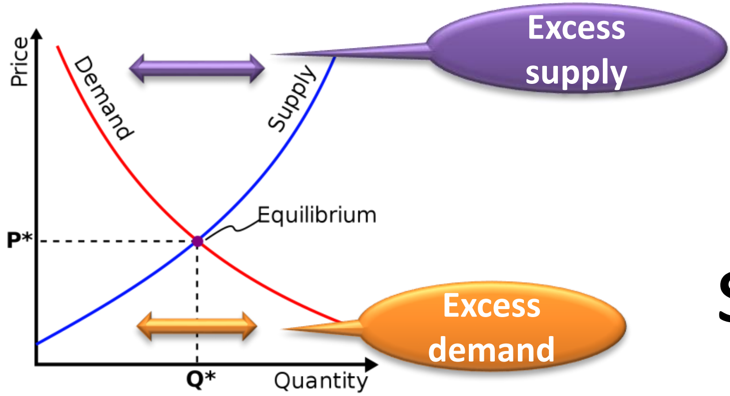
$$Q^* = Q_S(P^*) = Q_D(P^*)$$



Excess demand and supply

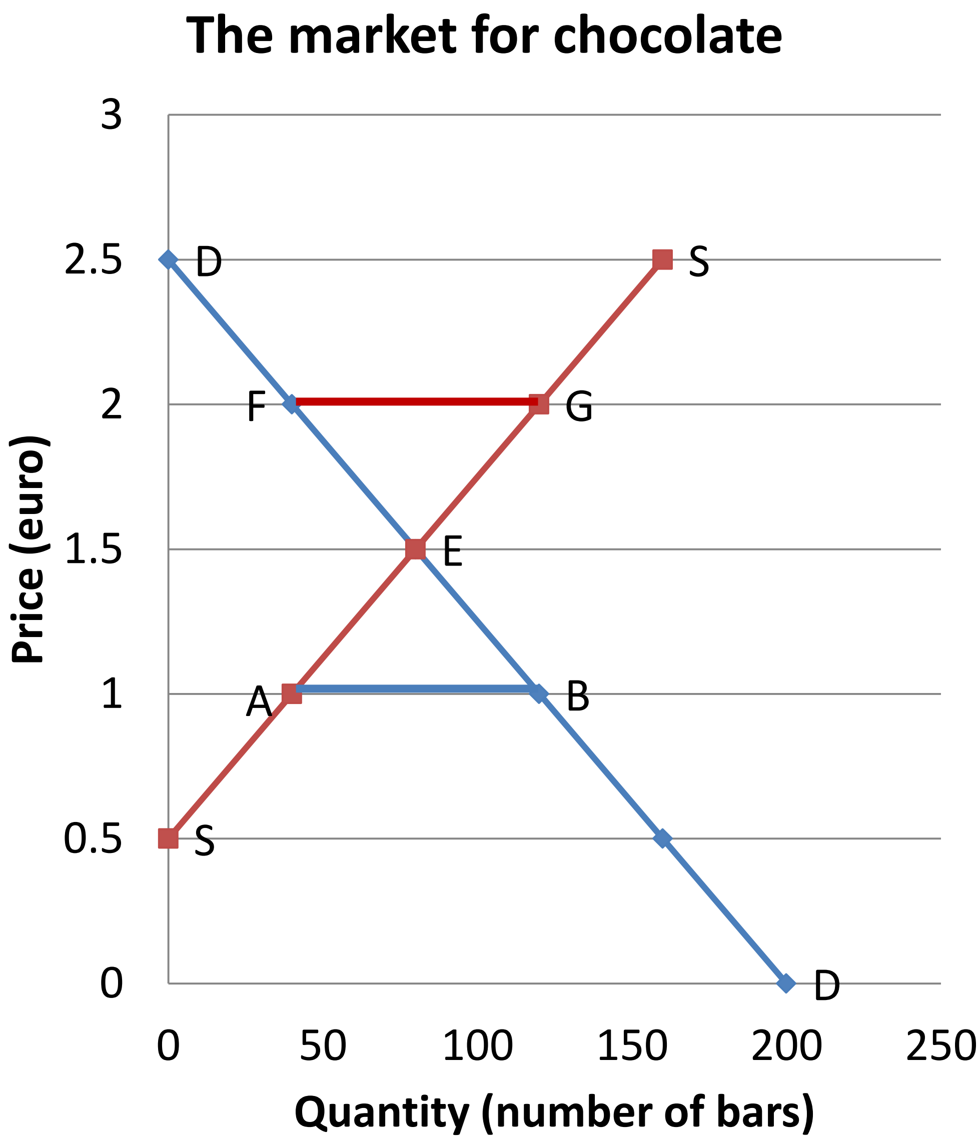
- At prices below the equilibrium price, the quantity demanded exceeds the quantity supplied and some buyers are frustrated. There is a shortage ('excess demand').
- Conversely, at any price above the equilibrium price, the quantity supplied exceeds the quantity demanded. Sellers have unsold stock ('excess supply').





Demand and supply curves

- The demand curve shows the relation between price and quantity demanded, holding other things constant. ($D(P): P \rightarrow Q_D$)
- The supply curve shows the relation between price and quantity supplied, holding other things constant. ($S(P): P \rightarrow Q_S$)
- Excess supply or excess demand provide incentives to change prices towards the equilibrium price.



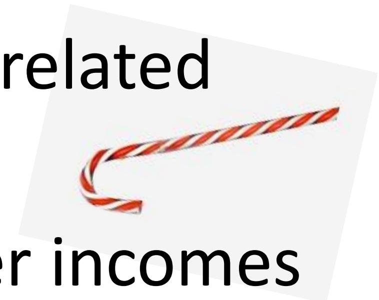
Market equilibrium is at E.
At prices below the equilibrium price there is excess demand: AB shows the excess demand at the price €1.
At prices above the equilibrium price there is excess supply: FG shows the excess supply at the price €2.

Determinants of quantity supplied and demanded

Shifts in the demand curve

Determinants of quantity demanded:

- Prices of related goods
- Consumer incomes
- Tastes or habits



Determinants of quantity supplied:

- The price of inputs
- Technology
- The degree of government regulation

Shifts in the supply curve

The price of the commodity itself

Movements ***along*** a curve

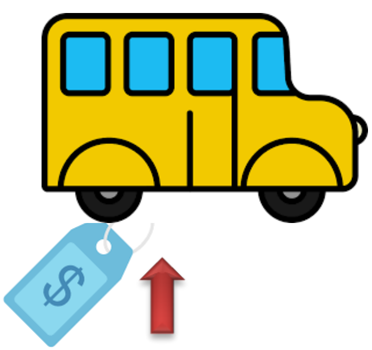
Behind the demand curve

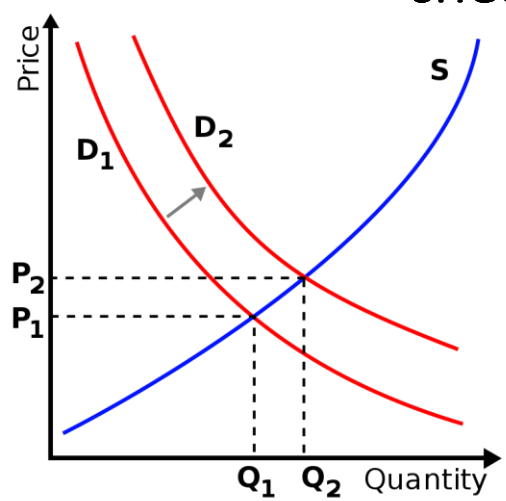
The price of related goods:

An increase in price of a substitute good (e.g. buses for cars) or a decrease in price of a complement good (petrol for cars) will raise the quantity demanded at each price.

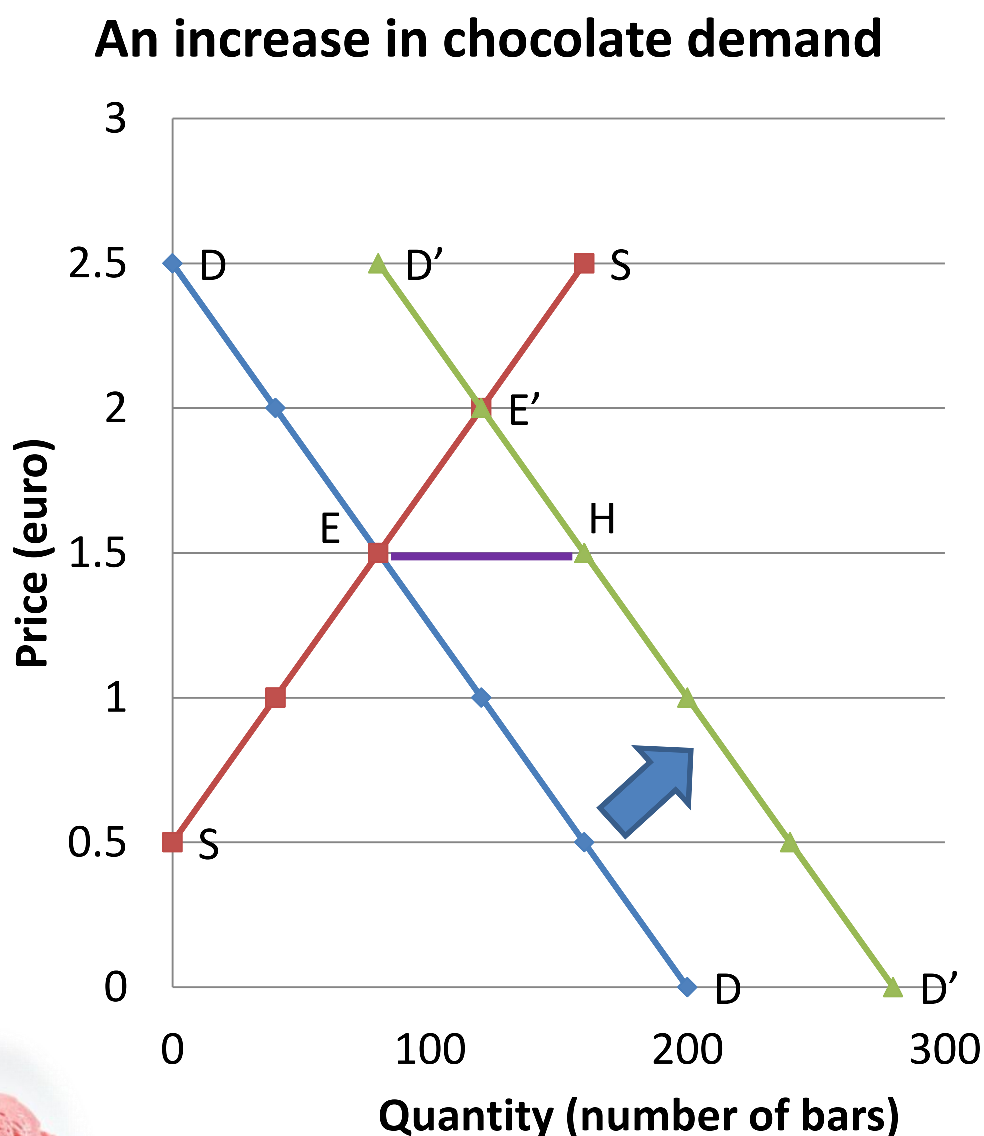
Consumer income:

An increase in consumer income will increase demand for the good if the good is a normal good (like most goods) but decrease demand for the good if it is an inferior good (typically, but not necessarily, cheap, low quality goods).

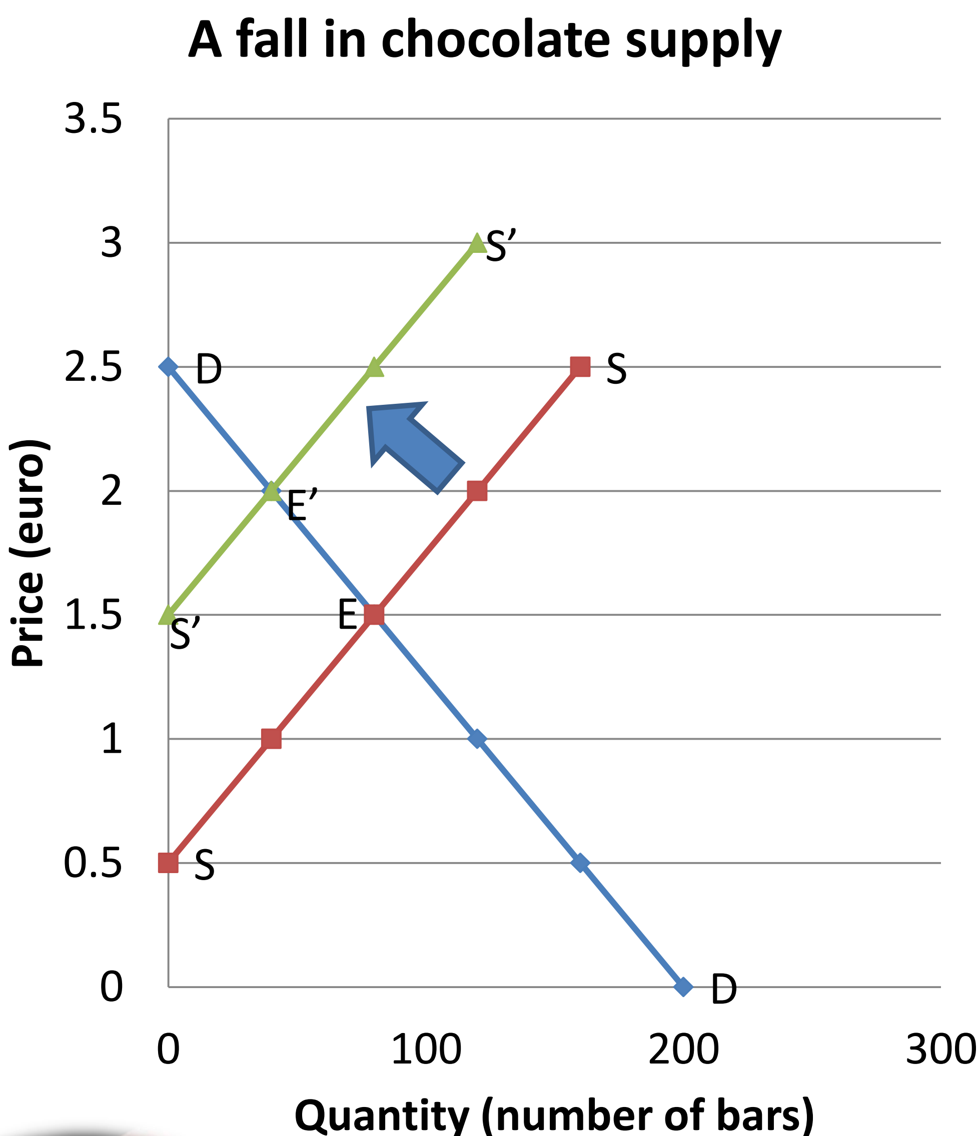




<u>Inferior good:</u> goods/services which are in greater demand during a recession than in a boom, for example second-hand clothes.



At low ice cream prices, the demand curve for chocolate is DD and the market equilibrium occurs at E. Higher ice cream prices raise the demand for chocolate, shifting the demand curve to D’D’. At the former equilibrium price there is now excess demand EH, which gradually bids up the price of chocolate until the new equilibrium is reached at E’.



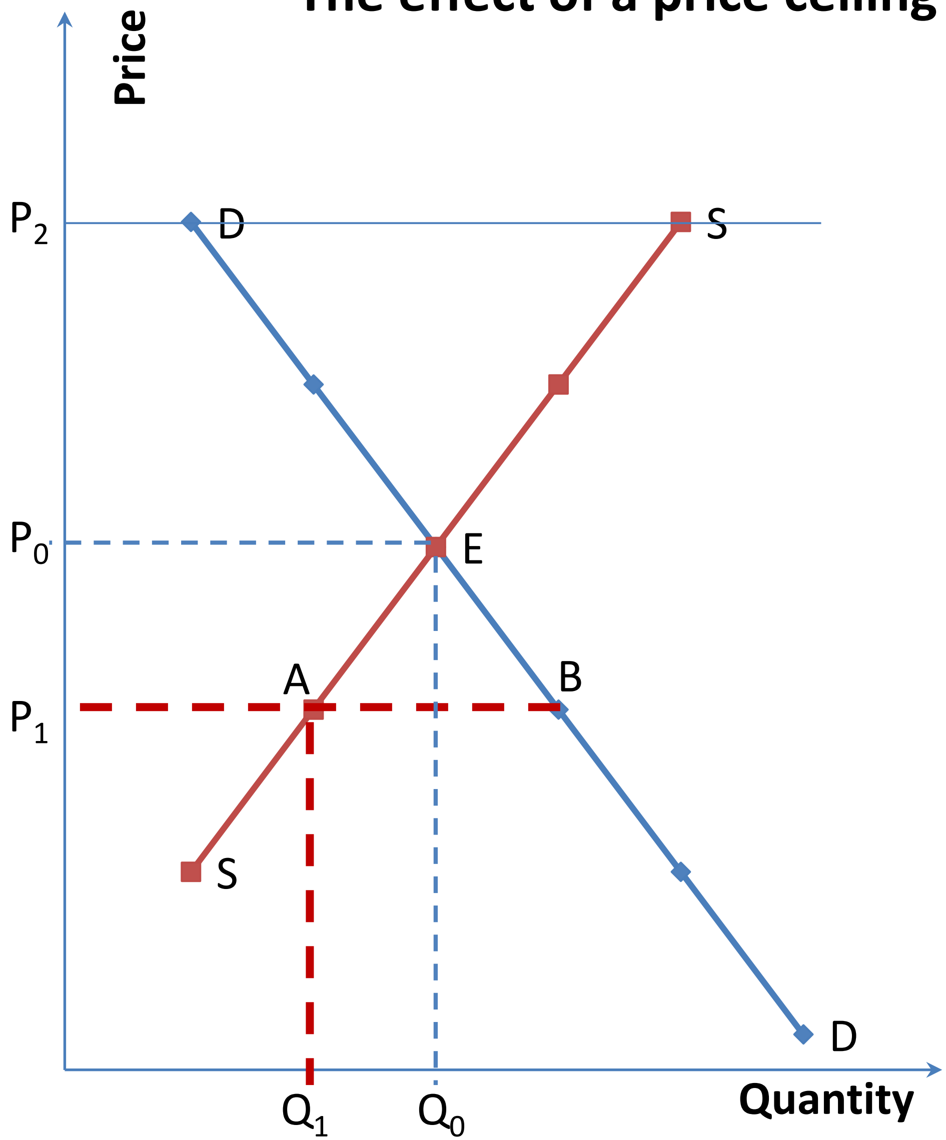
The supply curve initially is SS and market equilibrium is at E. A reduction in the supply of chocolate shifts the supply curve to the left to S'S'. The new equilibrium at E' has a higher equilibrium price and a lower equilibrium quantity than the old equilibrium at E.

- Any factor inducing an increase in demand shifts the demand curve to the right, increasing equilibrium price and equilibrium quantity.
- A decrease in demand (downward shift of the demand curve) reduces both equilibrium price and quantity.
- Any factor increasing supply shifts the supply curve to the right, increasing equilibrium quantity but reducing equilibrium price.
- Reductions in supply (leftward shift of the supply curve) reduce equilibrium quantity but increase equilibrium price.

Free markets and price controls

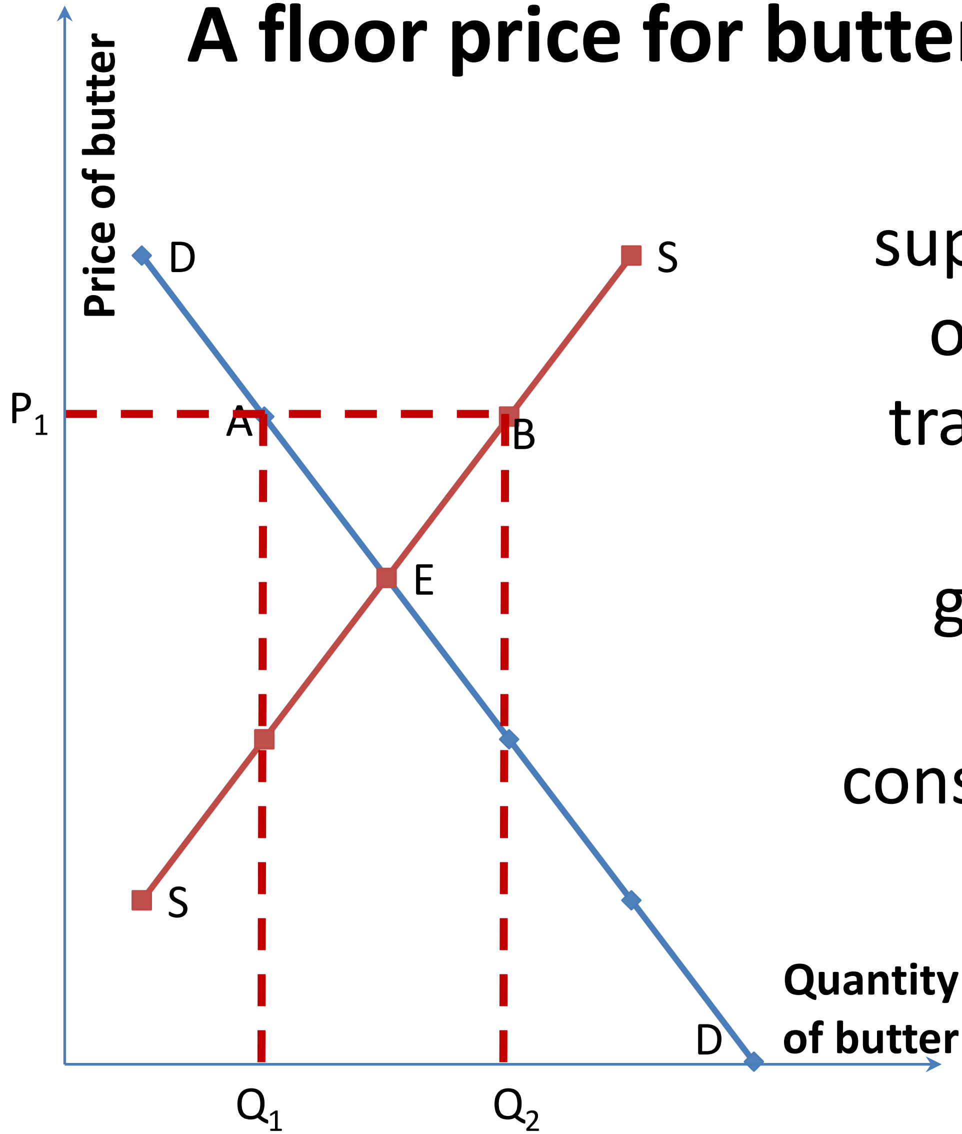
- Free markets allow prices to be determined purely by the forces of supply and demand.
- Price controls are government rules or laws that forbid the adjustment of prices to clear markets.
- **Price ceilings** make it illegal to charge more than a specific maximum price (‘ceiling price’).
- **Price floors** mean that prices can’t be lower than a specific minimum price (‘floor price’).

The effect of a price ceiling



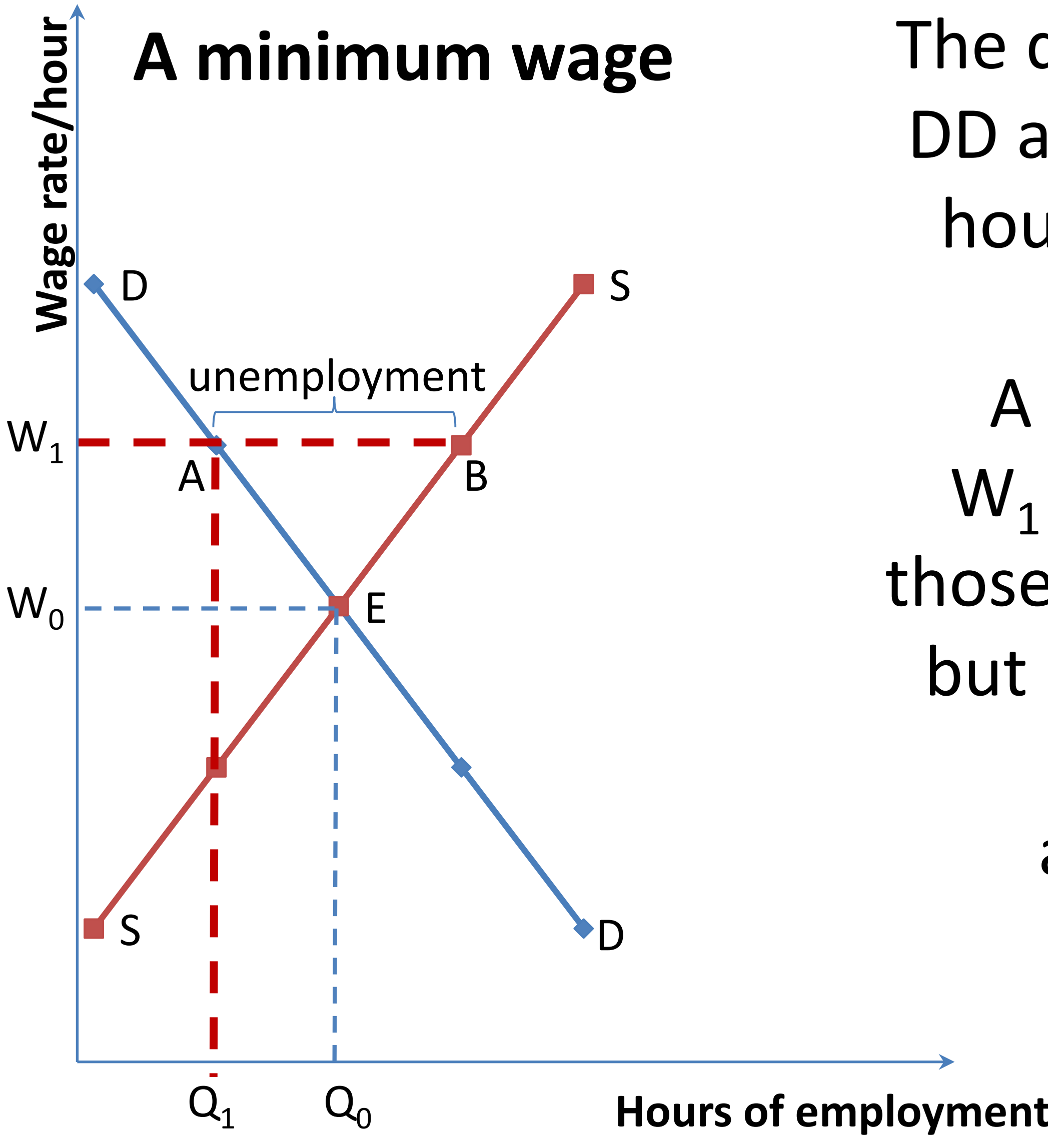
Free market equilibrium occurs at the point E.
The high price P_0 chokes off quantity demanded to ration scarce supply.
A price ceiling at price P_1 succeeds in holding down the price but leads to excess demand AB. It also reduces quantity supplied from Q_0 to Q_1.
A price ceiling at P_2 is irrelevant since the free market equilibrium at E can still be attained.

A floor price for butter



At the floor price P_1 supply is Q_2, but demand only Q_1. Only Q_1 will be traded. By buying up the excess supply AB, the government can satisfy both suppliers and consumers at the price P_1.

A minimum wage

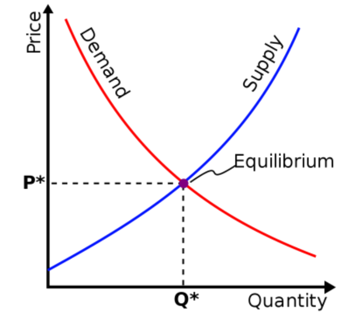


The demand curve for hours DD and the supply curve for hours SS imply free market equilibrium at E.
A legal minimum wage at W_1 raises hourly wages for those who remain employed but reduces the quantity of hours of employment available from Q_0 to Q_1.

Effective price controls

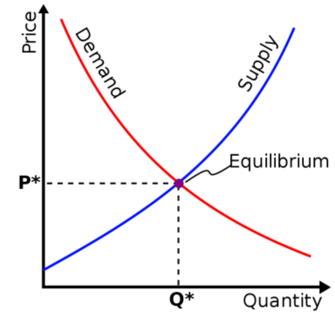
- To be effective, a price ceiling must be imposed below the free market equilibrium price. It will then reduce the quantity supplied and lead to excess demand unless the government itself provides the extra quantity required.
- An effective price floor must be imposed above the free market equilibrium price. It will then reduce the quantity demanded unless the government adds its own demand to that of the private sector.

How markets answer what and for whom to produce?

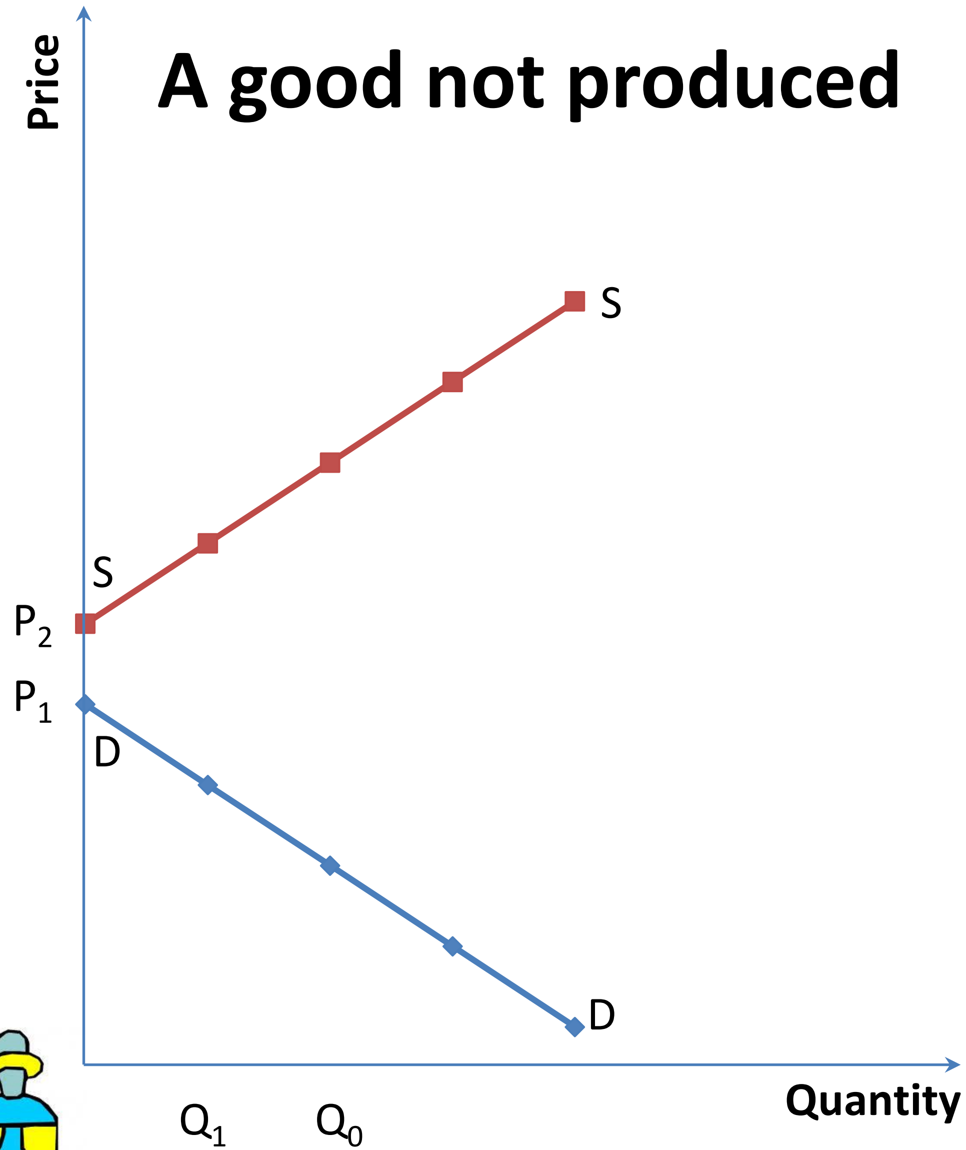


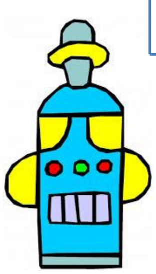
- The market decides how much of a good should be produced by finding the price at which the quantity demanded equals the quantity supplied.
- The market tells us for whom the goods are produced: each good is purchased by all those consumers willing (and able to) pay at least the equilibrium price for the good.

How markets answer what and for whom to produce?



- The market also tells us who is producing: all those willing to supply at the equilibrium price.
- Finally, the market determines what goods are being produced. Nature supplies goods free of charge, but people engage in costly (*including op. costs*) production activities only if they are paid. The supply curve tells us how much has to be paid to induce supply.



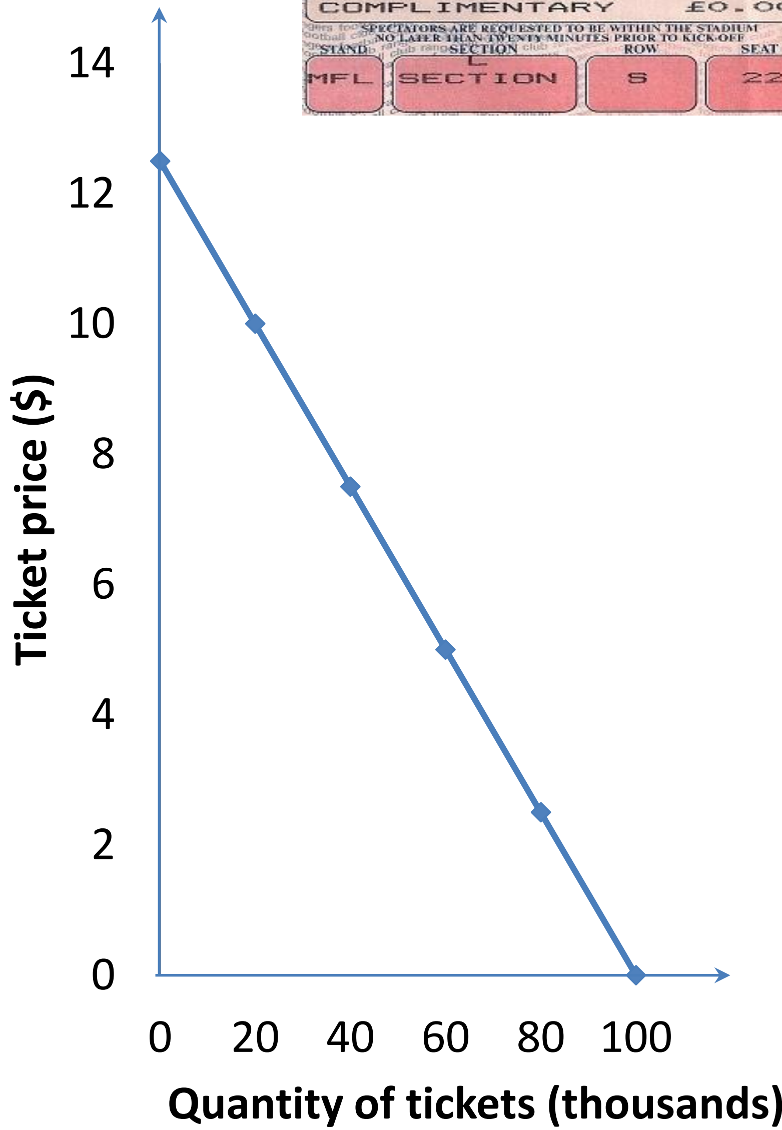


The figure to the left shows a good that will not be produced. Even P_1, the highest price consumers will pay, is lower than P_2, the minimum price producers require to produce any of this good.

Elasticities of Demand and Supply

Micro- and Macroeconomics

The demand for football tickets



For given prices of related goods and consumer incomes, higher ticket prices reduce the quantity of tickets demanded.

How can firms **increase** their revenues?

The price elasticity of demand

- The (own-)price elasticity of demand (also: demand elasticity) is the percentage change in the quantity demanded divided by the corresponding percentage change in its price.

$$\varepsilon_D = \frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}} = \frac{p\Delta q}{q\Delta p}$$

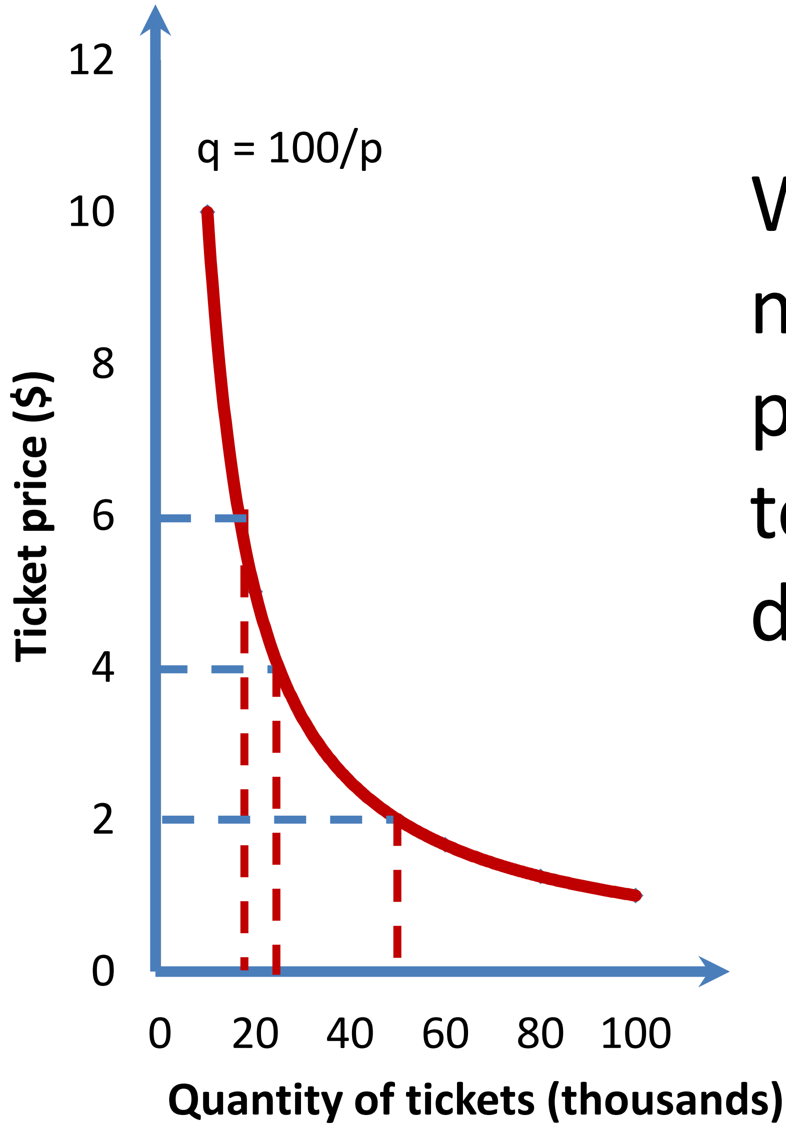
$$\varepsilon_D = \frac{\Delta q\%}{\Delta p\%}$$

It measures the sensitivity of quantity demanded to changes in the own price of a good, holding constant the prices of other goods and income. Demand elasticities are (almost always) negative since demand curves slope down. In general, the demand elasticity changes as we move along a given demand curve. Along a straight-line demand curve, elasticity falls in absolute value as we move down from the vertical intercept.

The demand for football tickets

(1) Price ($/ticket)	(2) Tickets demanded (000s)	(3) Price elasticity of demand
12.50	0	$-\infty$
10.00	20	-4
7.50	40	-1.5
5.00	60	-0.67
2.50	80	-0.25
0	100	0

A nonlinear demand curve



When a demand curve is nonlinear, price rises and price cuts of equal size lead to quantity changes that differ in size.

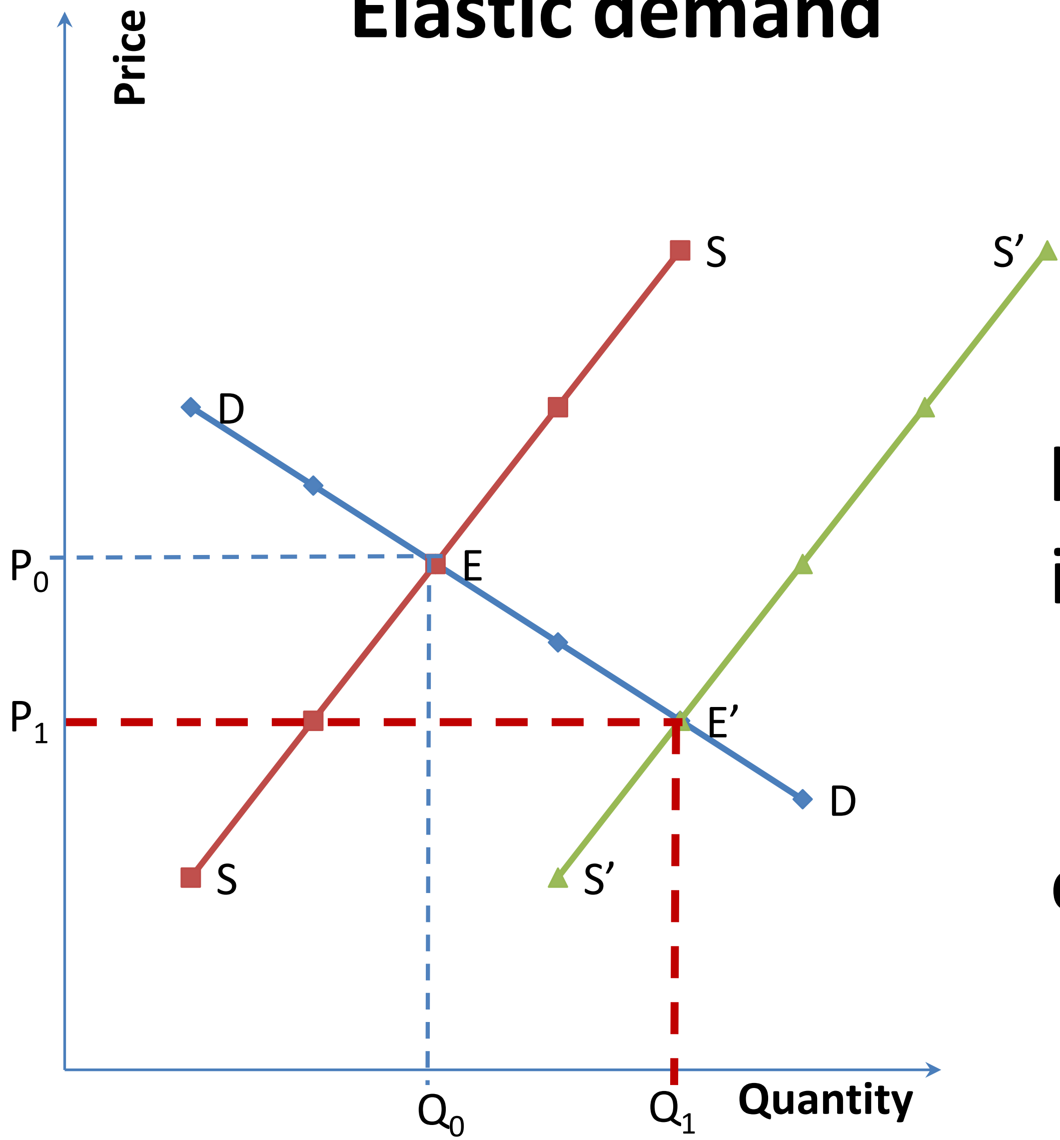
Economists resolve this ambiguity about the definition of elasticities by defining them with respect to very small (infinitesimal) changes:

$$\varepsilon_D = \frac{\partial q}{\partial p}\frac{p}{q} = \frac{\partial \ln(q[p])}{\partial \ln(p)}$$

Elastic and inelastic demand

- Although elasticity typically falls (in absolute value) as we move down the demand curve, an important dividing line occurs at the demand elasticity of **−1**.
- Demand is **elastic** if the price elasticity is more negative than −1.
- Demand is **inelastic** if the price elasticity lies between −1 and 0.
- If the demand elasticity is exactly −1, demand is **unit-elastic**.

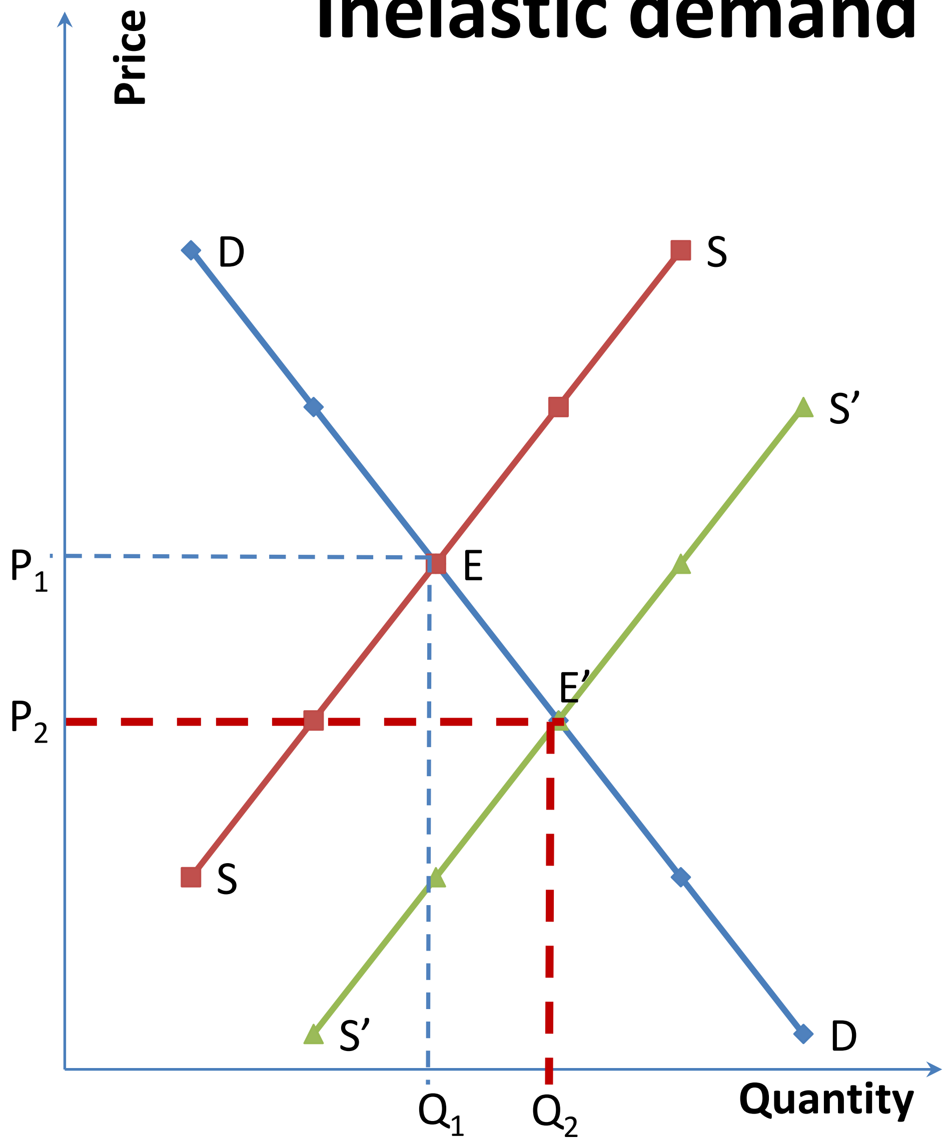
Elastic demand



The supply curve fluctuates between SS and S'S'.

In this case, demand is elastic, and supply shifts lead to large changes in equilibrium quantity but little change in equilibrium price.

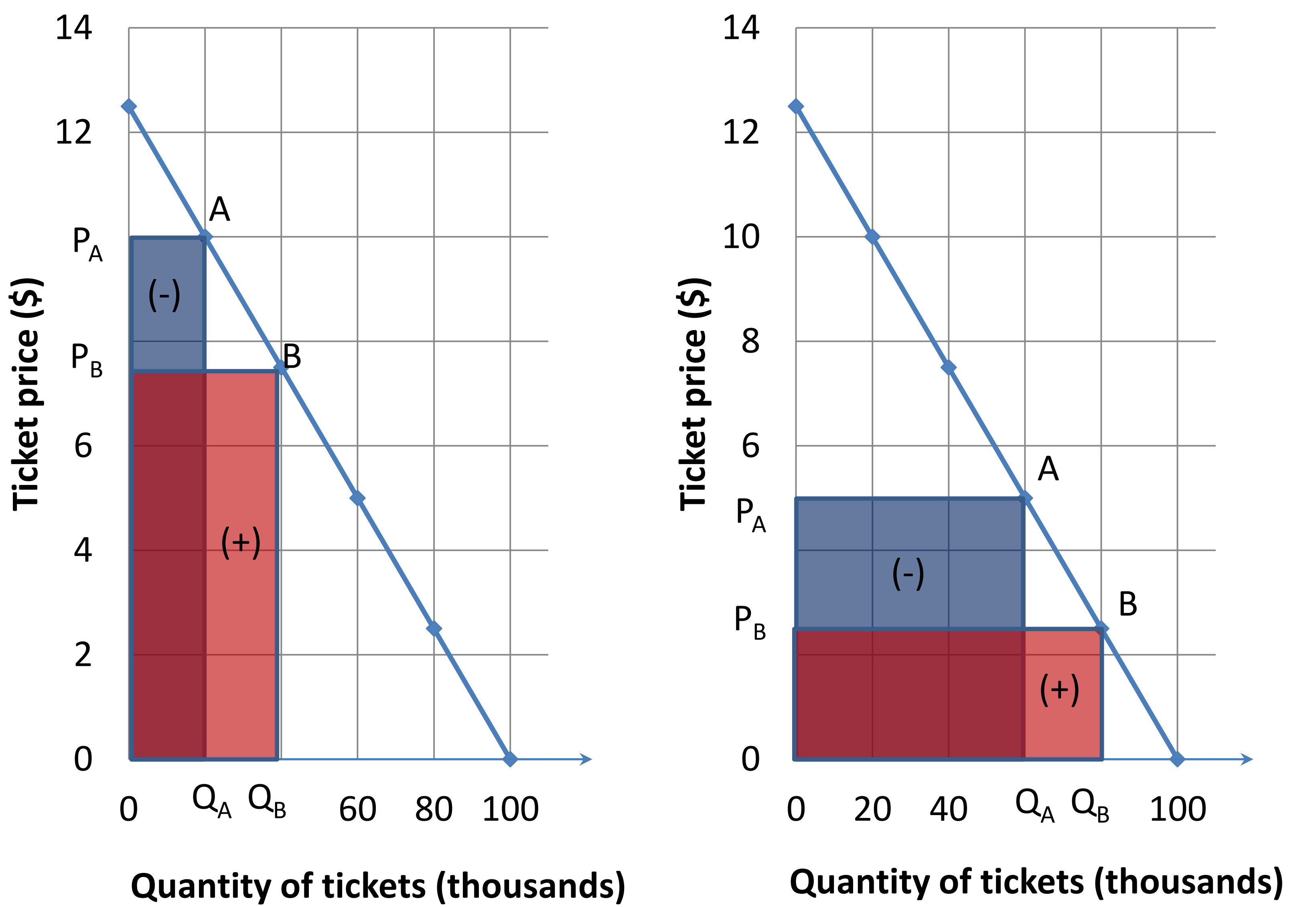
Inelastic demand



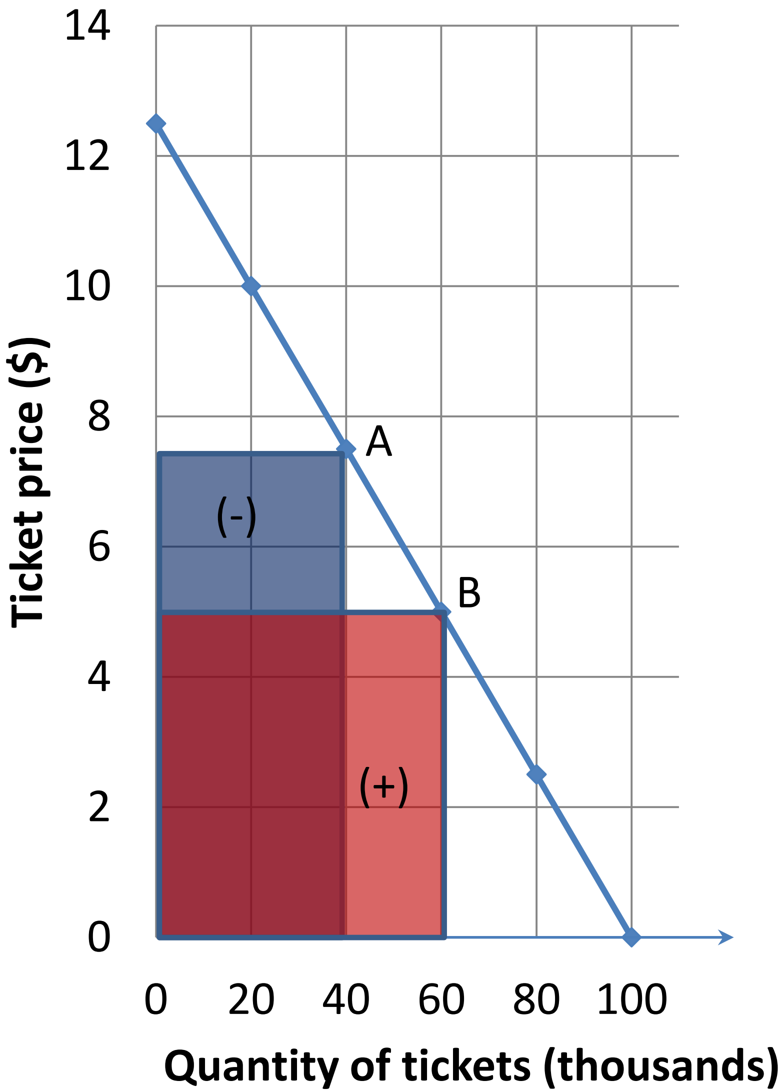
In this case, demand is less elastic, and supply shifts lead to larger changes in equilibrium price but smaller changes in equilibrium quantity.

If demand is unit-elastic $\Delta p\% = -\Delta q\%$.

The effect of price changes on expenditure



The effect of price changes on expenditure



When the price is reduced from P_A to P_B, expenditure changes from $Q_A \cdot P_A$ to $Q_B \cdot P_B$. Spending rises when demand is elastic (first case), falls when demand is inelastic (second case), and is unchanged when demand is unit-elastic (see the figure to the left).

Demand elasticities and changes in spending

Change in total spending caused by	Price elasticity of demand: Elastic (e.g. −5)	Unit-elastic (−1)	Inelastic (e.g. −0.2)
Price rise	Fall	Unchanged	Rise
Price cut	Rise	Unchanged	Fall

(1) Ticket price ($)	(2) Quantity demanded (000s)	(3) Price elasticity of demand	(4) Total spending ($000s)
12.5	0	-∞	0
10	20	-4	200
7.5	40	-1.5	300
6.25	50	-1	312.5
5	60	-0.67	300
2.5	80	-0.25	200
0	100	0	0

Short run and long run

- The demand elasticity depends on how long customers have to adjust to a price change. In the short run, substitution possibilities may be limited.
- Demand elasticities will typically rise (become more negative) with the length of time allowed for adjustment. The time required for complete adjustment (→ long run) varies from good to good.

The cross-price elasticity of demand

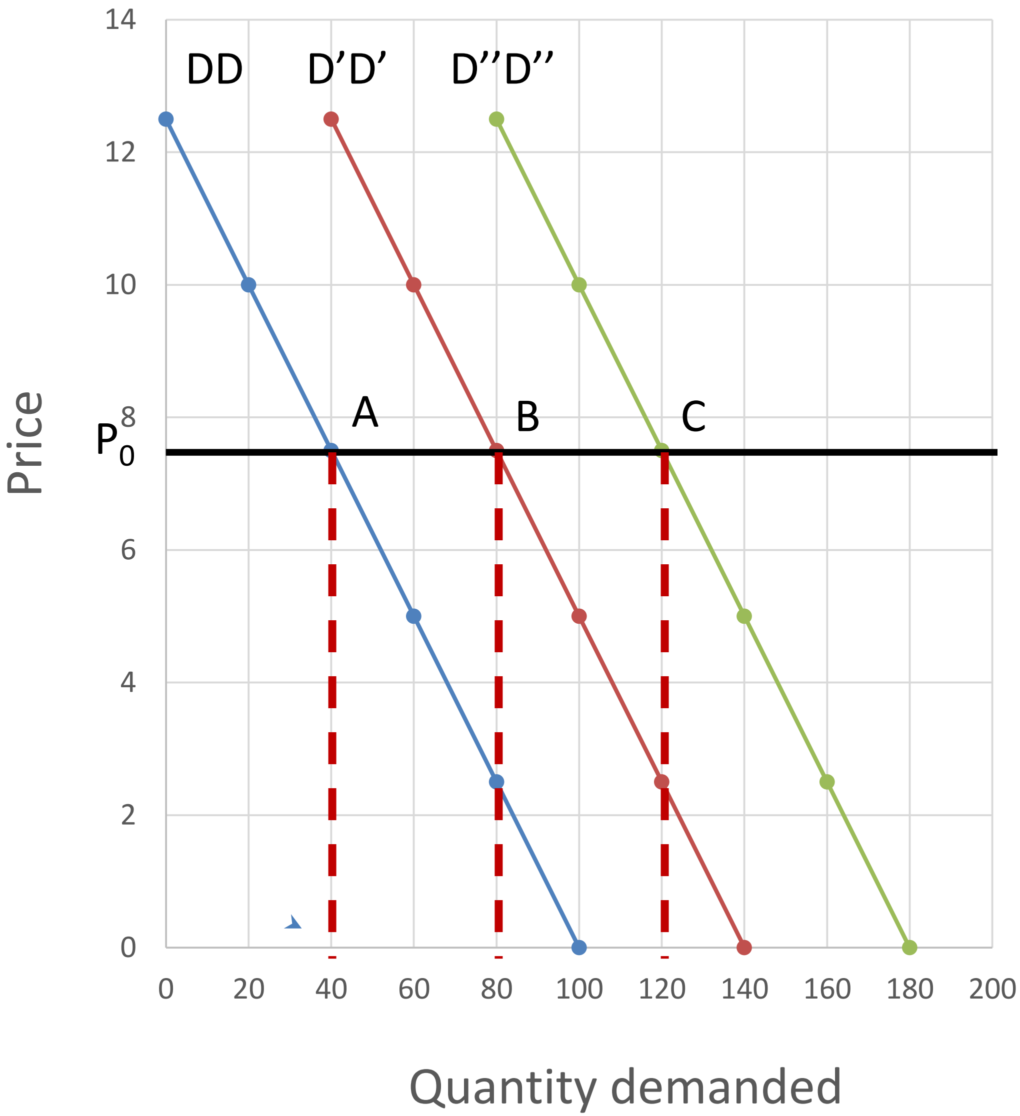
- The cross-price elasticity of demand for good i with respect to changes in the price of good j is the percentage change in the quantity of good i demanded, divided by the corresponding percentage change in the price of good j.

$$\varepsilon = \frac{\partial q_i}{\partial p_j} \cdot \frac{p_j}{q_i} = \frac{\partial \ln(q_i[p_i, p_j])}{\partial \ln(p_j)}$$

Positive cross-elasticities tend to imply that goods are substitutes.

Negative cross-price elasticities suggest that goods are complements.

Income elasticity and shifts in the demand curve



Beginning at A on the demand curve DD, the income elasticity measures the horizontal shift in the demand curve when income rises 1 per cent.

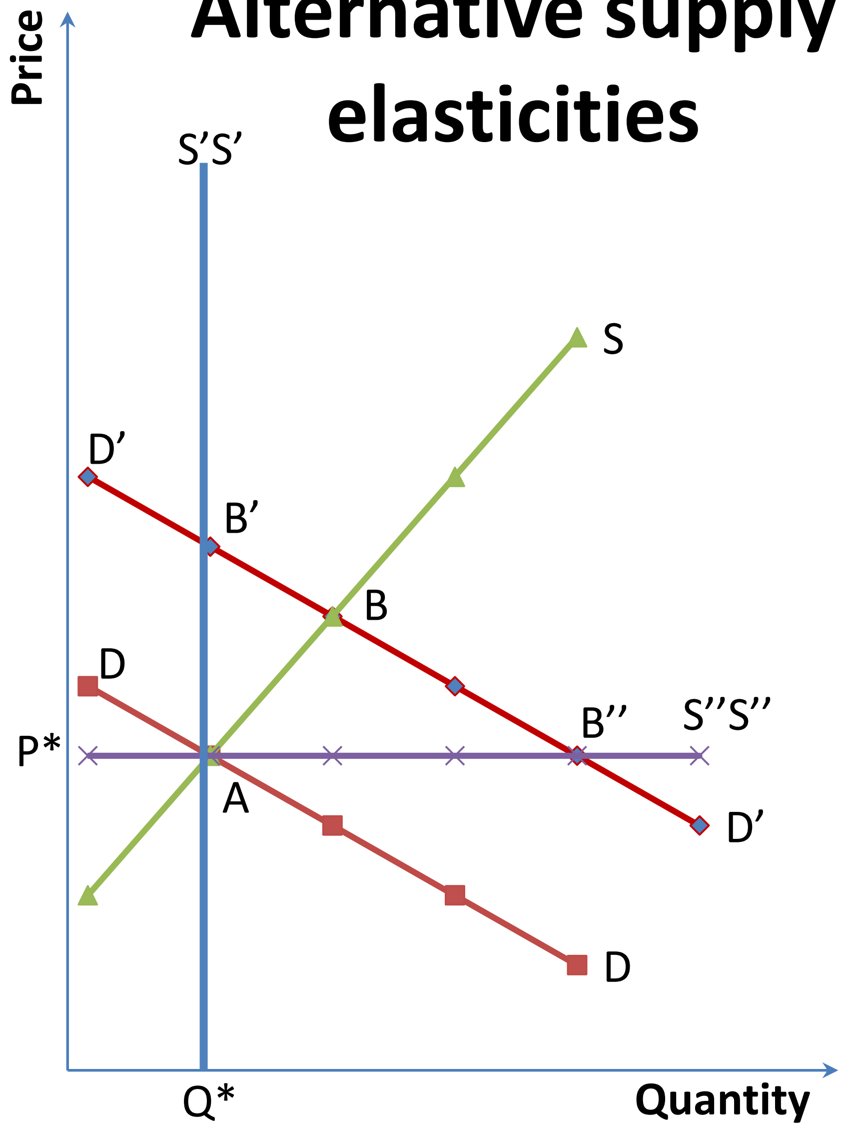
At the given price P_0, a shift to B on the demand curve D'D' reflects a lower income elasticity than a shift to C on the demand curve D''D''. Leftward shifts in the demand curve when income rises indicate a negative income elasticity.

Demand responses to a 1% rise in income

Good	Income elasticity	Quantity demanded	Budget share	Example
Normal	Positive	Rises		
Luxury	Above 1	Rises more than 1%	Rises	BMW
Necessity	Between 0 and 1	Rises less than 1%	Falls	Food
Inferior	Negative	Falls	Falls	Bread

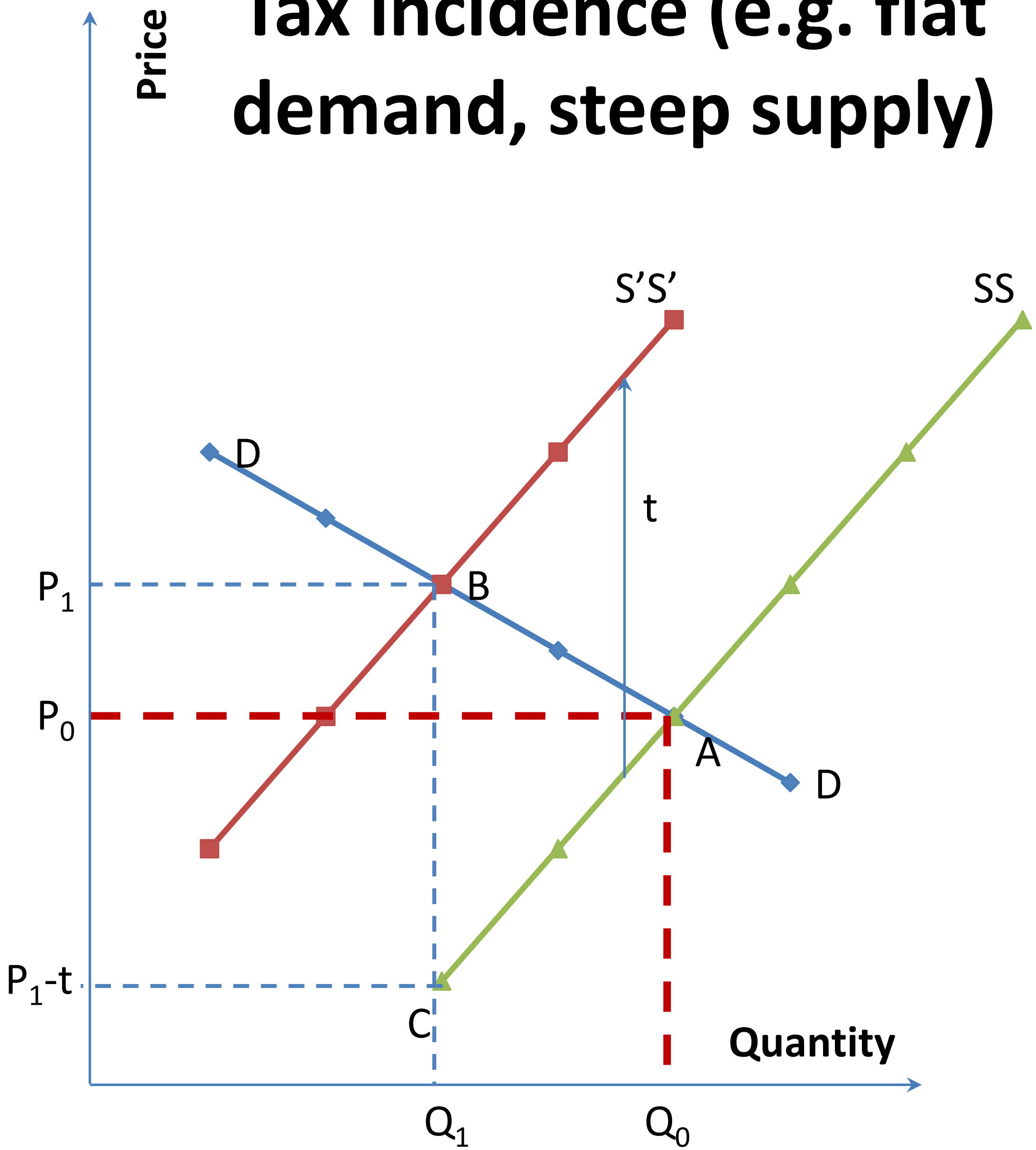
The **budget share** of a good is its price times the quantity demanded, divided by total consumer spending or income.

Alternative supply elasticities



The supply elasticity measures the percentage response of quantity supplied to a 1 per cent increase in the price of a commodity. Since supply curves slope up, supply elasticity is positive (or at least non-negative).

Tax incidence (e.g. flat demand, steep supply)



Tax incidence measures who really pays the tax. Since tax changes induce changes in the equilibrium prices and quantities, this can be very different from the people from whom the government appears to collect the money.

Specific and ad valorem taxes

- For **specific** taxes (t per unit; $T = t \cdot q$), slopes of supply and demand curves are relevant.
- For **ad valorem** taxes (these are measured as a percentage of the commodity's value*), elasticities of supply and demand are relevant.
- In either case, it is the relatively more price insensitive side of the market that bears more of the burden of a tax.

*Common example: value added taxes;

Tax revenue for ad valorem taxes = $\tau \cdot p \cdot q$

Consumer choice and demand decisions 1

Budget lines

Indifference curves

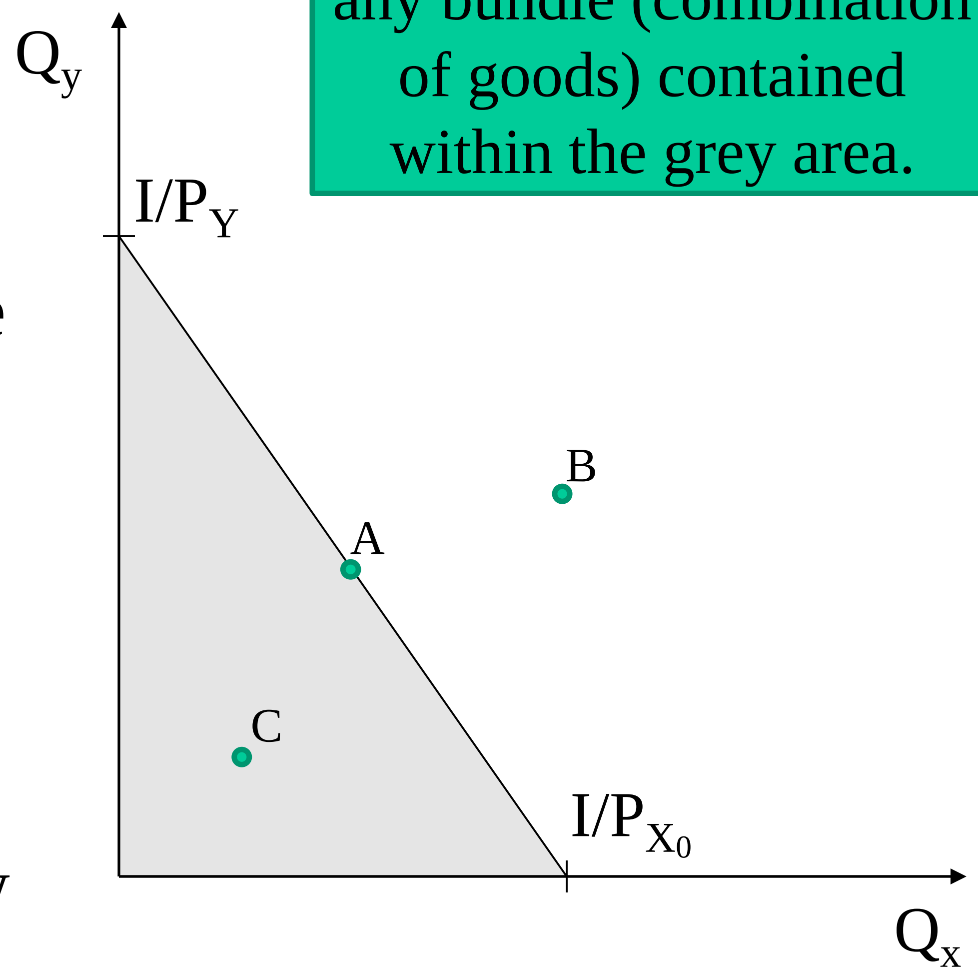
Consumer choice

MICRO- AND MACROECONOMICS

The budget constraint

- The budget constraint describes the different bundles that the consumer can afford.
- Points ***on*** the budget line (such as ***A***) use up the entire consumer budget.
- Points ***above*** the budget line are unaffordable.
- Points ***inside*** the budget line (like ***C***) would allow additional spending.

The consumer can buy any bundle (combination of goods) contained within the grey area.

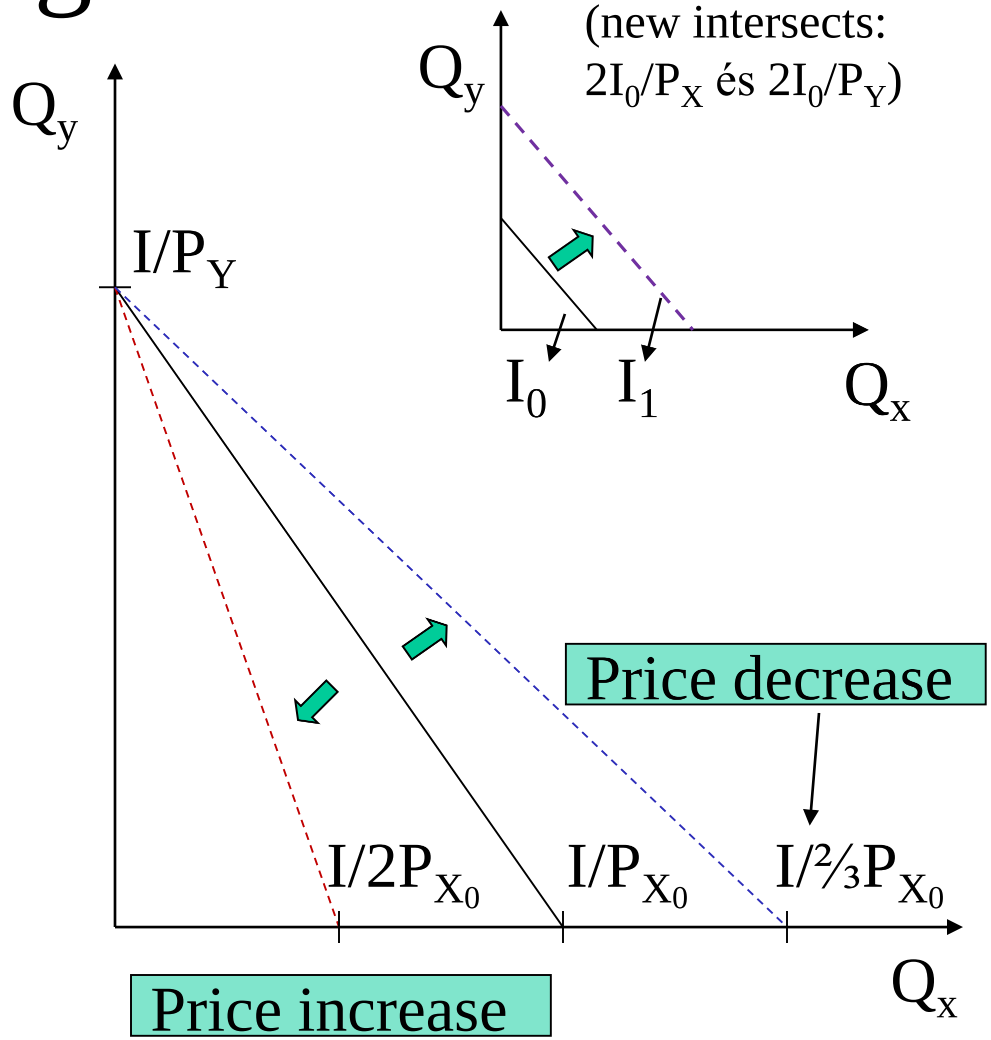


The effects of price and income changes

- The budget line shows the maximum combinations of goods that the consumer can afford, **given income and the prevailing prices**.
- Budget constraint (for 2 goods): $P_X Q_X + P_Y Q_Y \leq I$
- Slope: $-P_X/P_Y$

An increase in income ($I_1 = 2I_0$)

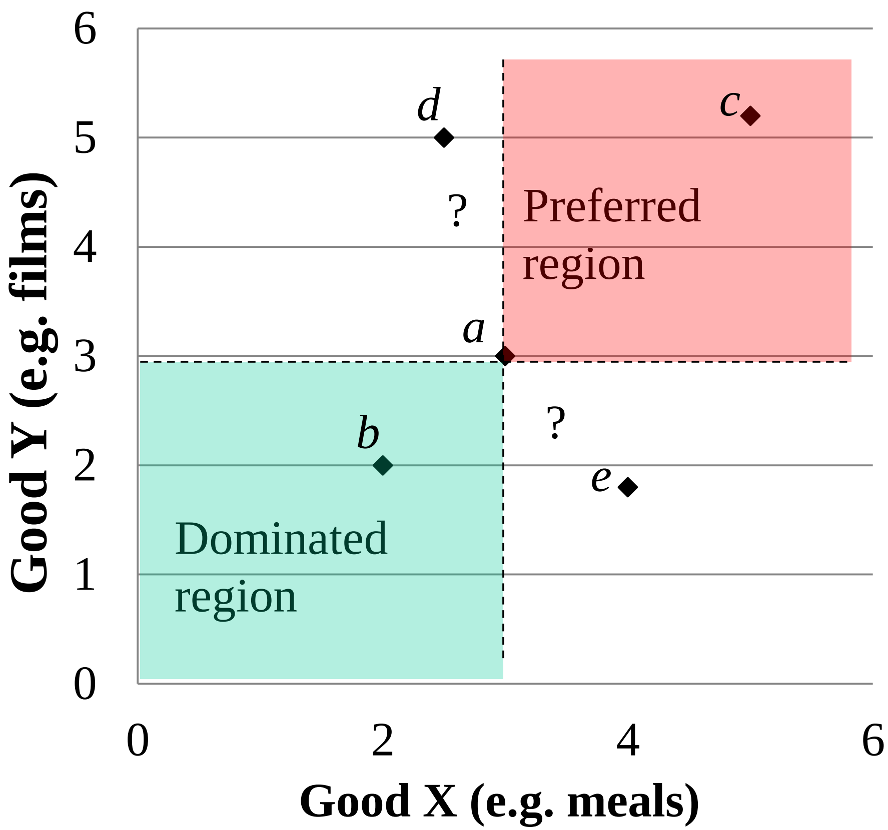
➔Parallel shift in the budget line (new intersects: $2I_0/P_X$ és $2I_0/P_Y$)



Consumer tastes

- Three main assumptions:
  - The consumer can rank alternative bundles of goods, according to the satisfaction or utility that they provide.
  - We will assume that the consumer prefers more to less.
  - Consumer tastes exhibit a diminishing marginal rate of substitution. (To hold utility constant, diminishing quantities of one good will be sacrificed to obtain successive equal increases in the quantity of the other good.)

Ranking alternative consumption bundles



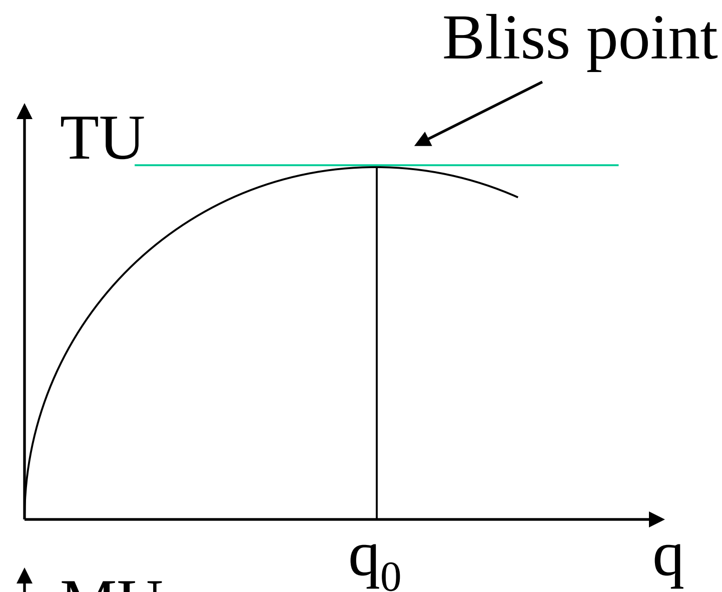
- The consumer evaluates consumption bundles ***a***, ***b***, ***c***, ***d*** and ***e***.
- With respect to point ***a***, any point to the north-east (like ***c***) is preferred and any point to the south-west (like ***b***) is dominated by ***a***.
- Points such as ***d*** or ***e*** in the other two regions may or may not be preferred to ***a***, depending on the consumer tastes.

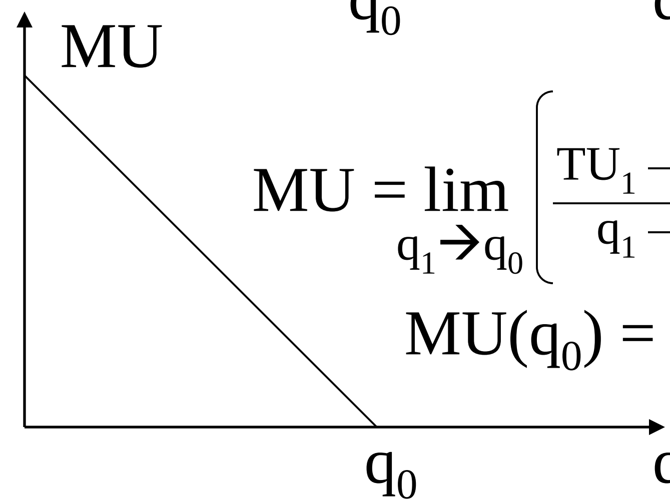
Measurable utility

TU – *total utility*

MU – *marginal utility*

- We assume that the consumers can rank different bundles according to the utility or satisfaction they give.
- Saying bundle A gives more utility than bundle B just means the consumer prefers A to B. We don't need to know by how much A is preferred to B.
- Nineteenth-century economists believed utility levels could actually be measured, as if each consumer had a utility meter measuring his/her happiness. This extra assumption is unnecessary but it might make the mathematical treatment easier.
- The marginal utility of a good is the increase in total utility obtained by consuming one additional unit of that good, for given consumption of other goods.





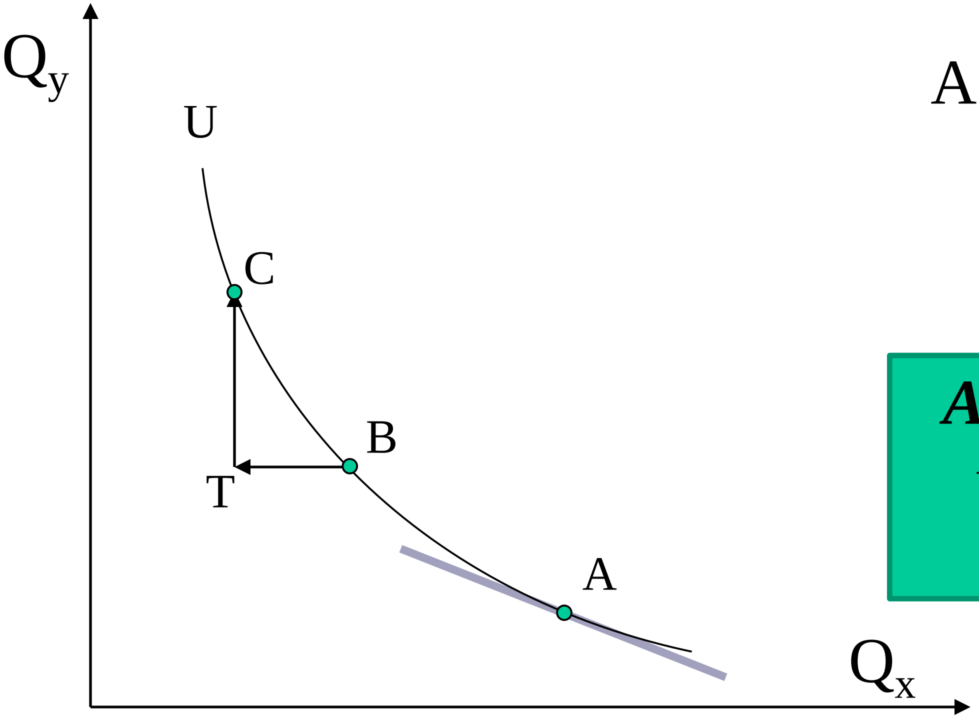
$$MU = \lim_{q_1 \to q_0} \left(\frac{TU_1 - TU_0}{q_1 - q_0} \right)$$

$$MU(q_0) = 0$$

Indifference curves

An indifference curve shows all the consumption bundles yielding a particular level of utility.

The marginal rate of substitution is the slope of the indifference curve at the point from which we begin.



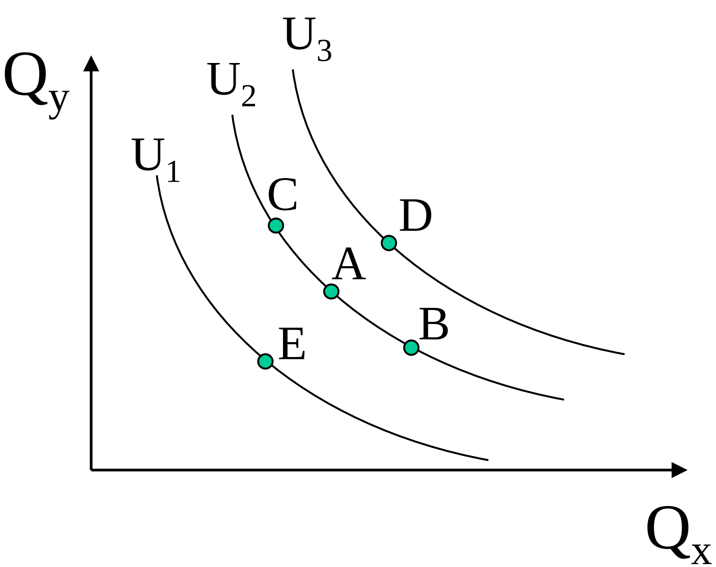
Assuming measurable utility:

$$MRS = -\frac{MU_X}{MU_Y}$$

A and ***B*** are on the same curve: therefore they must yield the same level of utility.

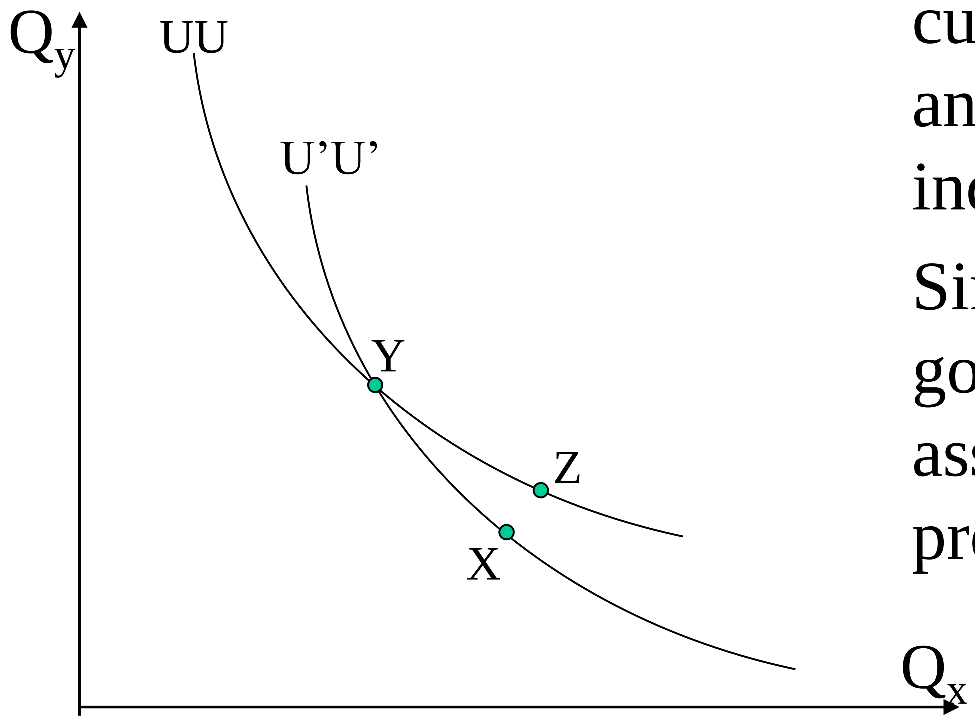
Representing consumer tastes by indifference curves

• D offers more of both goods than A and is therefore preferred to A.
• E offers less of both goods than A and therefore yields less utility than A.



- Along each curve consumer utility is constant. Since more is preferred to less, any point on a higher indifference curve is preferred to any point on a lower indifference curve.
- Indifference curves slope downwards. Otherwise the consumer would have more of both goods and be better off.
- Diminishing marginal rates of substitution imply that each curve becomes flatter as we move along it to the right.

Indifference curves cannot intersect



If indifference curves intersected, the consumer would be indifferent between Z and Y on the indifference curves UU, and between Y and X on U'U', and hence indifferent between X and Z.

Since Z offers more of both goods than X, this violates the assumption that consumers prefer more to less.

Consumer choice

To complete the model, we assume the consumer chooses the affordable bundle that maximizes their utility.

They will select a point on the budget line at which an indifference curve just touches the budget line.

The budget line is a tangent to the indifference curve at this point.

Assuming measurable utility, the consumer's choice is optimal, when:

$$\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y}$$

When this holds, the consumer cannot rearrange the division of their total spending to increase their utility. This also implies:

$$\frac{P_X}{P_Y} = \frac{MU_X}{MU_Y} = -MRS^1$$

[1] *Marginal Rate of Substitution*

Consumer choice in action

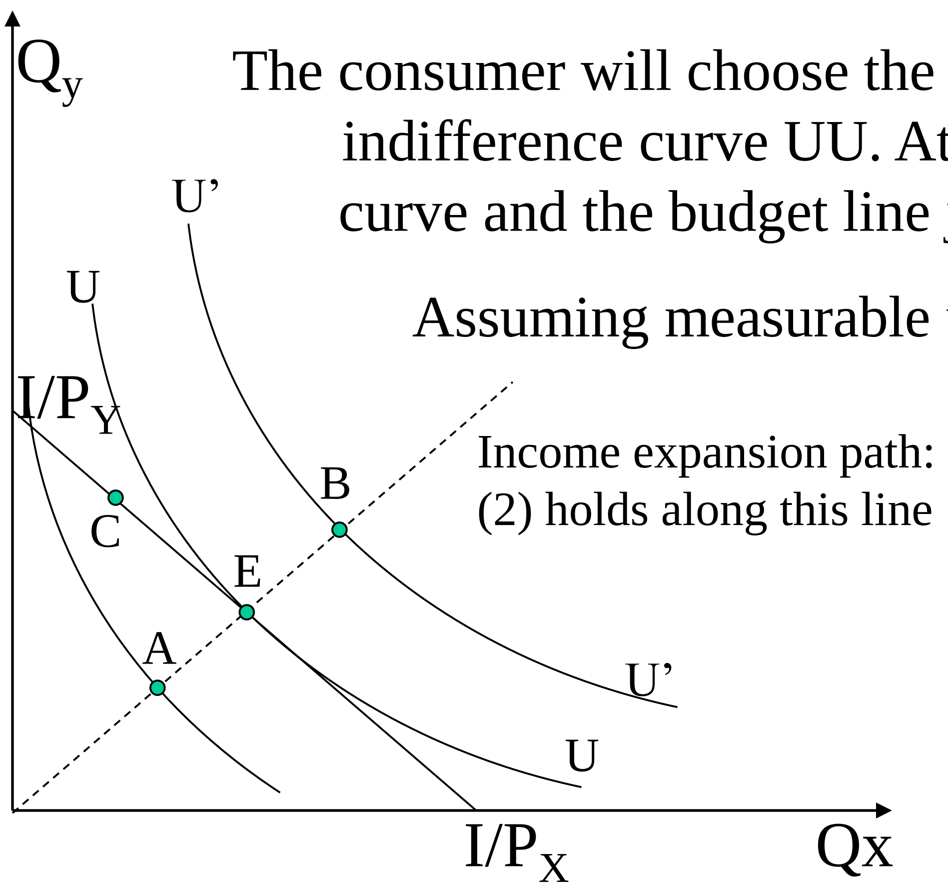
Points above the budget line are unaffordable. The consumer cannot reach the indifference curve U'U' (e.g. they can't afford B).

Points such as A and C are affordable but they don't allow the consumer to reach the indifference curve UU.

The consumer will choose the point E to reach the highest possible indifference curve UU. At the chosen point E, the indifference curve and the budget line just touch and their slopes are equal.

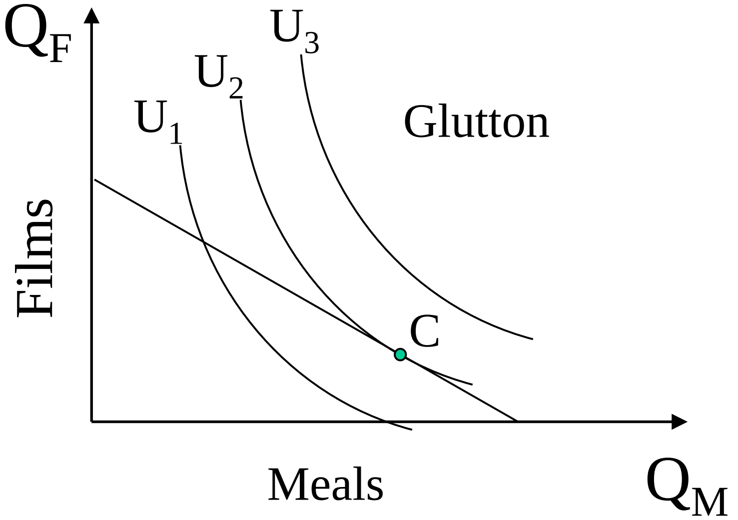
Assuming measurable utility, the optimality conditions are:

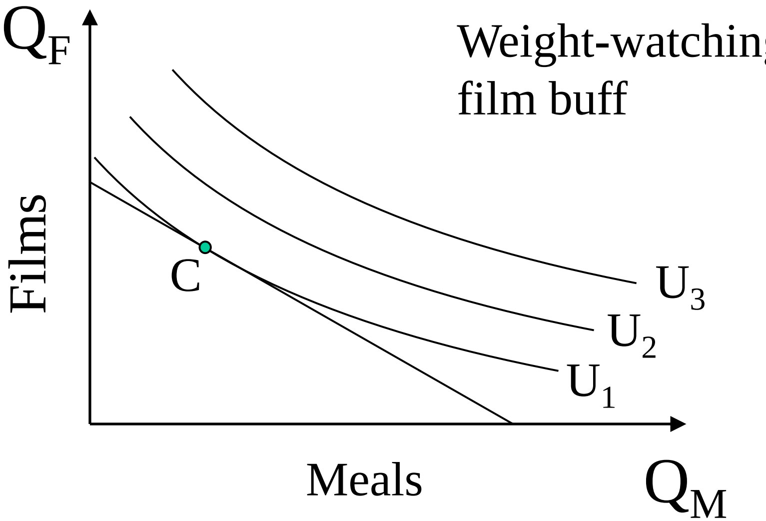
$$(1)\quad I = P_X X + P_Y Y$$



$$\text{and}\quad (2)\qquad \frac{\mathbf{P_X}}{\mathbf{P_Y}} = \frac{\mathbf{MU_X}}{\mathbf{MU_Y}} = -\mathbf{MRS^*}$$

The effect of tastes on consumer choice





Holding utility constant on any indifference curve, to get more food a glutton sacrifices more films than a film buff. Both of them face the same budget line and choose the point C, maximizing utility where the indifference curve is tangent to the budget line. The glutton has steep indifference curves and eats a lot of meals before the diminishing marginal rate of substitution flattens the indifference curve sufficiently. The film buff has flat indifference curves and the point of tangency is much further to the left. The glutton chooses more meals but fewer films than the film buff.

Consumer choice and demand decisions 2

Income and substitution effects

ICC and Engel curves

PCC and demand curves

MICRO- AND MACROECONOMICS

A change in the price of one good

- A change in the price of one good rotates the budget line around the point at which none of that good is purchased. Such a price change has an income effect and a substitution effect.
- The substitution effect of a price change is the adjustment of demand to the relative price change alone.
- The income effect of a price change is the adjustment of demand to the change in real income alone.

Income and substitution effects

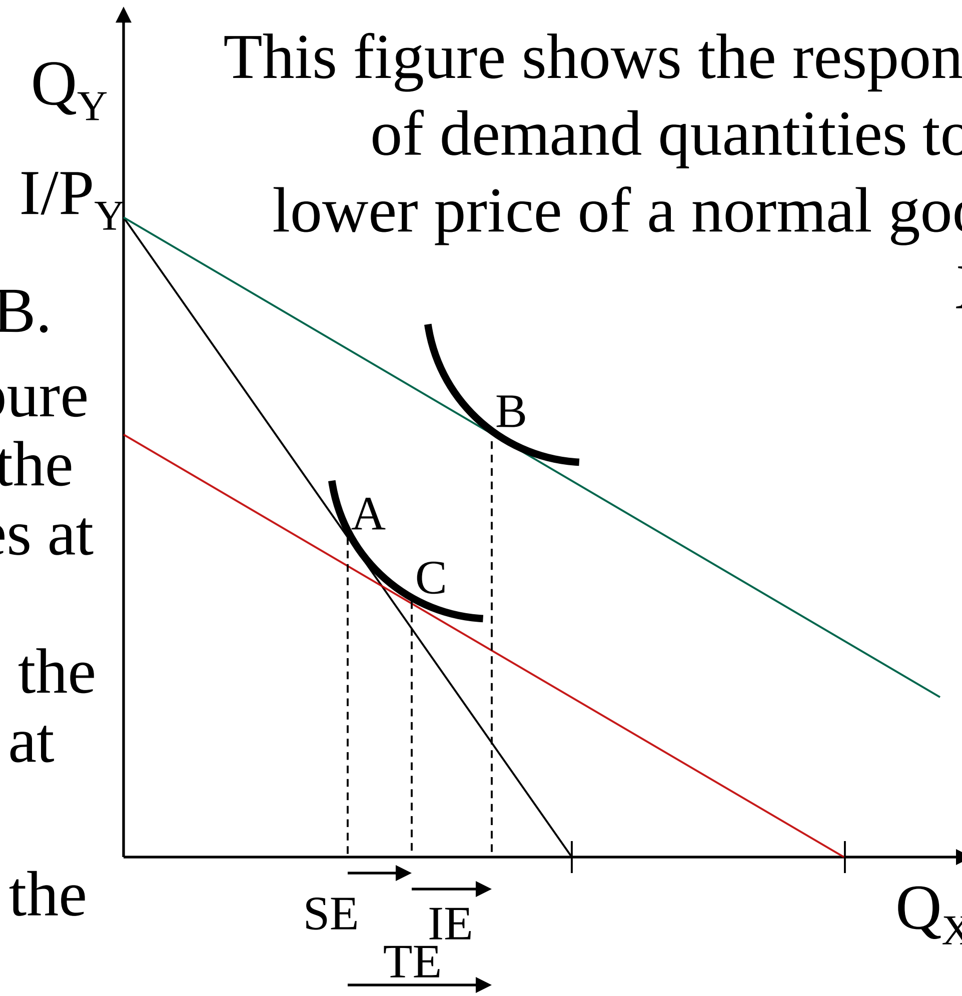
A decrease in P_x rotates the budget line around the point (0; I/P_y) at which no good X is bought.

The consumer moves from A to B.

This can be decomposed into a pure substitution effect, from A to C, the response to relative price changes at the old standard of living, plus a pure income effect, from C to B, the response to a rise in real income at constant relative prices.

The substitution effect increases the quantity of X demanded. The income effect also increases the quantity of X demanded if X is a normal good.

This figure shows the response of demand quantities to a lower price of a normal good X.



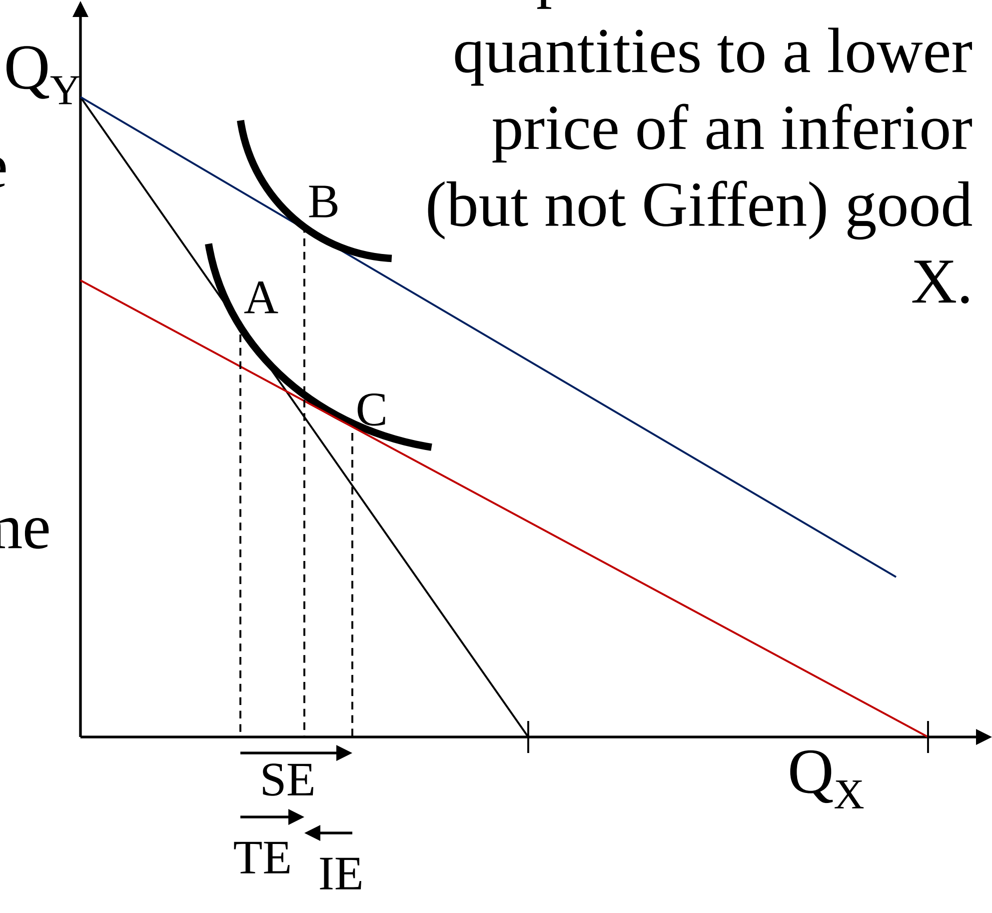
Under these circumstances, price cuts increase the quantity demanded and demand curves slope downwards.

An increase in income reduces demand for the inferior good

This figure shows the response of demand quantities to a lower price of an inferior (but not Giffen) good X.

Although the substitution effect must increase the quantity of good X demanded when its price is reduced (A→C), the income effect goes in the opposite direction if the good is inferior.

If X is an inferior good, the quantity demanded falls as income rises. The consumer then moves from C to B.



A Giffen good

The figure to the right shows the response of demand quantities to a lower price of a Giffen good X.

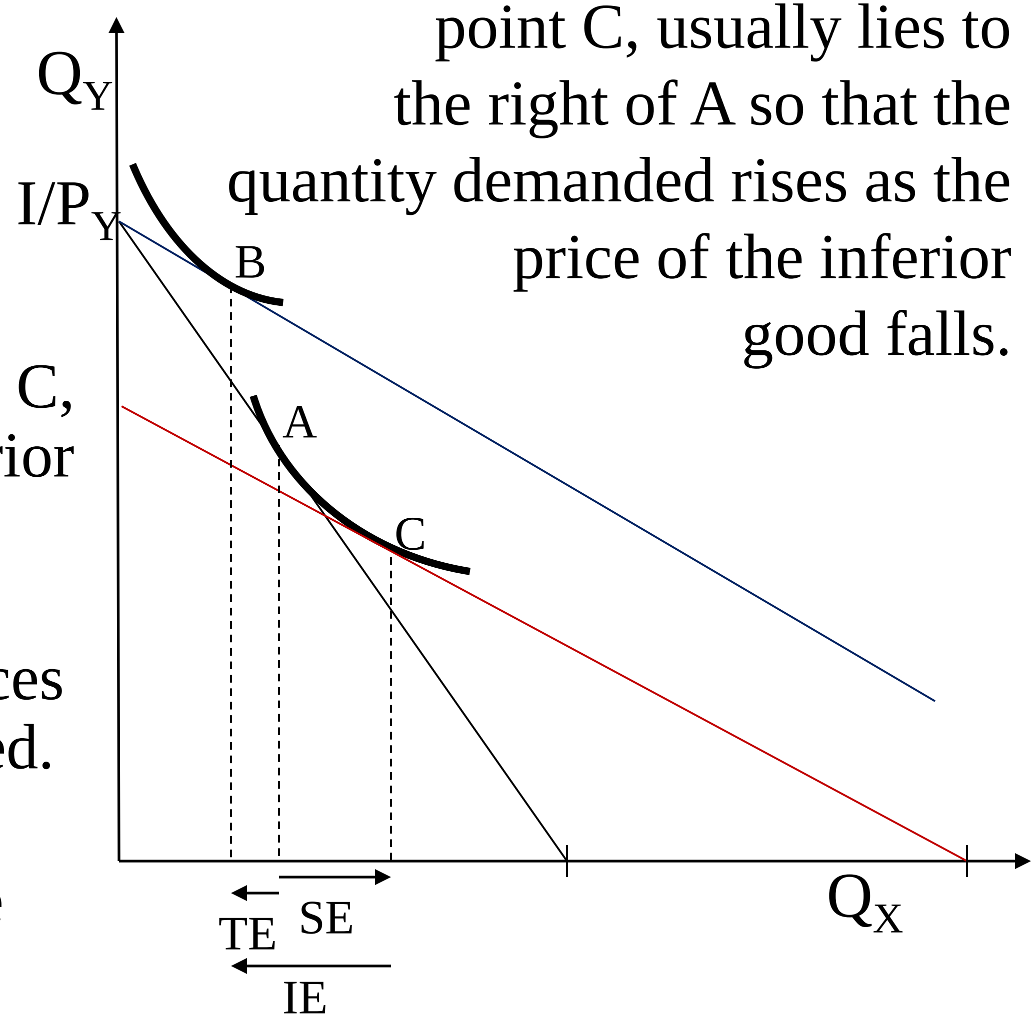
A price reduction rotates the budget line around the point (0; I/Py) at which no good X is bought.

The substitution effect, from A to C, increases the quantity of the inferior good demanded.

Since the good is inferior, the income effect, from C to B, reduces the quantity of the good demanded.

For a Giffen good, the income effect dominates and B lies to the left of A.

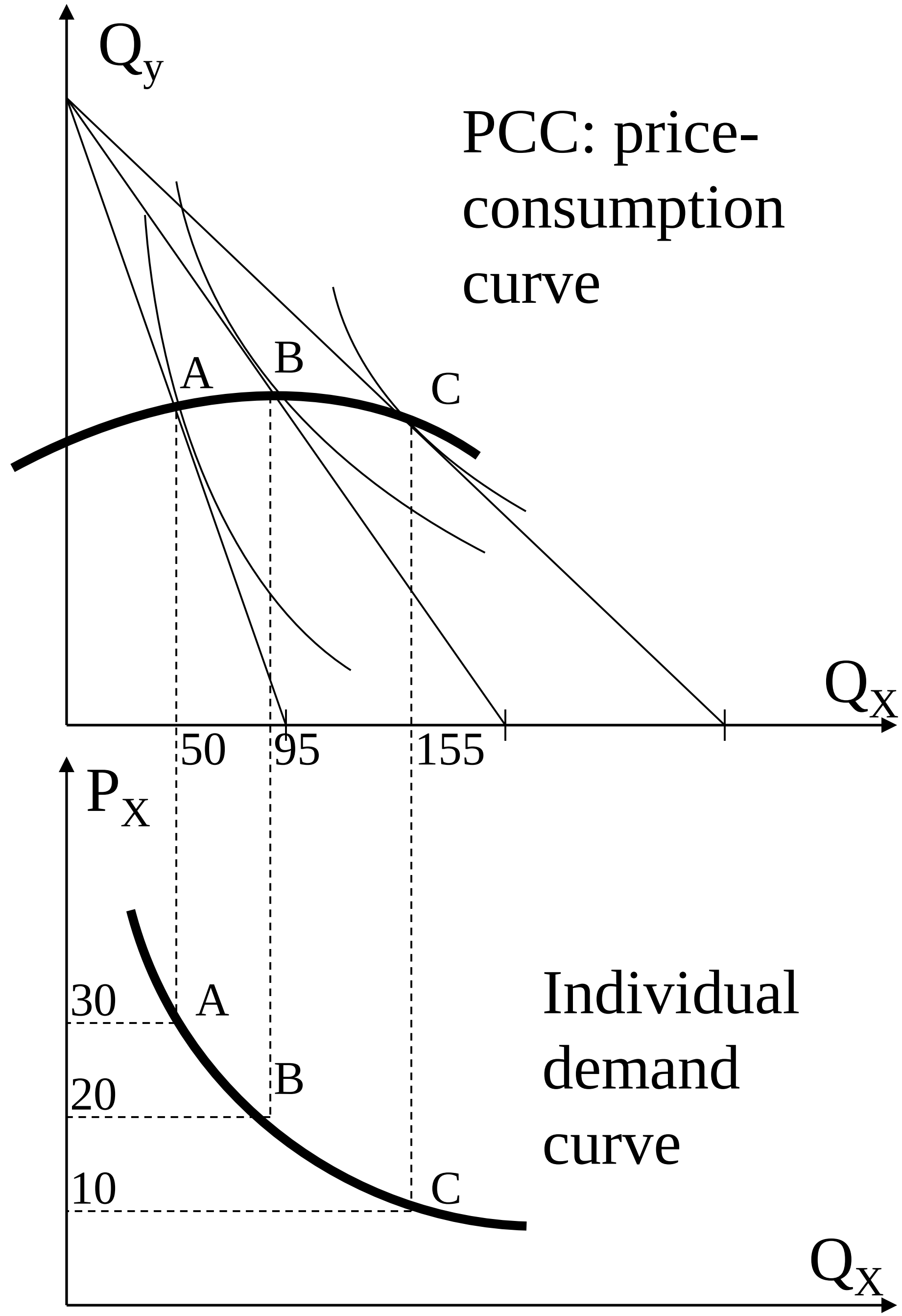
In practice, the income effect for most inferior goods is less strong and the point B, although to the left of point C, usually lies to the right of A so that the quantity demanded rises as the price of the inferior good falls.



Deriving PCC and individual demand curves

The price–consumption curve is the set of optimal points as the price of one good (here: good x) varies, with other prices (like P_y) and income held constant.

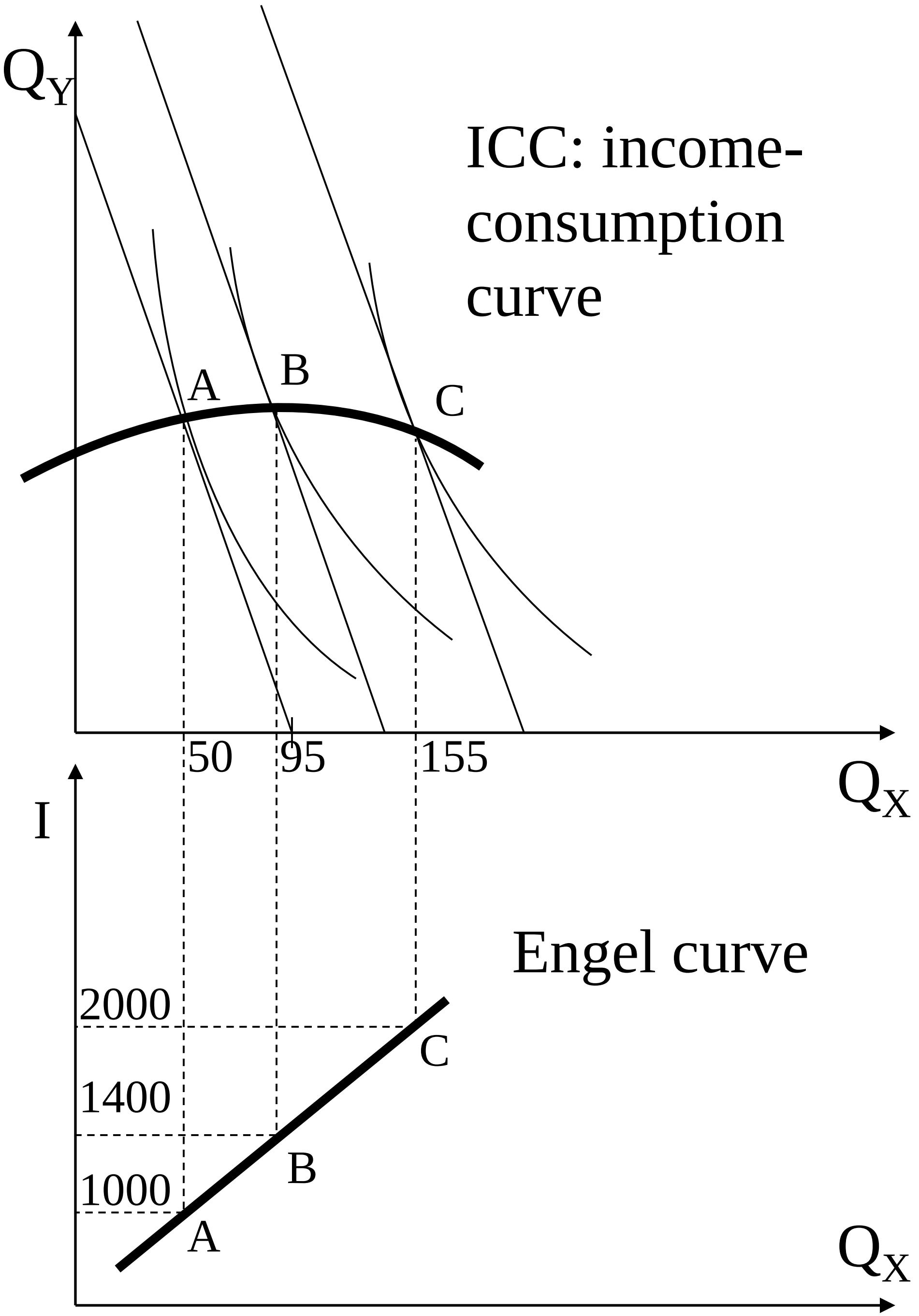
The demand curve shows the relation between price and quantity demanded, holding other things constant.



Deriving ICC and Engel curves

The income–consumption curve (or: the income expansion path) is the set of optimal points as income varies, with prices held constant.

Engel curves show the relation between income and quantity demanded, holding other things constant.



Consumer choice and demand decisions 3

Cross-price elasticities and consumer choice

Complements and substitutes

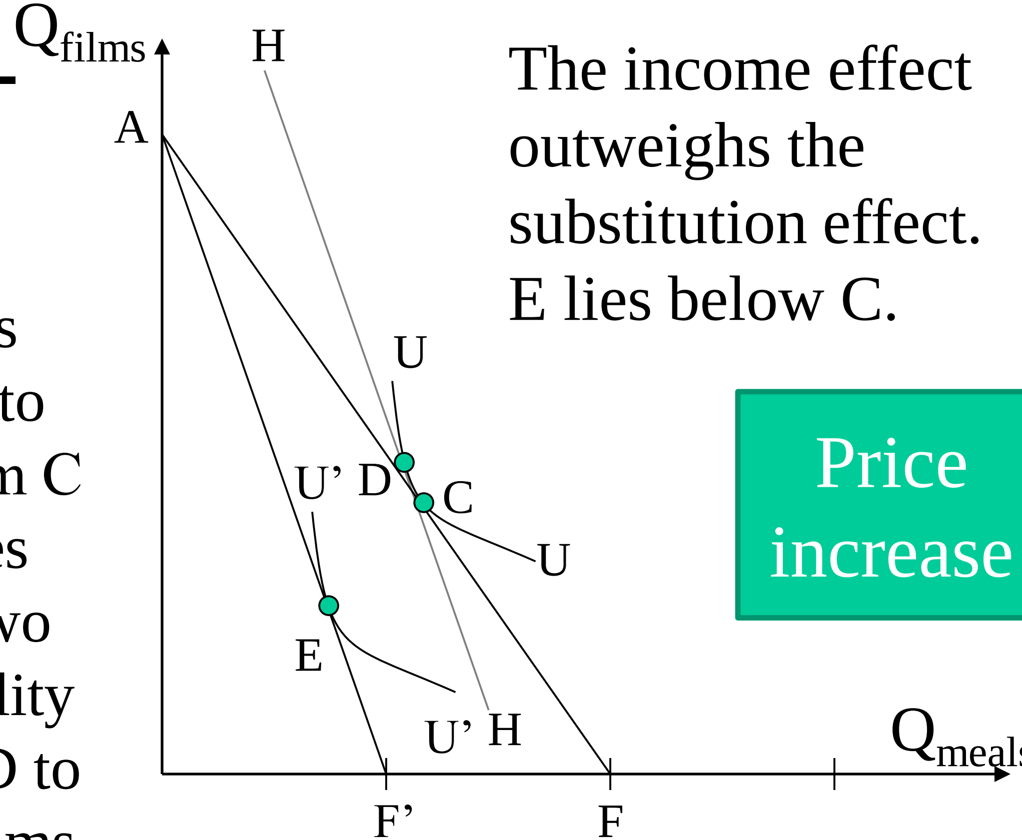
The market demand curve

Transfers in kind

MICRO- AND MACROECONOMICS

A negative cross-price elasticity

An increase in the price of meals rotates the budget line from AF to AF’. The substitution effect from C to D is small. Indifference curves have large curvature since the two goods are poor substitutes in utility terms. The income effect from D to E implies a large reduction in films for two reasons. First, the reduction in real income is larger the further to the right the initial point C. Second, films are a luxury good whose quantity demanded is sensitive to changes in real income.



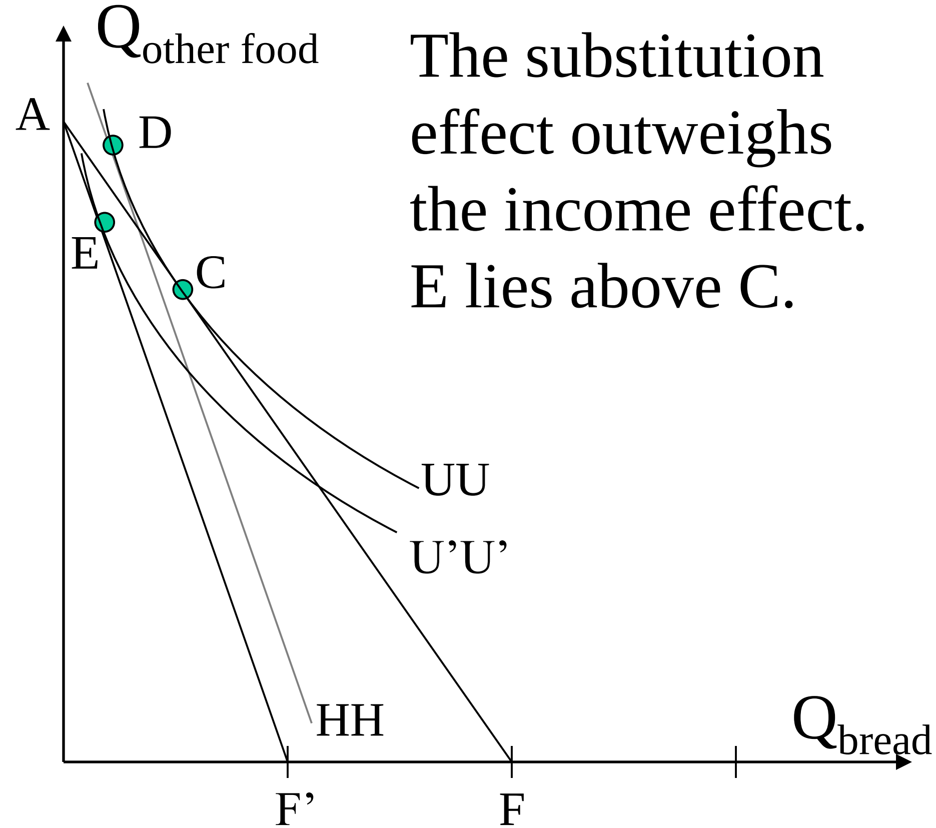
The income effect outweighs the substitution effect. E lies below C.

Price increase

Legend:
UU: Utility before the price increase
U’U’: Utility after the price increase
AF: budget line before the price increase
AF’: budget line after the price increase
HH: hypothetical budget line (parallel to AF’ but tangent to UU)

A positive cross-price elasticity

An increase in the price of bread rotates the budget line from AF to AF'. The substitution effect from C to D is large. Indifference curves have little curvature since the two goods are good substitutes in utility terms. The income effect from D to E is relatively small because the income elasticity of demand for other food is low and because the reduction in real income is small since bread forms a small share of the consumer budget.



The substitution effect outweighs the income effect. E lies above C.

Legend:
UU: Utility before the price increase
U'U': Utility after the price increase
AF: budget line before the price increase
AF': budget line after the price increase
HH: hypothetical budget line (parallel to AF' but tangent to UU)

The effect of an increase in the price of good **i** on the quantity demanded of goods **i** and **j**

Good	Type	Substitu-tion effect	Income effect	Total effect
i	Normal	Negative	Negative	Negative
	Inferior	Negative	Positive	Ambiguous
j	Normal	Positive	Negative	Ambiguous
	Inferior	Positive	Positive	Positive

Substitution effect with two goods

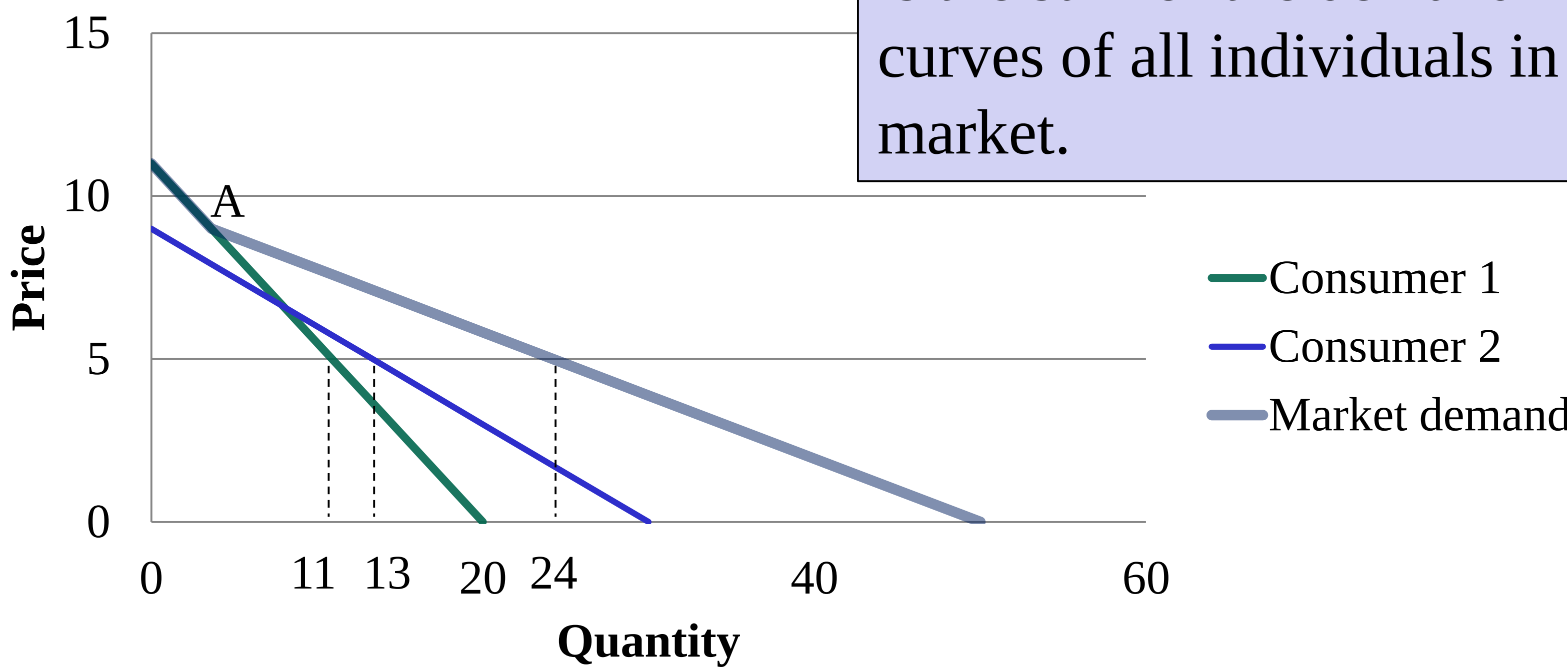
- Income and substitution effects are used to understand the effects of a price change.
- Whatever the direction of the income effect, with only two goods the substitution effect is always negative (if the price is increased).
- The pure relative price effect leads the consumer to substitute away from the good whose relative price has risen towards the good whose relative price has fallen.

Substitution effect with more than two goods

- Even with many goods, there is always a substitution effect *away* from goods whose relative price has risen. However, substitution may not be *towards* all other goods.
- The pure substitution effect of a price increase also reduces demand for goods that are complementary (=consumed jointly) to the good whose price has risen (e.g. pipes and pipe tobacco, cars and petrol etc.).

Individual demand curves and the market demand curve

The **market demand curve** is the sum of the demand curves of all individuals in a market.

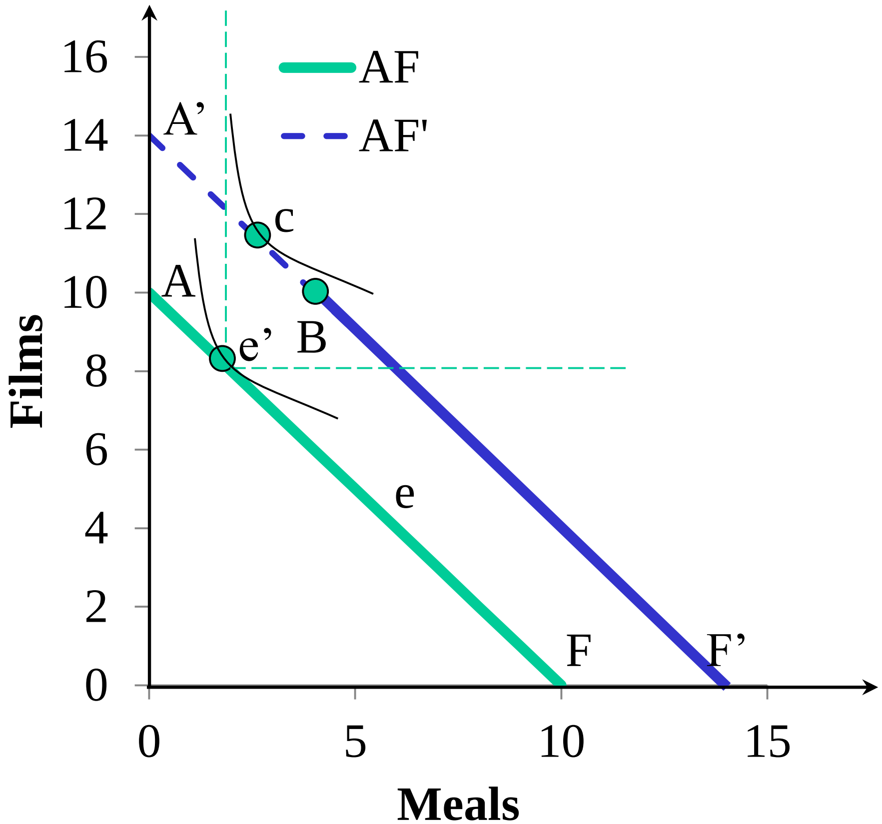


The market demand curve is the horizontal sum of individual demand curves. For example, if the price £5, the quantity demanded by consumer 1 is 11 units, and consumer 2 is 13 units. The total quantity demanded in the market at £5 is thus 24 units as shown in the market demand curve. The market demand curve is kinked at point A, the price at which consumer 2 first comes into the market.

Transfers in kind

- A transfer is a payment, usually by the government, for which no corresponding service (e.g. labour) is provided by the recipient. A transfer in kind is the gift of a good or a service.
- An example of a transfer in kind is food stamps, given to the poor to buy food.
- The stamps must be spent on food, not beer, films, or petrol.

Transfers in cash and in kind



A food transfer in kind may leave consumers less satisfied than a cash transfer of the same value.

A consumer at e' might wish to spend less than the full allowance on food moving to c. The budget line is A'BF' under a cash transfer. The in-kind transfer restricts the budget line to ABF', ruling out points A'B.

Consumers prefer to receive transfers in cash rather than in kind, if the two transfers have the same monetary value. A transfer in kind may restrict the choices a consumer can make.

Exercises for Topics 2-3

Micro- and Macroeconomics

Exercise 1: Tax Incidence

- In the market for cigarettes, the demand function can be described by the equation $D(p) = 100 - p$, while the supply function is $S(p) = p - 10$. The government introduces a specific tax of 10 $/unit on cigarettes, which is collected from the producers.

a) Calculate the pre-tax equilibrium price and quantity and the consumer and producer surpluses!

b) How would these change after the tax is introduced? Calculate the post-tax price and quantity traded!

c) Calculate the tax revenue and the post-tax consumer and producer surpluses & the deadweight loss!

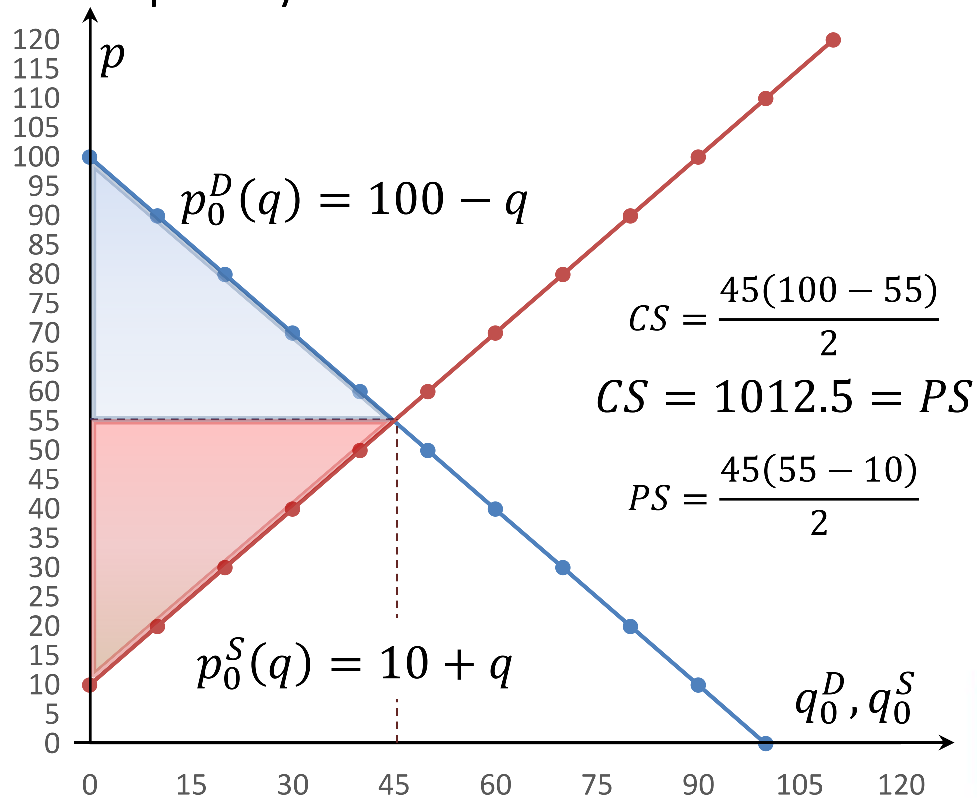
d) Now suppose that the tax is collected from the consumers instead of the producers. Calculate the (new) post-tax price and quantity traded!

Exercise 1: Tax Incidence
Pre-tax Equilibrium Price and Quantity

- In the market for cigarettes, the demand function can be described by the equation $D(p) = 100 - p$, while the supply function is $S(p) = p - 10$.
- The government introduces a specific tax of 10$/unit on cigarettes, which is collected from the producers.

a) Calculate the pre-tax equilibrium price and quantity and the consumer and producer surpluses*

- $p_0^*: D(p) = S(p)$
- $100 - p = p - 10$
- $2p = 110$
- $p_0^* = 55$
- $q_0^* = S(p_0^*) = 45;$



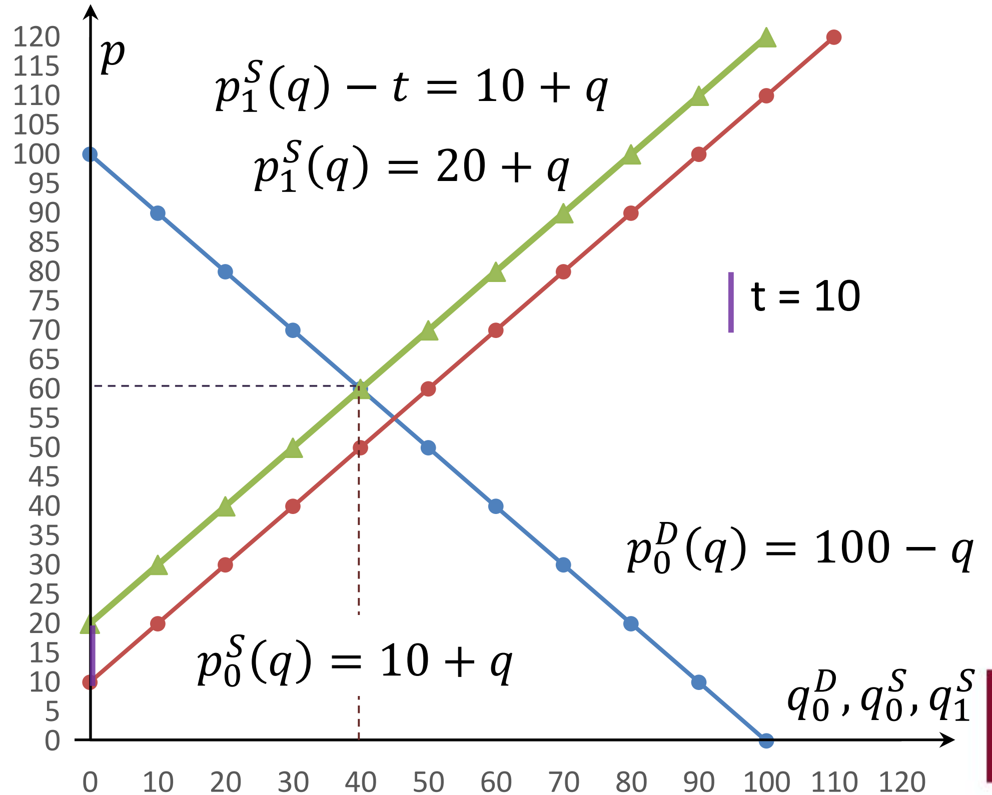
***Consumer surplus** is a measure of consumer welfare, the difference between the price that **consumers** pay and the price that they are willing to pay.

Conversely, the **producer surplus** is the difference between how much a producer would be willing to accept for given quantity of a good versus how much they can receive by selling the good at the market price.

Exercise 1: Tax Incidence
Post-Tax Price and Quantity Traded

b) How would these change after the tax is introduced? Calculate the post-tax price and quantity traded!

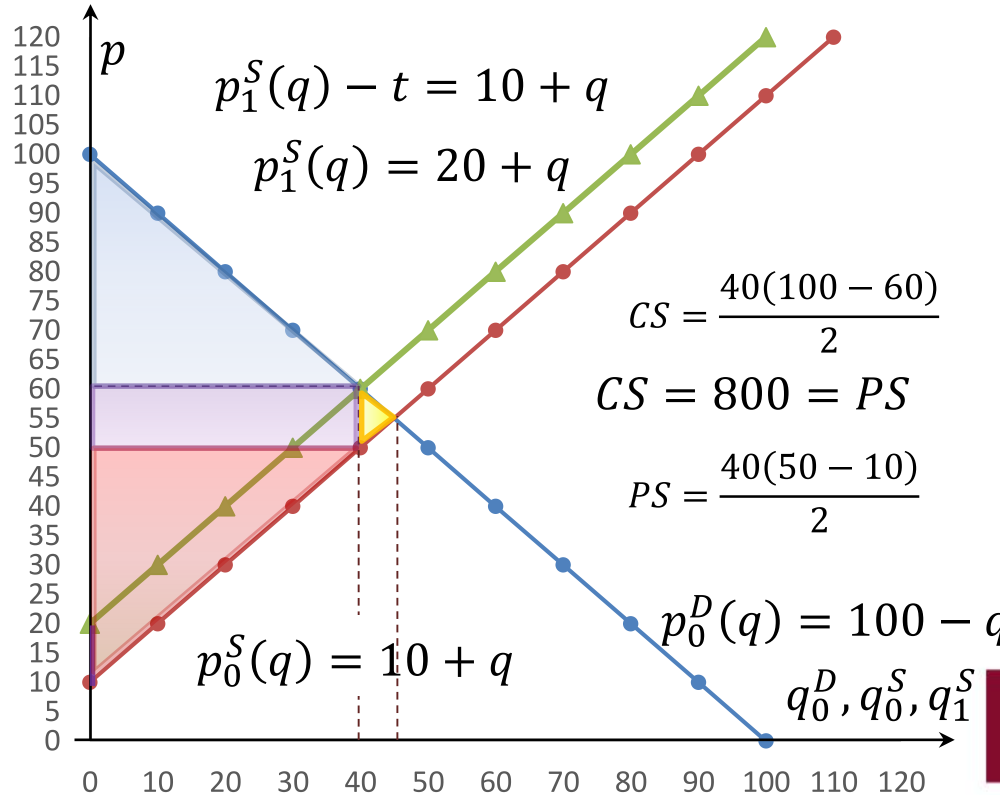
- $p_{Gr}^*: D(p) = S(p - 10)$
- $100 - p = 1(p - 10) - 10$
- $2p = 120$
- $p_{Gr}^* = 60$ (market price) $\rightarrow$
  $p_N^* = 50$ (revenue/unit)
- $q_1^* = D(p_{Gr}^*) = S(p_N^*) = 40;$



Exercise 1: Tax Incidence
Welfare implications

c) Calculate the tax revenue and the post-tax consumer and producer surpluses & the deadweight loss!

- $p^*_{Gr}: D(p) = S(p - 10)$
- $100 - p = 1(p - 10) - 10$
- $2p = 120 \qquad DWL = \frac{t\Delta q}{2} = 25$
- $p^*_{Gr} = 60 \;\rightarrow p^*_N = 50$
- $q^*_1 = D(p^*_{Gr}) = S(p^*_N) = 40;$
- Tax Revenue: $T = t \cdot q^*_1 = 400$



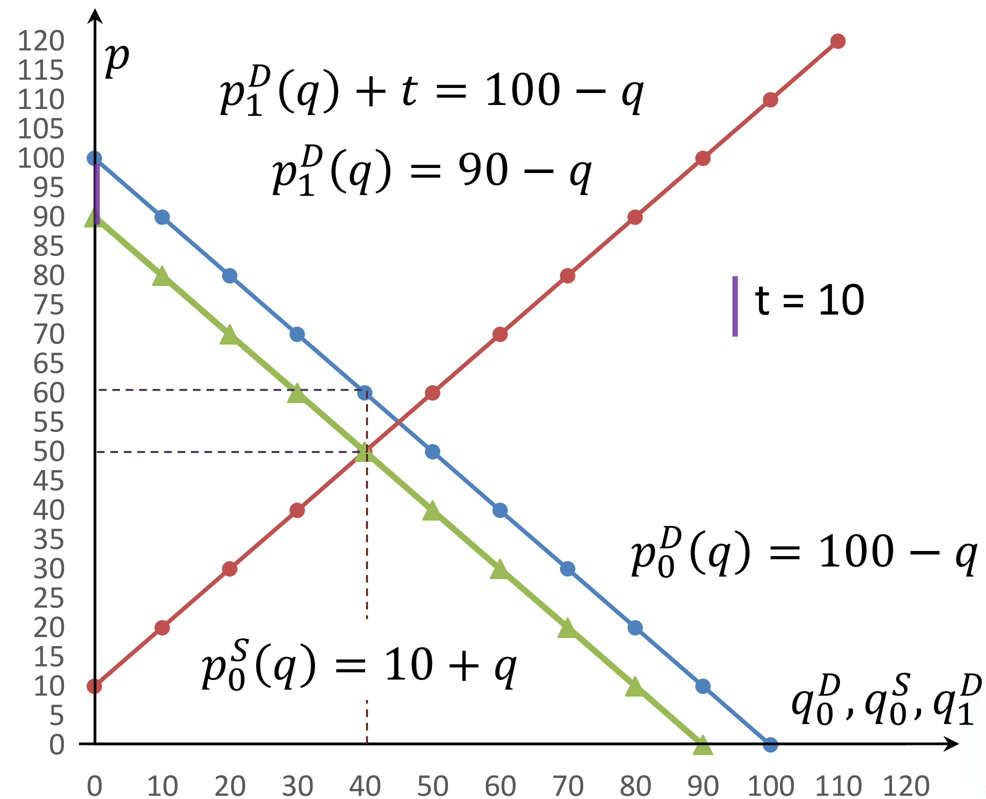
MŰEGYETEM 1782

Budapest University of Techn

Exercise 1: Tax Incidence
Tax Collected from the Consumers

d) Now suppose that the tax is collected from the consumers instead of the producers. Calculate the (new) post-tax price and quantity traded!

- p_N^*: $D(p+10) = S(p)$
- $100 - 1(p+10) = p - 10$
- $2p = 100 \rightarrow p_N^* = 50$ (price)
- $p_{Gr}^* = 60$ (cost for consumers)
- $q_1^* = D(p_{Gr}^*) = S(p_N^*) = 40;$
- CS, PS, DWL do not change.



Thank you for your attention!

Introducing Supply Decisions

MICRO- AND MACROECONOMICS

Types of firms

- There are three main types of firms: self-employed sole traders, partnerships, and companies.
- Sole traders are the most numerous but are often very small. The large firms are companies. Companies are owned by their shareholders but run by the board of directors.
- Shareholders of a company have limited liability. The most they can lose is the money they spent buying shares. Partners and sole traders have unlimited liability: they can be forced to sell their personal possessions if the business goes bust.

Supply decisions

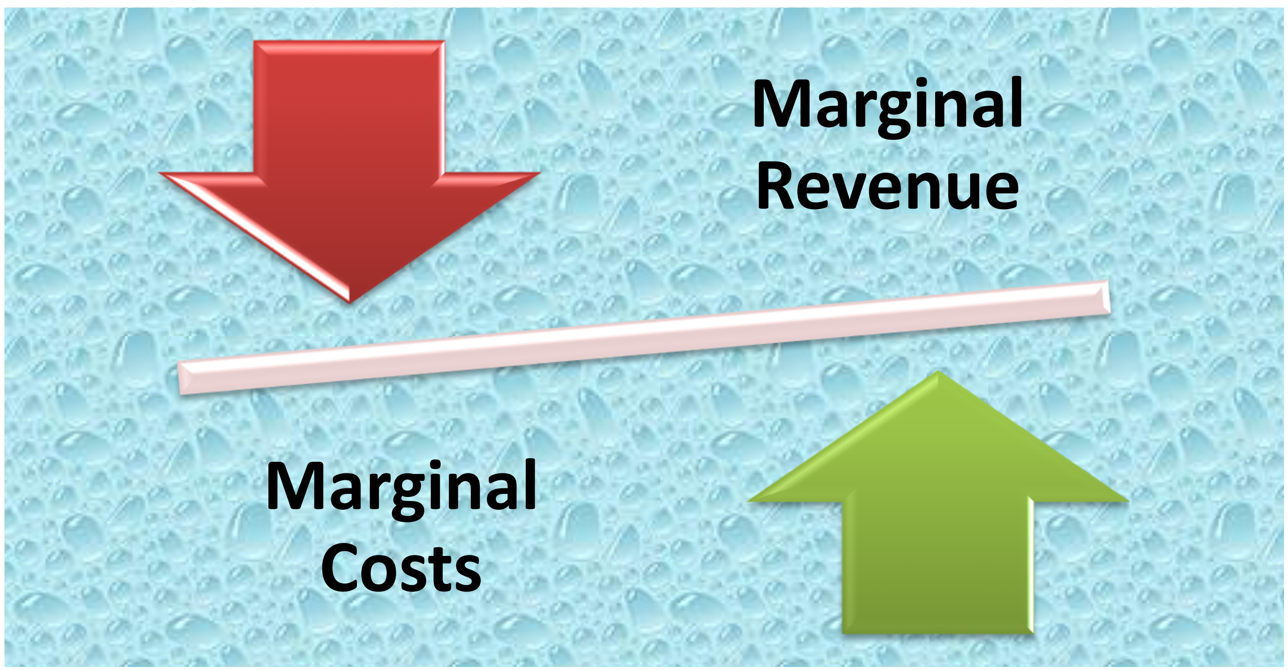
- No matter how small or large a firm is, we will assume that their main goal is to maximize their profits:

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

- Profits are the excess of revenues (**TR**) over costs (**TC**).
- In order to maximize their profits, firms have to make several important decisions. These include determining the optimal (profit-maximizing)
  - ➢ <u>Quantity produced (**q**)</u> ← 'theory of supply'
  - ➢ (Output) price (**P**) → Aim: maximize **TR**(**q**) if **q** is given (The optimal price can be determined according to the demand curve facing the firm).
  - ➢ Technology and factors of production → Aim: minimize **TC**(**q**) if **q** is given (can be calculated from a production function and the rental/wage rates)

Determinants of profits

- For each possible output level a firm needs to calculate what it *costs* to make this output and how much *revenue* is earned by selling it.



Determinants of profits

- For each possible output level a firm needs to calculate what it *costs* to make this output and how much *revenue* is earned by selling it.
- At each output, production costs depend (1) on technology, which determines the inputs needed; and (2) on the input prices that the firm faces.
- Sales revenue depends on the demand curve faced by the firm. The demand curve determines the price for which any output quantity can be sold and thus the revenue the firm earns.

Economic costs and profits

- Economists and accountants take different views of cost and profit.
- An accountant is interested in tracking the actual receipts and payments of a company.
- Economists identify the cost of using a resource not as the payment actually made but as its opportunity cost.
- Opportunity cost is the amount lost by not using a resource (labour, capital) in its best alternative use.

Examples of opportunity costs

- Opportunity costs include the cost of the owner's time and effort in running a business.
- For example, if you could have earned $25,000 a year working for someone else, and the accounting profit of a firm you run is $20,000, being self-employed is losing you at least $5000.
- Accounting profits also ignore the use of owned (as opposed to borrowed) financial capital. The money you put up to start a business could have been deposited in an interest-bearing bank account or used to buy shares in other firms.

Economic costs and supernormal profits

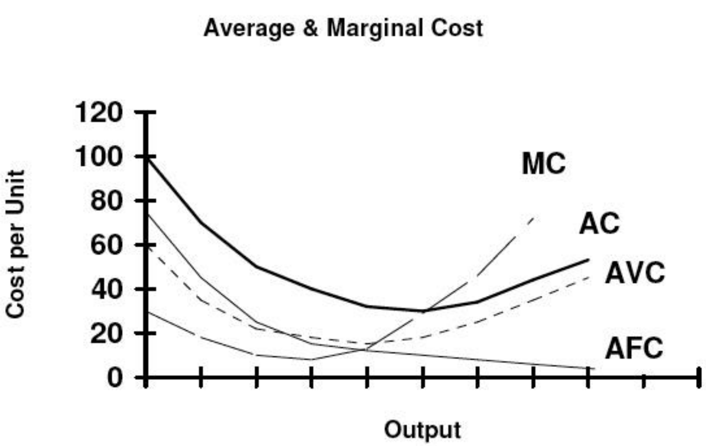
- These opportunity costs are part of the economic costs of the business but not its accounting costs.
- If, after deducting opportunity costs, the business still makes a profit, economists call this ‘supernormal profit’. Supernormal profit is the pure profit accruing to the owners after allowing for all economic costs.
- Supernormal profits are the true indicator of how well a firm is doing by tying up the owner’s time and funds in the business.

The firm's supply decision

- Suppose a firm makes spoons. The firm knows different techniques for making spoons, and the cost of hiring inputs – the wage rate for workers and rental for leasing a machine.
- The firm also knows its demand curve, and hence its revenue from selling different quantities of spoons at different prices.
- To maximize profits the firm chooses the best level of output. Changing output affects both the costs of production and the revenue from sales.
- Costs and demand conditions jointly determine the output choice of a profit-maximizing firm.

Cost minimization

- The firm certainly wants to make its chosen output level at the least possible cost.
- Otherwise, by producing the same output at lower cost it could increase profits.
- Thus a profit maximizing firm must produce its chosen output as cheaply as possible.



Cost and production functions

The total cost curve

- Knowing the available production methods and the cost of hiring workers and machines, the firm calculates the least cost at which each output can be made.*
- To make a few spoons it is not worth using many machines; to make more spoons, it makes sense to use more machines.

*TC(Q) is the minimum cost (w*L + r*K) needed to produce a given quantity (Q).
(K – physical capital, r – avg. rental rate, L – hours employed, w – avg. hourly wage)

Cost, revenue, profit (weekly)

(1) Output	(2) Total cost (€)	(3) Price (€)	(4) Total revenue (1) × (3) (€)	(5) Profit (4) − (2) (€)
0	10	–	0	−10
1	25	21	21	−4
2	36	20	40	4
3	44	19	57	13
4	51	18	72	21
5	59	17	85	26
6	69	16	96	27
7	81	15	105	24
8	95	14	112	17
9	111	13	117	6
10	129	12	120	−9

Quantity and costs

- The table on the previous slide shows various outputs in column (1).
- Column (2) shows the minimum cost at which each output can be made.
- The firm incurs a cost of €10 even when output is zero. This is the cost of being in business at all – running an office, renting a telephone etc.
- Thereafter, costs rise with output. Costs include the opportunity costs of all resources used in production. At high levels of output, cost rises sharply as output increases: the firm has to pay the workers overtime to work weekends and nights.

Total revenue

(1) Output	(2) Total cost	(3) Price	(4) Total revenue	(5) Profit
	(€)	(€)	(1) × (3) (€)	(4) – (2) (€)
0	10	–	0	−10
1	25	21	21	−4
2	36	20	40	4
3	44	19	57	13
4	51	18	72	21
5	59	17	85	26
6	69	16	96	27
7	81	15	105	24
8	95	14	112	17
9	111	13	117	6
10	129	12	120	−9

- The revenue from an output depends on price and hence demand.
- Column (3) of the table shows the maximum price at which each output can be sold (according to the demand curve facing the firm).
- Column (4) calculates sales revenue, price times quantity. At a price of €21 the firm sells only one spoon. The lower the price, the more it sells: its demand curve slopes down.

Profit

(1) Output	(2) Total cost (€)	(3) Price (€)	(4) Total revenue (1) × (3) (€)	(5) Profit (4) − (2) (€)
0	10	–	0	−10
1	25	21	21	−4
2	36	20	40	4
3	44	19	57	13
4	51	18	72	21
5	59	17	85	26
6	**69**	**16**	**96**	**27**
7	81	15	105	24
8	95	14	112	17
9	111	13	117	6
10	129	12	120	−9

- The last column shows profit, the difference between revenue and cost. At low output, profit is negative. At the highest output of 10, profit is again negative. At intermediate outputs, the firm makes positive profit.
- The highest profit is €27 a week, at an output of 6 spoons. At €16 each, total revenue is €96. Production costs, properly calculated, is €69, leaving a profit of €27 a week. This chosen output, or supply decision, is the highlighted row in the table.

Profits and revenue

- Maximizing profit is not the same as maximizing revenue.
- By selling 10 spoons a week the firm could earn €120, but it would cost €129.
- Making the last few spoons is expensive and brings in little extra revenue. It is more profitable to make less.

(1) Output	(2) Total cost	(3) Price	(4) Total revenue	(5) Profit
	(€)	(€)	(1) × (3) (€)	(4) – (2) (€)
8	95	14	112	17
9	111	13	117	6
10	129	12	120	−9

A different angle

(1) Output	(2) Total cost	(3) Price	(4) Total revenue	(5) Profit
	(€)	(€)	(1) × (3) (€)	(4) − (2) (€)
0	10	–	0	−10
1	25	21	21	−4
2	36	20	40	4
3	44	19	57	13
4	51	18	72	21
5	59	17	85	26
6	69	16	96	27
7	81	15	105	24
8	95	14	112	17
9	111	13	117	6
10	129	12	120	−9

- We could also ask at each output level, whether the firm should increase output still further.
- Suppose the firm makes 3 spoons and considers making 4 spoons.
- Our table shows this raises total cost from €44 to €51, a €7 increase in total cost.
- Revenue rises from €57 to €72, a rise of €15.
- Raising output from 3 to 4 spoons adds more to revenue than cost. Profit rises by €8 (€15 more revenue, minus €7 more cost).

Marginal cost and revenue

- This approach – examining how one more unit of output affects profit – focuses on the marginal cost and marginal revenue of producing one more unit.
- **Marginal cost (MC)** is the rise in total cost when output rises one unit.
- **Marginal revenue (MR)** is the rise in total revenue when output rises one unit.

The firm’s supply decision (2)

- If marginal revenue exceeds marginal cost, the firm should raise output. Producing and selling an extra unit adds more to total revenue than to total cost, raising total profit.
- If marginal cost exceeds marginal revenue, the extra unit of output reduces total profit.
- Thus we can use MC and MR to calculate the output that maximizes profits. So long as MR exceeds MC, keep increasing output. As soon as MR falls short of MC, stop increasing output.

Calculating the marginal cost

- The most precise way of calculating the marginal cost is differentiating the total cost with respect to the quantity: $MC(q) = \frac{\partial TC(q)}{\partial q}$
- But you cannot do this if the total cost function is not differentiable or not even defined for noninteger quantities. In that case, you can calculate the marginal cost as a difference: $MC(q) = TC(q) - TC(q-1)$

Total and marginal cost

Output	Total cost (€)	Marginal cost (€)
0	10	
1	25	15
2	36	11
3	44	8
4	51	7
5	59	8
6	69	10
7	81	12
8	95	14
9	111	16
10	129	18

The table to the left uses the data from our previous table to calculate the marginal cost of producing each extra unit of output.

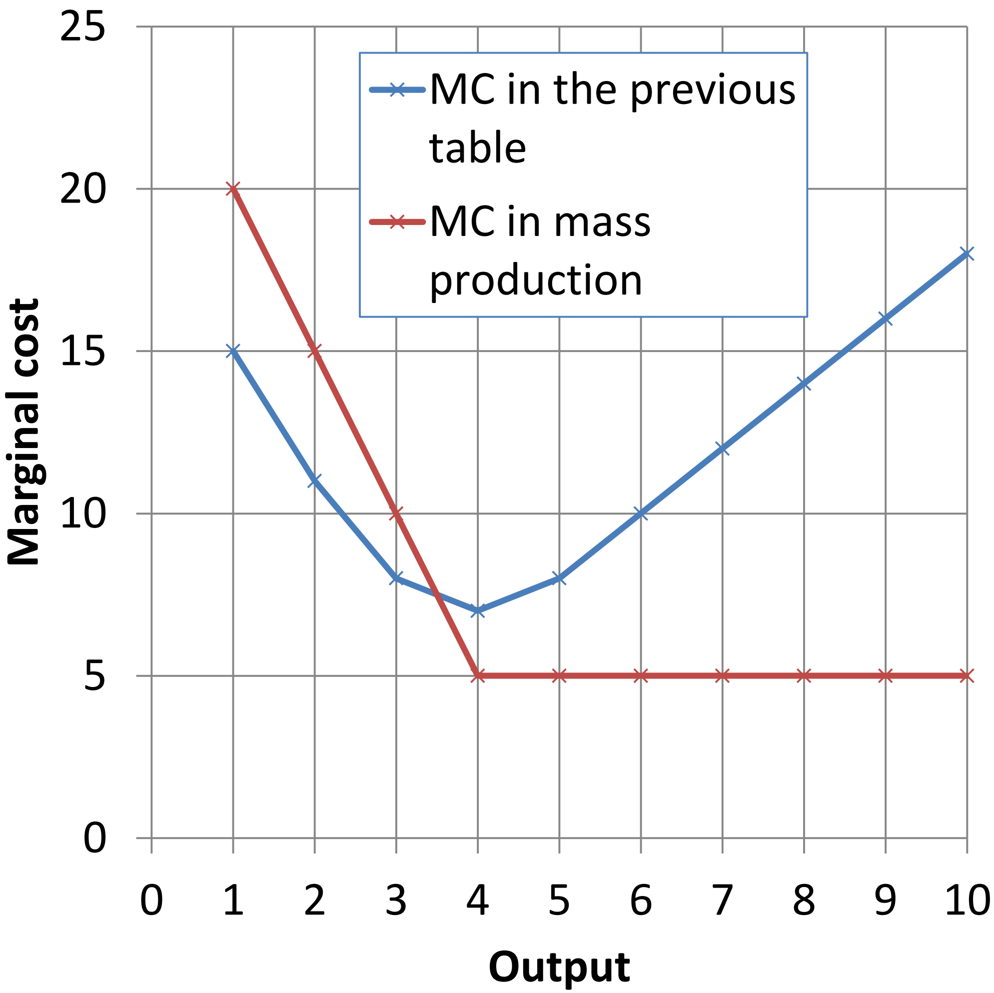
Increasing output from 0 to 1 raises total cost from €10 to €25. The marginal cost of the first unit is €15. This table shows the marginal cost of each output level, the extra total cost of raising output by the last unit.

Marginal cost is large when output is low but also when output is high. Marginal cost is lowest when making the fourth unit, which adds only €7 to total costs.

Marginal costs and production techniques

- As output increases, why do marginal costs start high, then fall, then rise again?
- The answer reflects different production techniques:
  – At low output, the firm uses simple techniques.
  – As output rises, more sophisticated machines are used, making extra output quite cheaply.
  – But as output rises still further, the difficulties of managing a large firm emerge. Raising output gets hard and marginal costs rise.

Marginal costs



The figure to the left plots the relation between output and marginal cost, which varies from firm to firm. In a coal mine that is nearly worked out, marginal cost rises steeply with extra output. In mass production industries, as output increases marginal cost may decline and then become constant.

A more precise way of calculating the marginal revenue

- We can also define the marginal revenue as the derivative of the total revenue function.
- However, this will definitely not work for revenue functions that are not defined for noninteger quantities.

$$\mathrm{TR(q)} = \mathrm{p(q)} \times \mathrm{q} \quad \mathrm{MR} = \frac{\partial \mathrm{TR}}{\partial \mathrm{q}}$$

$$\mathrm{MR(q)} = \mathrm{p(q)} + \mathrm{q}\frac{\partial \mathrm{p(q)}}{\partial \mathrm{q}} =$$

$$= \mathrm{p(q)}\left(1 + \frac{\mathrm{q}}{\mathrm{p}}\frac{\partial \mathrm{p(q)}}{\partial \mathrm{q}}\right) = \mathrm{p}\left(1 + \frac{1}{\varepsilon}\right)$$

Where ε is the price elasticity of demand;
and since it is (almost always) negative, MR ≤ p

- For these, we should define the marginal revenue as a difference:

$$MR(q) = TR(q) - TR(q-1)$$

- We will use this definition for the remainder of this lecture.

Price, total revenue, and marginal revenue (€)

Q	P	Total revenue	Marginal revenue
0	–	0	
1	21	21	21
2	20	40	19
3	19	57	17
4	18	72	15
5	17	85	13
6	16	96	11
7	15	105	9
8	14	112	7
9	13	117	5
10	12	120	3

- Still based on our first table, the table to the left shows marginal revenue, the extra total revenue when an extra unit of output is made and sold.
- Raising output from 0 to 1 raises revenue from €0 to €21. The marginal revenue of the first unit is €21.
- Raising output from 7 to 8 units raises revenue from €105 to €112 so marginal revenue is €7.
- Total revenue and marginal revenue depend on the demand curve for the firm's product.

The relationship between output and marginal revenue

Q	P (€)	Total revenue (€)	Marginal revenue (€)
0	–	0	
1	21	21	21
2	20	40	19
3	19	57	17
4	18	72	15
5	17	85	13
6	16	96	11
7	15	105	9
8	14	112	7
9	13	117	5
10	12	120	3
11	11	121	1
12	10	120	-1

- Marginal revenue falls steadily as output rises and can be negative at high output levels.
- To sell 12 spoons the price must be cut to €10 each. Total revenue is €120.
- Since 11 spoons earn €121, the marginal revenue from 11 to 12 spoons is €120 – €121, and thus –€1.

Decomposing marginal revenue

- To understand how marginal revenue changes with output, we keep track of two separate effects:
- Marginal revenue = extra revenue from making and selling one more unit

$$MR(q) = \Delta TR(q)$$
$$= TR(q) - TR(q-1) =$$

= [price for which last unit sold]

$$P(q) -$$

− [revenue lost by selling existing units at a lower price]

$$[P(q-1) - P(q)] \cdot [q-1]$$

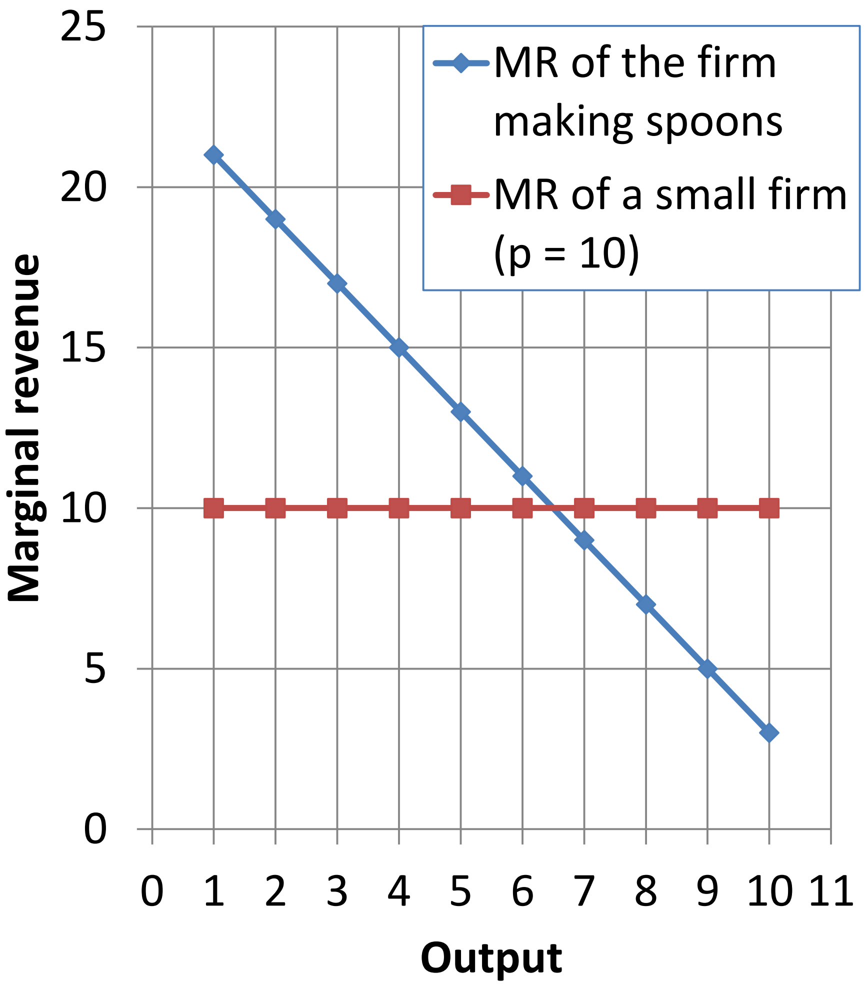
Demand and revenue

- Demand curves (almost always) slope down. To sell more output, the price must be cut.
- Selling an extra unit of output at this lower price is the first component of marginal revenue.
- However, to sell that extra unit the firm has to cut the price for which all previous units of output can be sold. This effect reduces the marginal revenue obtained from selling an extra unit of output.

Output and MR

- Marginal revenue falls steadily for two reasons:
  - First, because demand curves slope down, the extra unit must be sold at a lower price.
  - Second, successive price reductions reduce the revenue earned from existing levels of output, and at larger output, there are more existing units on which revenue is lost when prices fall further.

The shape of the MR curve



- The shape of the marginal revenue curve reflects the shape of the demand curve.
- In the figure, you can see the (blue) MR of the firm making spoons, which slopes down.
- But: a small firm in a huge market might sell as much output as it wants without affecting the market price.
- That firm's demand curve is horizontal at the going price. In this special case, the price is the marginal revenue (red). No revenue is lost on existing output when more output is sold.

Using MR and MC to choose output

(1) Q	(2) MR (€)	(3) MC (€)	(4) Mπ (€) = MR–MC	Output decision
1	21	15	6	Raise
2	19	11	8	Raise
3	17	8	9	Raise
4	15	7	8	Raise
5	13	8	5	Raise
6	11	10	1	
7	9	12	–3	Lower
8	7	14	–7	Lower
9	5	16	–11	Lower
10	3	18	–15	Lower

We seek a q that maximizes $\pi = \mathrm{TR} - \mathrm{TC}$

$$\mathrm{M}\pi = \frac{\partial \mathrm{TR}}{\partial q} - \frac{\partial \mathrm{TC}}{\partial q} = \mathrm{MR} - \mathrm{MC} = 0$$

- Combining MC and MR, the table to the left examines the output that maximizes the firm's profits.
- If MR exceeds MC, a 1-unit increase in output will increase profits. The last column shows that this reasoning leads the firm to make at least 6 units of output.
- The firm now considers increasing output from 6 to 7 units. Marginal revenue is €9 and marginal cost €12. Profits fall by €3. Output should not be expanded to 7 units, or to any level above this. The firm should expand up to 6 units of output but no further. This output maximizes profits, as we know already from our previous table.

TC and TR versus MC and MR

- Our first table, based on TC and TR, and the last table, based on MC and MR, are different ways to study the same problem.
- Economists frequently use marginal analysis.
- ‘Is there a small change that could make the firm better off?’
- If so, the current position cannot be the best possible one and changes should be made.

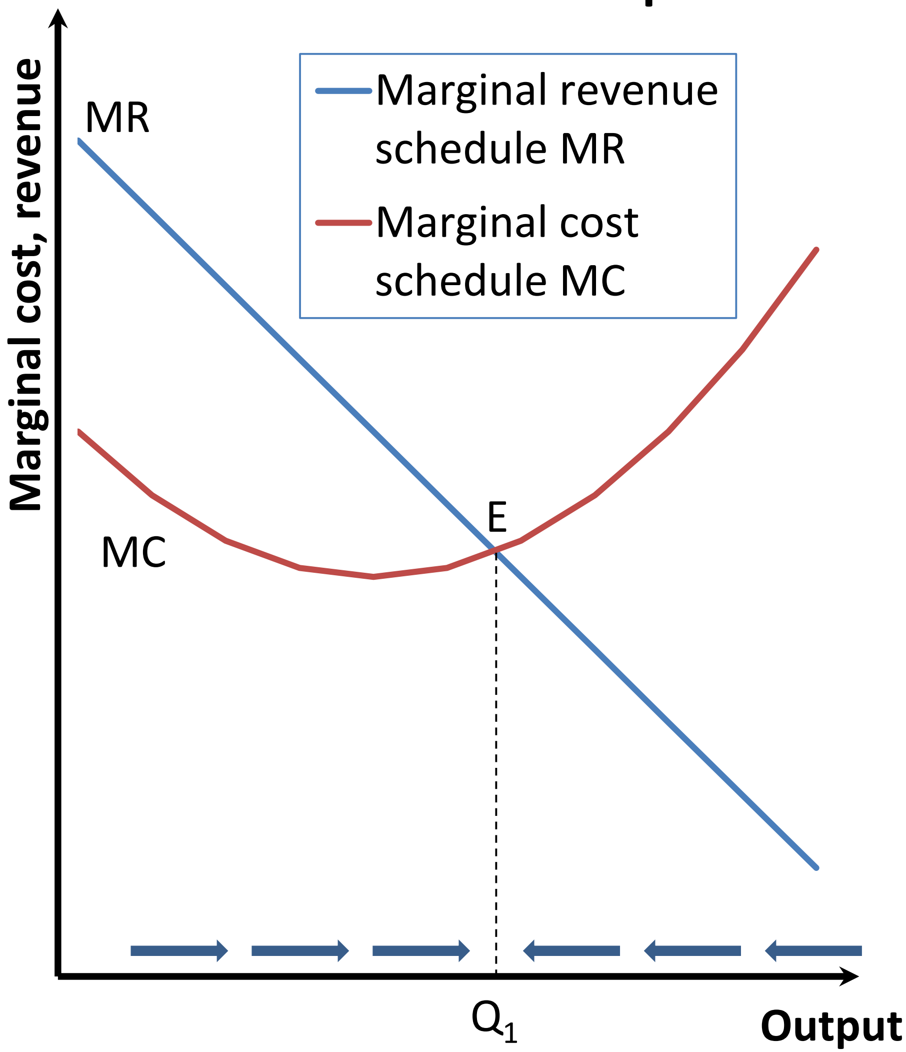
Negative profits

- Marginal analysis is very useful, but it should be subjected to one very important check. It may miss an all-or-nothing choice.
- For example, suppose that MR exceeds MC up to an output level of 6 units but thereafter MR is less than MC. 6 units seems to be the best possible output level.
- However, if profits are negative at this output, the firm should close down if this helps reduce its losses.

Output levels are not always integers

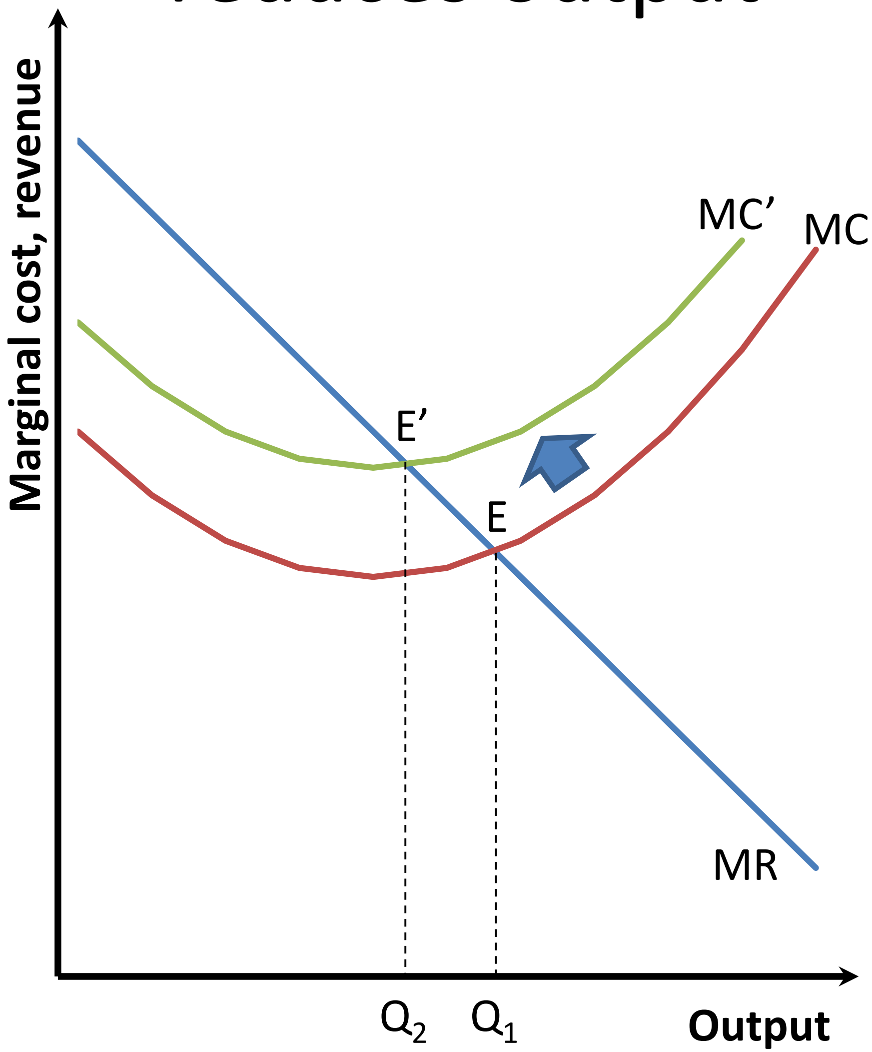
- Thus far we have assumed the firm produces an integer number of goods, such as 0, 1, or 6, rather than a quantity such as 0.5 or 6.7.
- Output is not usually confined to integer levels. For goods such as wheat or milk, the firm can sell in fractional amounts (e.g. 1.5 litres of milk).
- Even for goods such as cars, sold in whole units, the firm may be selling 75 cars every four weeks, or 18.75 cars a week. It is convenient to imagine that firms can vary output and sales levels continuously.
- We can then draw smooth curves for marginal cost (MC) and marginal revenue (MR).

MC and MR determine the firm's output



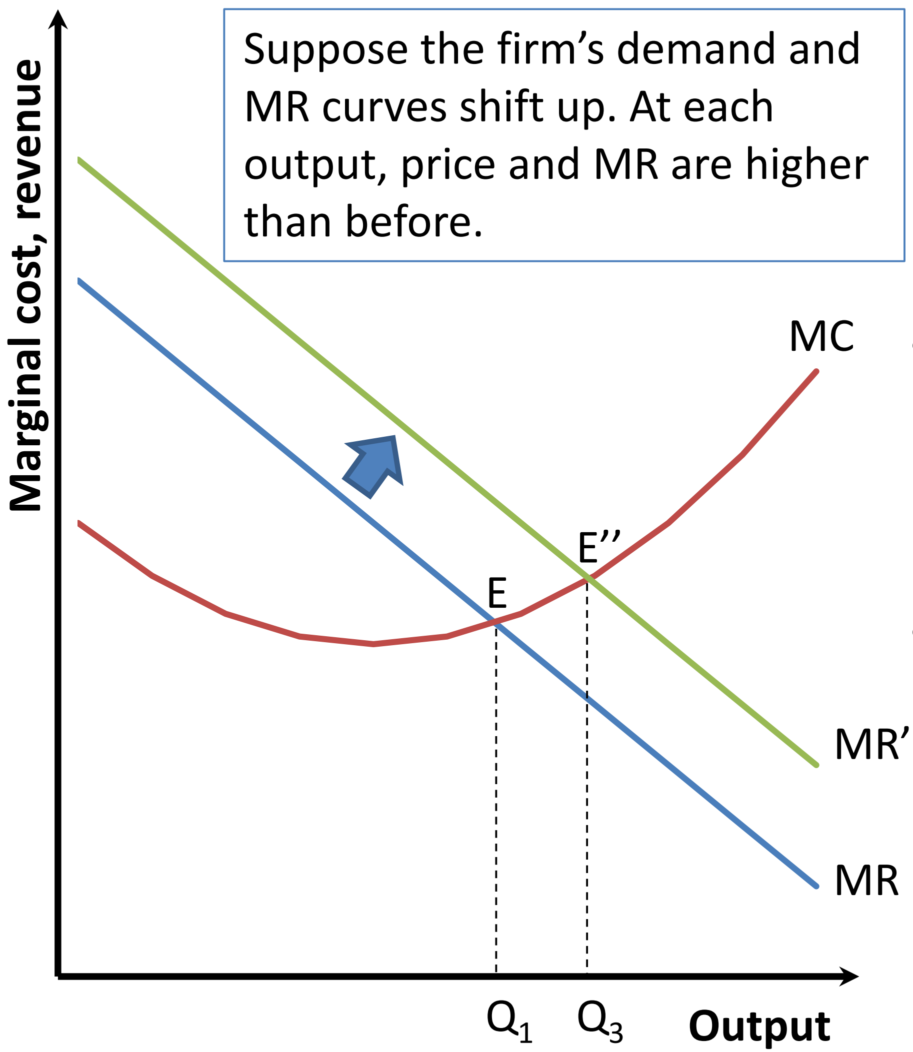
- The MC and MR schedules are shown changing smoothly. The firm's optimal output is Q_1, at which MR is equal to MC.
- Anywhere to the left of Q_1, MR is larger than MC and the firm should increase output, as shown by the arrows.
- Where output is greater than Q_1, MR is less than MC and profits are increased by reducing output.
- If the firm is losing money at Q_1 it has to check whether it might be better not to produce at all than to produce Q_1.

An increase in MC reduces output



- The marginal cost curve shifts from MC to MC' as a result of an increase in the costs of using a factor of production: for instance, the wage may have risen.
- This upward shift moves the intersection of MC and MR curves from E to E'. Output falls from Q_1 to Q_2.
- Thus, when the firm's costs rise, it decides to produce less.

An upward shift in MR increases output



- When the MR curve shifts upward from MR to MR', the intersection point between the marginal revenue and cost curves shifts from E to E''.
- The firm's optimal level of output increases from Q_1 to Q_3.
- The upward shift in the marginal revenue curve could result, for instance, from an increase in the number of customers in the firm's market.

Do firms know their marginal cost and revenue curves?

- Do firms in the real world know their marginal cost and marginal revenue curves, let alone go through some sophisticated calculations to make sure output is chosen to equate the two?
- Such thought experiments by firms are not necessary for the relevance of our model of supply. If, by luck, hunch, or judgement, a firm succeeds in maximizing profits, marginal cost and marginal revenue must be equal.
- Our formal analysis merely tracks the hunches of smart managers who get things right and survive in a tough business world.

Appendix: A firm's accounts

- Firms report two sets of accounts, one for stocks and one for flows. **Stocks** are measured at a point in time, **flows** are corresponding measures during a period of time.
- A firm reports profit-and-loss accounts per year (flow accounts) and a balance sheet showing assets and liabilities at a point in time (stock accounts).
- The two are related: the profits and losses change assets and liabilities over time.

Flow accounts: income statement and cash flow

- An **income statement** lists revenues and costs. Revenue is what the firm earns from selling goods or services in a given period, cost (for an accountant) is the expense incurred in production in that period and profit is revenue minus cost.
- A firm's **cash flow** is the net amount of money actually received during the period (≠ profits).
- Actual receipts and payments may differ from economic revenue and cost. Profitable firms may still have a poor cash flow, for example when customers are slow to pay.

Stock accounts: the balance sheet

- The balance sheet lists the **assets** the firm owns and the **liabilities** for which it is responsible at a point in time.
- A firm’s **net worth** is the assets it owns minus the liabilities it owes.
- A firm’s assets are its cash and deposits, money owed by its customers, inventories in its warehouses, its factory, machinery etc.
- Its liabilities are bills it has yet to pay, the mortgage on its factory, bank loans etc.


Thank you

Costs and Supply 1

Introduction

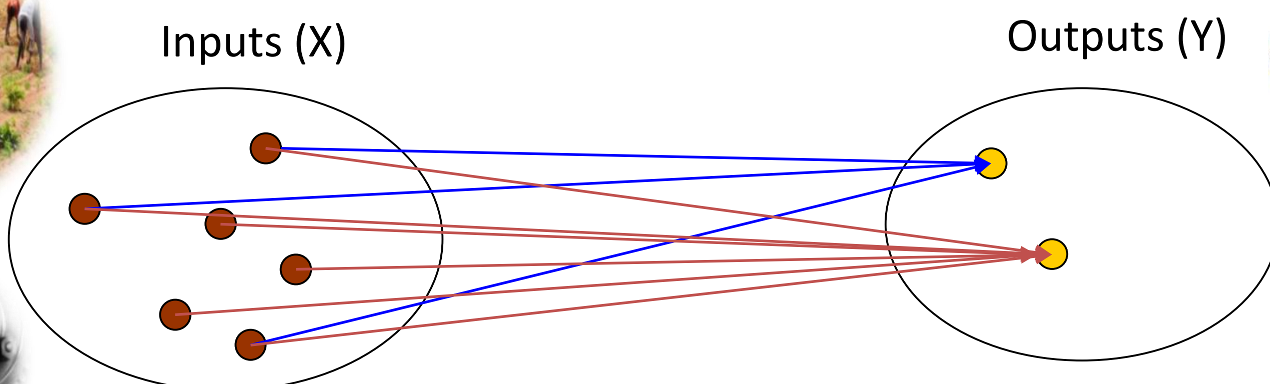
Production Function

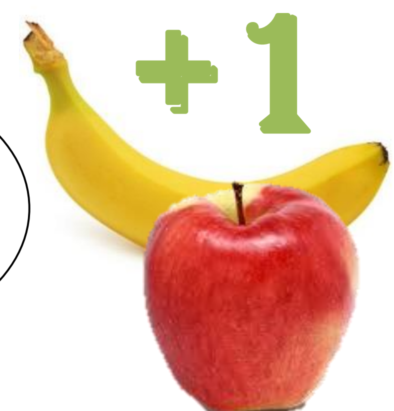
Economies of Scale

Micro- and Macroeconomics

The firm's technology: input and output

- We start by introducing the production function, which describes the firm's technology.
- An **input** (or **factor of production**) is a good or service used to produce output[s] (other goods or services).



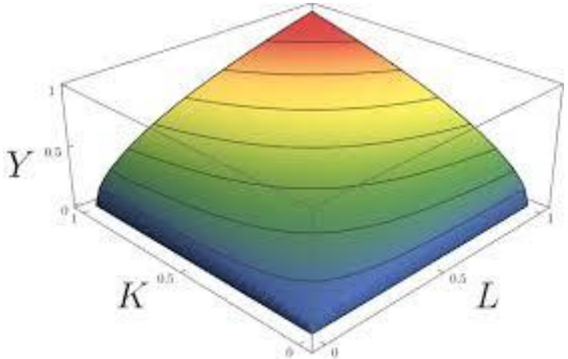


$$\underline{y} = f(\underline{x}) \quad : \underline{x} \in X;\ \underline{y} \in Y; \quad f(\underline{x}_i) \geq \underline{y}_i \ \ \forall i$$

$\underline{y}$: output(s); $\underline{x}$: input(s); f: production function; Y: set of outputs; X: set of inputs

Inputs (factors of production)

- Inputs include labour, machinery, buildings, raw materials, and energy.
- Suppose our firm uses inputs to make spoons. This is an engineering and management problem.
- Making spoons is largely a matter of technology and on-the-job experience.

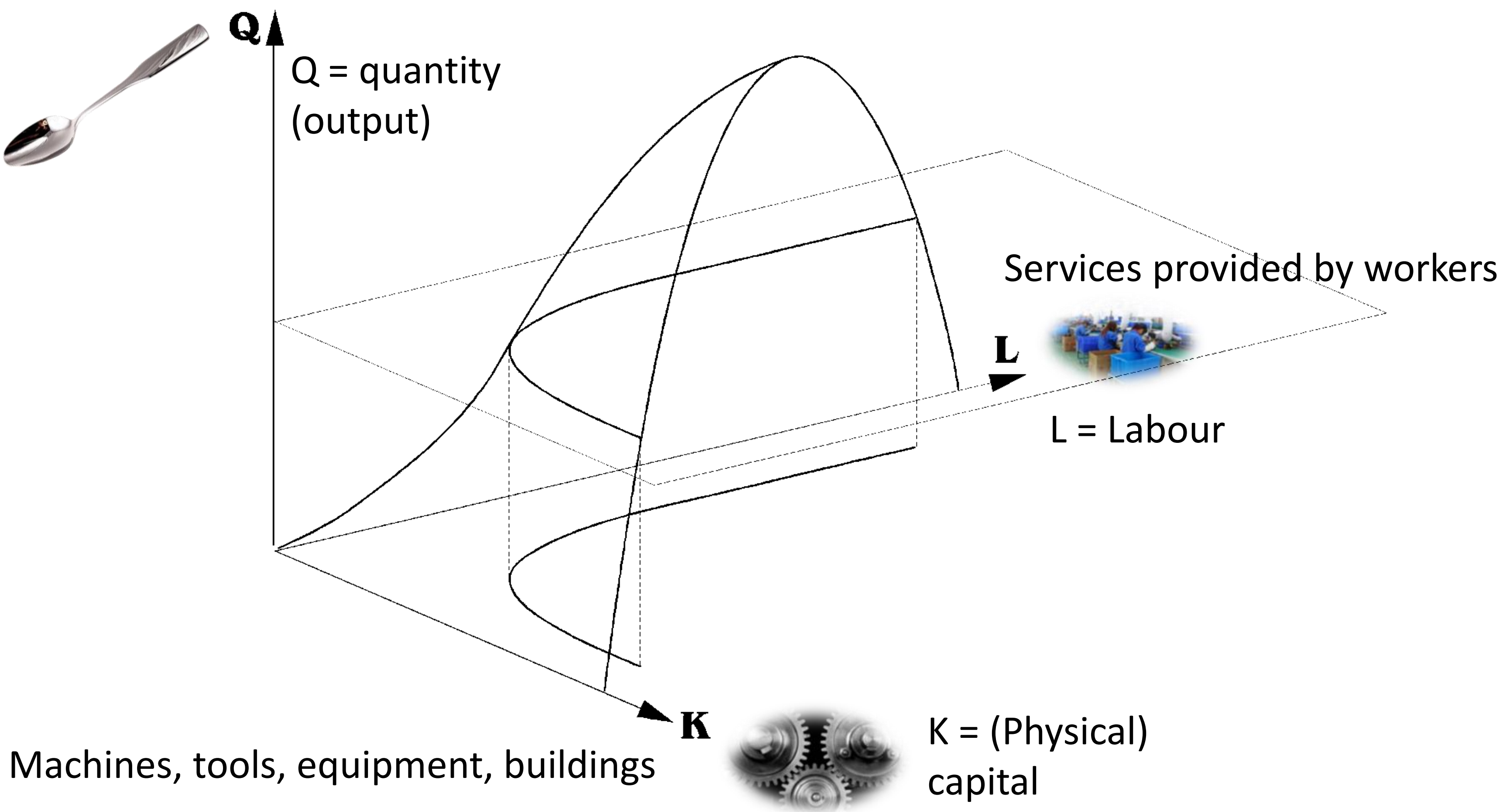


The production function

- The production function summarizes technically efficient ways to combine inputs to produce output.
- A production technique is **technically efficient** if there is no other way to make a given output using less of one input and no more of the other inputs.
- The **production function** is the set of all technically efficient techniques.

Production functions

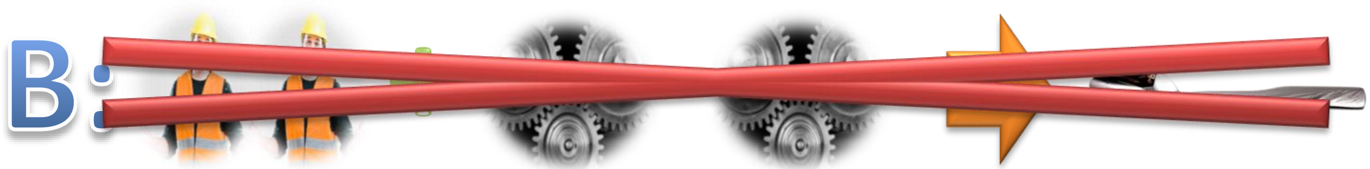
- Production function (in theory): $Q = f(L,K,A,E)$
- Simplified version: $Q = f(K,L)$



Wasteful production methods

- Since profit maximizing firms are not interested in wasteful production methods, we restrict our attention to those that are technically efficient.
- To make a spoon, method ***A*** needs 2 workers and 1 machine, but method ***B*** needs 2 workers and 2 machines.

- Method ***B*** is less efficient than method ***A***. It uses more machines, but the same labour, to make the same output. Method ***B*** is not one of the efficient methods listed in the production function.



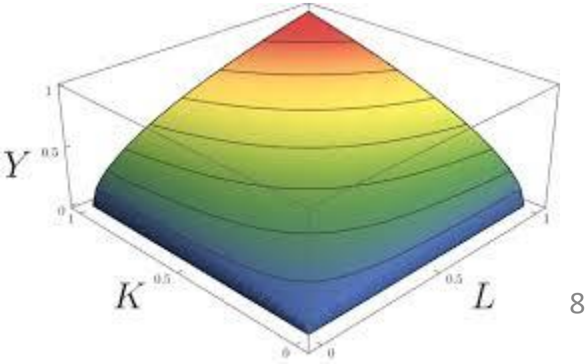
Example: A production function

Output 	Capital input	Labour input
100	4	4
100	2	6
106	2	7
200	4	12

- The table to the left shows some technically efficient methods in the production function. The first two rows show two ways to make 100 spoons: 4 machines and 4 workers, or 2 machines and 6 workers.
- Beginning from the latter, the third row shows the effect of adding an extra worker. Output rises by 6 spoons.
- The last row shows that doubling both inputs in the second row also doubles the output, though this need not be so: overcrowding a small factory can slow people down.

Why do firms need engineers?

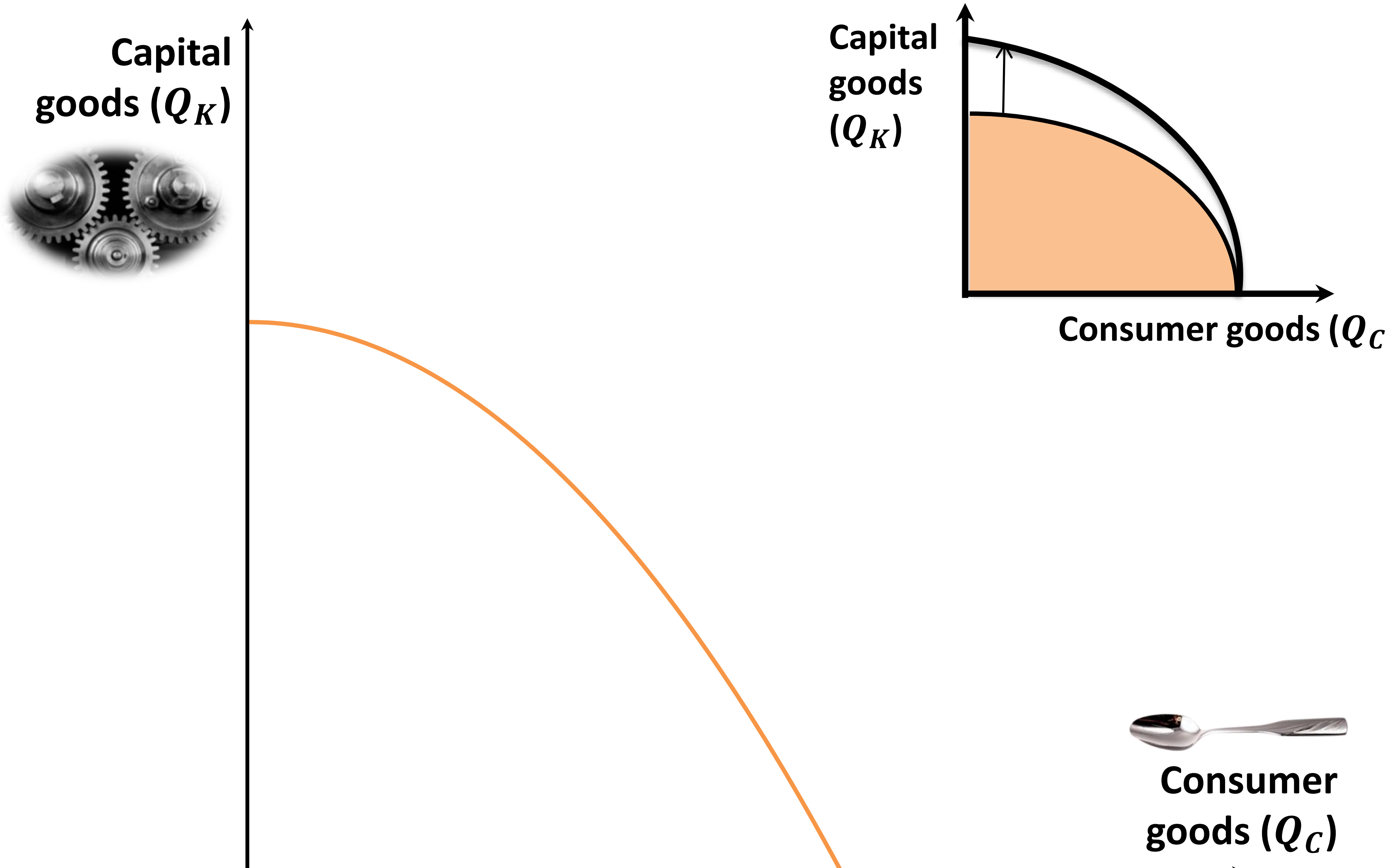
- The previous table could be enlarged to include other combinations of labour and capital that are also technically efficient.
- A firm discovers its production function, the complete set of technically efficient production techniques, by asking its engineers, designers, and time-and-motion experts; and by trial and error.



Technique, technology, and technical progress

- A **technique** is a particular way to combine inputs to make output.
- **Technology** is the list of all known techniques.
- **Technical progress** is a new technique allowing a given output to be made with fewer inputs than before.

Technical progress (PPF)



Technical progress

- A method previously technically efficient may become inefficient after a technical advance allows a better production technique.
- Technical progress alters the production function.
- For now, we assume a given technology and a given production function.

- The production function relates volumes of inputs to volume of output. To get costs, we also need to know input prices.
- Consider the lowest-cost way to make 100 spoons. Assume that there are two technically efficient techniques, the first two rows of our previous table, reproduced as the first two columns of the table below and labelled techniques ***A*** and ***B***.

Technique	Capital input	Labour input	Rental per machine	Wage per worker	Capital cost	Labour cost	Total cost
A	4	4	€320	€300	€1280	€1200	€2480
B	2	6	€320	€300	€640	€1800	€2440 Lower!

Economically efficient production methods

- It costs €320 to rent a machine, and €300 to hire a worker.
- To make 100 spoons, the table on the previous slide shows that the total cost is €2480 with technique ***A*** and €2440 with technique ***B***.
- The firm chooses ***B***. 100 spoons at a total cost of €2440 is one point on the total cost curve for spoons. It is the **economically efficient** (lowest-cost) production method at the going rental and wage rates.

Deriving the total cost curve

- To get the whole **total cost** curve, we repeat the calculation for each output. The production function tells us the inputs needed by each technique. Using input prices, we calculate the cost using each technique, and choose the lowest-cost production method.
- Joining up these points we get the total cost curve, which may switch from one production technique to another at different outputs. From the total cost curve we calculate the marginal cost curve – the rise in total cost at each output when output is increased by one more unit.

Factor intensity

- A technique using a lot of capital and little labour is ‘capital-intensive’.
- A technique using a lot of labour but relatively little capital is called ‘labour-intensive’.
- In our previous table, technique ***A*** was more capital-intensive and less labour-intensive than technique ***B***. (The ratio of capital input to labour is 1 in technique ***A*** but only one-third in technique ***B***.)

Factor prices and relative prices

- At the **factor prices** (prices per unit input) in our previous table, the more labour-intensive technique was cheaper.
- Suppose the wage rises from €300 to €340: labour is dearer but the rental on capital is unchanged.
- The **relative price** of labour has risen.

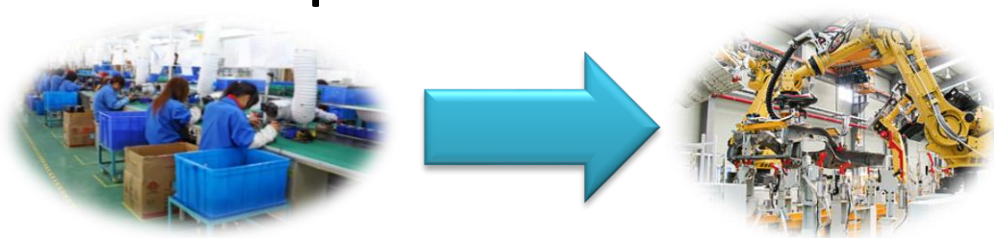
Effects of a price change

- We ask two questions: First, what happens to the total cost of making 100 spoons?
- Second, is there any change in the preferred technique?
- The table below recalculates production costs at the new factor prices.

Technique	Capital input	Labour input	Rental per machine	Wage per worker	Capital cost	Labour cost	Total cost
A	4	4	€320	€340	€1280	€1360	€2640 Lower!
B	2	6	€320	€340	€640	€2040	€2680

Effects of a price change (2)

- As we could see, since both techniques use some labour, the total cost of making 100 spoons by each technique rises.
- Repeating this argument at all output, the total cost curve must shift upwards when the wage rate (or the price of any other input) rises.
- In this example, the rise in the relative price of labour leads the firm to switch techniques: it switches to the more capital-intensive technique ***A***.

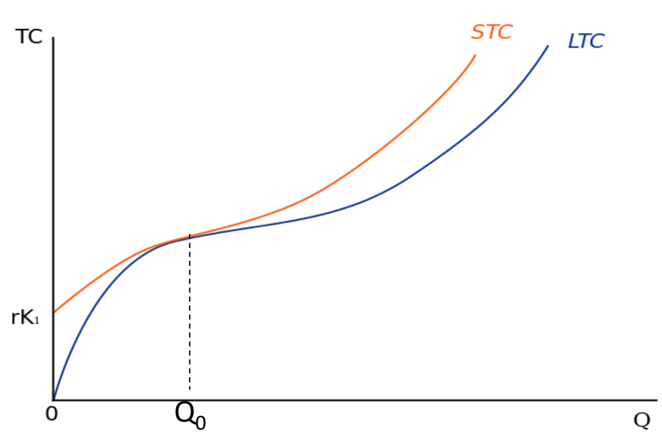


Long-run analysis

- Faced with an upward shift in its demand and MR curves, a firm will expand output.
- However, adjustment takes time. Initially, the firm can get its existing workforce to do overtime. In the long run, the firm can vary its factory size, switch techniques of production, hire new workers and negotiate new contracts with suppliers of raw materials.

Long run and short run

- The **long run** is the period long enough for the firm to adjust **all its inputs** to a change in conditions.
- In the **short run** the firm can make only **partial** adjustment of its inputs to a change in conditions.



Partial adjustments are more costly: short-run total costs are at least as high, but usually higher than the long-run total costs if the firm increases or decreases its output.

Higher short-run costs

- The firm may be able to alter the **shift length** at once.
- **Hiring or firing** workers takes longer, and it might be years before a **new factory** is designed, built, and operational.
- For now, we will only analyse long-run cost curves, when the firm can make all the adjustments it desires.

Long-run total and marginal costs

- **Long-run total cost** is the minimum cost of producing each output level when the firm can adjust all inputs.
- **Long-run marginal cost** is the rise in long run total cost if output rises permanently by one unit.

Alternatively, it may be defined as the derivate of the total cost function LTC(q):

$$\mathrm{LMC} = \frac{\partial \mathrm{LTC(q)}}{\partial \mathrm{q}}$$

Long-run costs

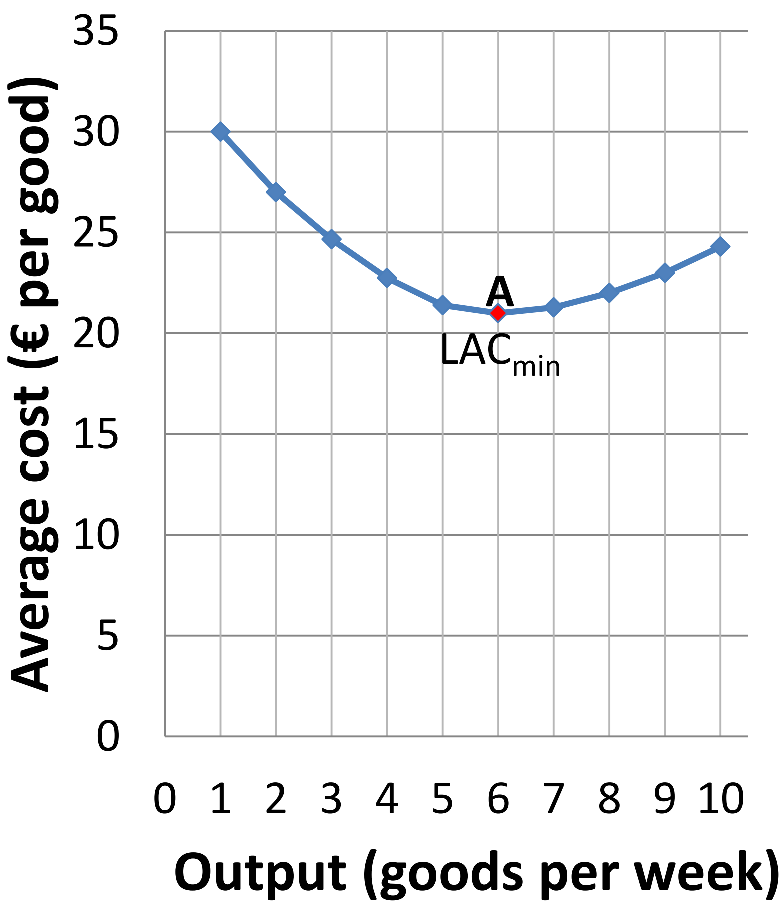
(1) Output	(2) Total cost (€)	(3) Marginal cost (€)	(4) Average cost (€)
0	0		
1	30	30	30
2	54	24	27
3	74	20	24.67
4	91	17	22.75
5	107	16	21.4
6	126	19	21
7	149	23	21.29
8	176	27	22
9	207	31	23
10	243	36	24.3

- The table to the left shows long-run total costs LTC and long-run marginal costs LMC of making each output.
- Since there is always an option to close down entirely, the LTC of producing zero output is zero. LTC describes the eventual costs after all adjustments have been made.
- LTC must rise with output: higher output always costs more to produce. LMC is always positive.

Long-run average cost

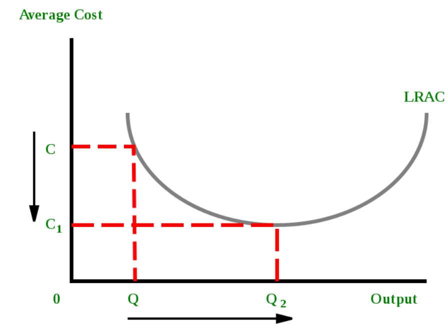
- Can large firms produce goods at a lower unit cost than small firms? Might it be a disadvantage to be (too) large?
- To answer these questions, we need to think about average cost per unit of output.
- **Long-run average cost** (LAC) is the total cost (LTC) divided by the level of output (Q).

The LAC curve (figure 1)



- Our previous table showed long-run average cost LAC (column 2 divided by column 1). These LAC data are plotted in the figure to the left (figure 1).
- Average cost starts out high, then falls, then rises again. This common pattern of average costs is called the U-shaped average cost curve. To see why U-shaped average cost curve is common in practice, we examine 'returns to scale'.

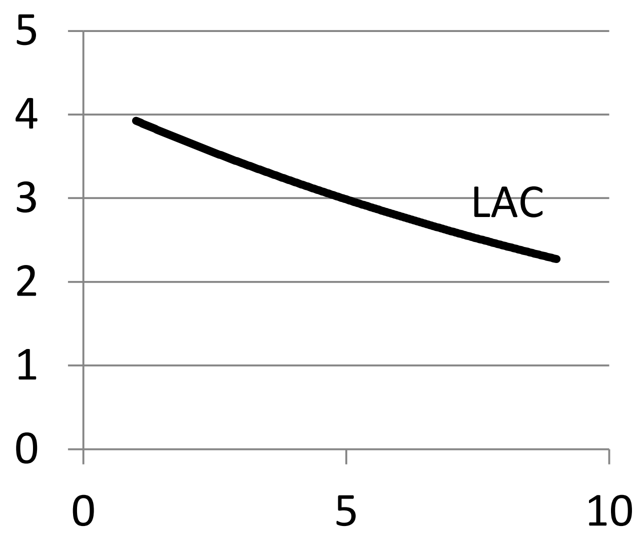
Returns to scale



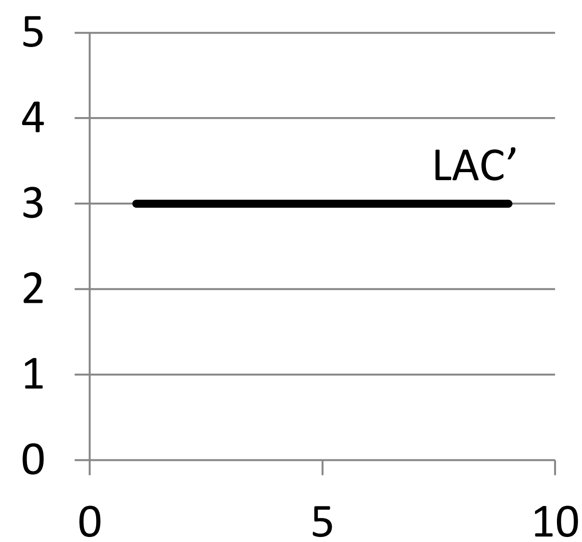
- **Economies of scale (or increasing returns to scale)** mean long-run average cost falls as output rises.
- **Diseconomies of scale (or decreasing returns to scale)** mean long-run average cost rises as output rises.
- **Constant returns to scale** mean long-run average costs are constant as output rises.

Returns to scale and long-run average cost (LAC) curves

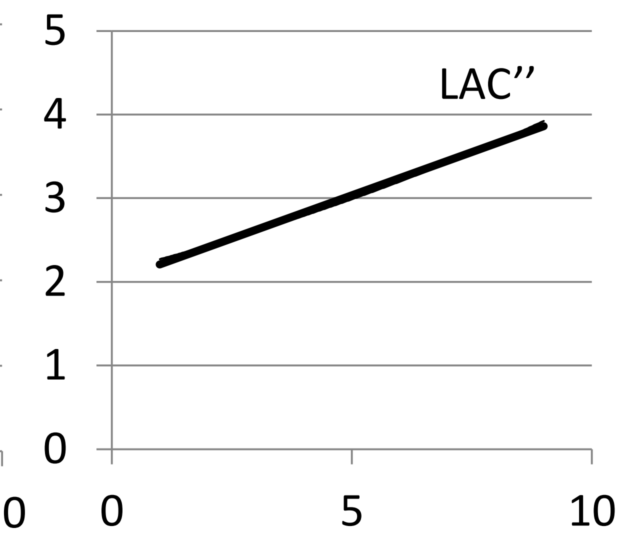
Increasing returns to scale (economies of scale)



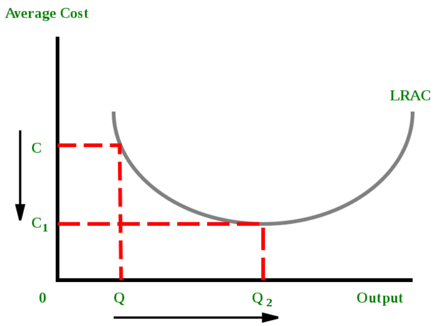
Constant returns to scale



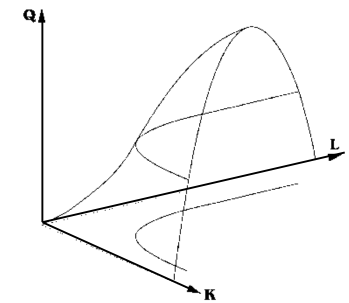
Decreasing returns to scale (diseconomies of scale)



- When LAC is declining, average costs of production fall as output increases and there are economies of scale.
- When LAC is increasing, average costs of production increase with higher output, and there are decreasing returns to scale.
- The intermediate case, where average costs are constant, has constant returns to scale.

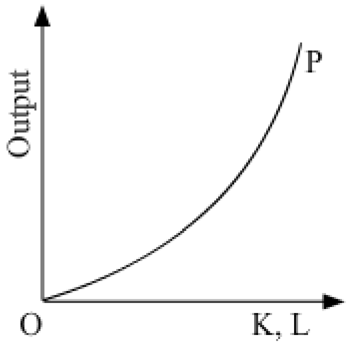


Returns to scale (2)

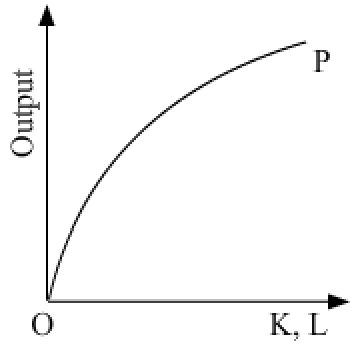


- In the figure above (and to the left), the U-shaped average cost curve has scale economies up to point Q_2, where average cost is lowest. At higher outputs there are diseconomies of scale.
- Why are there scale economies at low output levels but diseconomies of scale at high output levels? We draw a cost curve for given input prices. Changes in average costs as we move along the LAC curve cannot be explained by changes in factor prices. (Changes in factor prices ***shift*** cost curves.)
- The relationship between average costs and output as we move along the LAC curve depends on the technical relation between physical quantities of inputs and output, summarized in the production function.

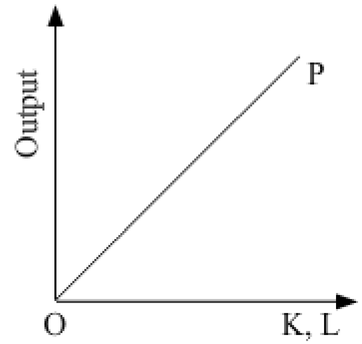
Returns to scale (3)



(a) Increasing Returns to Scale



(b) Decreasing Returns to Scale



(c) Constant Returns to Scale

Increasing returns to scale mean that one (big) company can produce more efficiently than more than one (smaller) firms utilizing the same factors of production → emergence of natural monopolies

Formally, „returns to scale”, refers to changes in output (quantity, q) resulting from a proportional change (λ) in all inputs:

a) If output increases by more than that proportional change, there are increasing returns to scale (economies of scale):

e.g. $Q = KL \quad Q(\lambda K, \lambda L) = (\lambda K)(\lambda L) = \lambda^2 Q(K, L)$

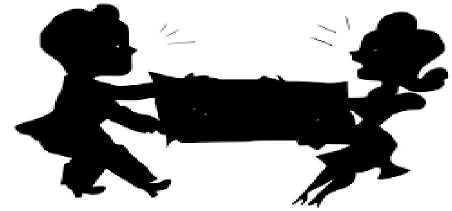
b) If output increases by less than that proportional change, there are decreasing returns to scale:

e.g. $Q = \sqrt[3]{KL} \quad Q(\lambda K, \lambda L) = \sqrt[3]{(\lambda K)(\lambda L)} = \lambda^{2/3} Q(K, L)$

c) If output increases by that same proportional change, there are constant returns to scale:

e.g. $Q = \sqrt{KL} \quad Q(\lambda K, \lambda L) = \sqrt{(\lambda K)(\lambda L)} = \lambda Q(K, L)$

Indivisibilities



- There are three reasons for economies of scale. The first is indivisibilities in the production process, a minimum quantity of inputs required by the firm to be in business at all whether or not output is produced.
- These are sometimes called quasi-fixed costs, because they do not vary with output level. To be in business a firm requires a manager, a telephone, an accountant, a market research survey. The firm cannot have half a manager and half a telephone merely because it wishes to operate at low output levels.

Quasi-fixed costs

- Beginning from small output levels, these costs do not initially increase with output.
- The manager can organize three workers as easily as two. As yet there is no need for a second telephone.
- There are economies of scale because these costs can be spread over more units of output as output is increased, reducing average cost per unit of output.
- However, as the firm expands further, it has to hire more managers and telephones and these economies of scale die away.

- The average cost curve stops falling.

Specialization

- The second reason for economies of scale is specialization.
- A sole trader must undertake all the different tasks of the business.
- As the firm expands and takes on more workers, each worker can concentrate on a single task and handle it more efficiently.

Machinery

- The third reason for scale economies is closely related. Large scale is often needed to take advantage of better machinery.
- No matter how productive a robot assembly line is, it is pointless to install one to make six cars a week. Average costs would be enormous.
- However, at high output levels the machinery cost can be spread over a large number of units of output and this production technique may produce so many cars that average costs are low.

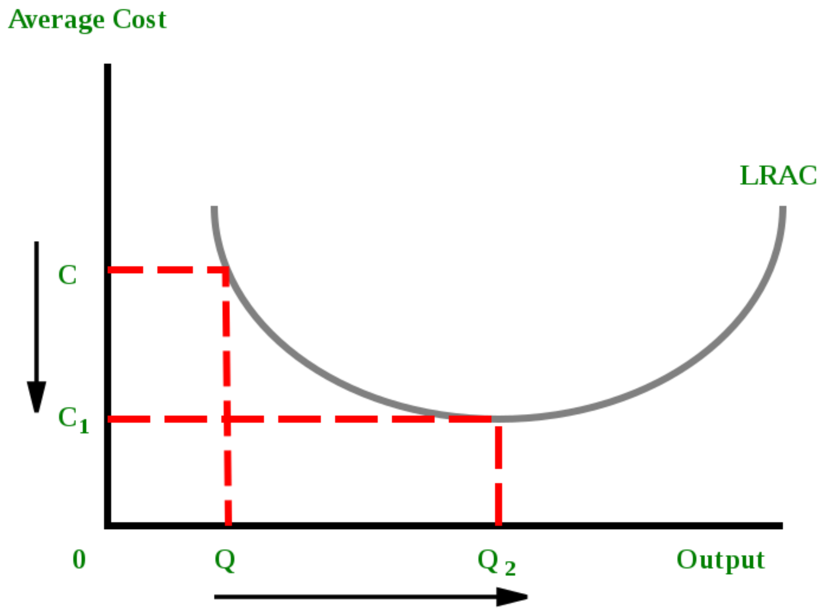
Managerial diseconomies of scale

- Beyond some output, the U-shaped average cost curve turns up again as diseconomies of scale begin.
- Management is harder as the firm gets larger: there are managerial diseconomies of scale.
- Large companies need many layers of management, themselves needing to be managed. The company becomes bureaucratic, co-ordination problems arise, and average costs begin to rise.

Other examples of diseconomies of scale

- Geography may also explain diseconomies of scale. If the first factory is located in the best site to minimize the cost of transporting goods to the market, the site of a second factory must be less advantageous.
- To take a different example, in extracting coal from a mine, a firm will extract the easiest coal first. To increase output, deeper coal seams have to be worked and these will be more expensive.

The shape of the average cost curve



- As output increases, the shape of the average cost curve thus depends on two things: how long economies of scale persist, and how quickly the diseconomies of scale set in.
- The balance of these two forces varies from industry to industry and firm to firm.

Returns to scale in practice

- To gather evidence on returns to scale we can talk to design engineers to see how production costs vary with output.
- Many studies of manufacturing industries confirm that scale economies continue over a wide range of output.
- The long-run average cost curve slopes down, albeit at an ever decreasing rate.

Manufacturing and service sector industries

- Scale economies in manufacturing industries are substantial.
- However, there are many industries, even in the manufacturing sector, where minimum efficient scale (MES) for a firm is small relative to the whole market and average costs are only a little higher if output is below minimum efficient scale.
- **Minimum efficient scale** is the lowest output at which the LAC curve reaches its minimum.
- For some industries, particularly personal services (hairdressers, doctors, etc.), economies of scale run out at quite low output levels.


Thank you

Costs and Supply A

Appendix:

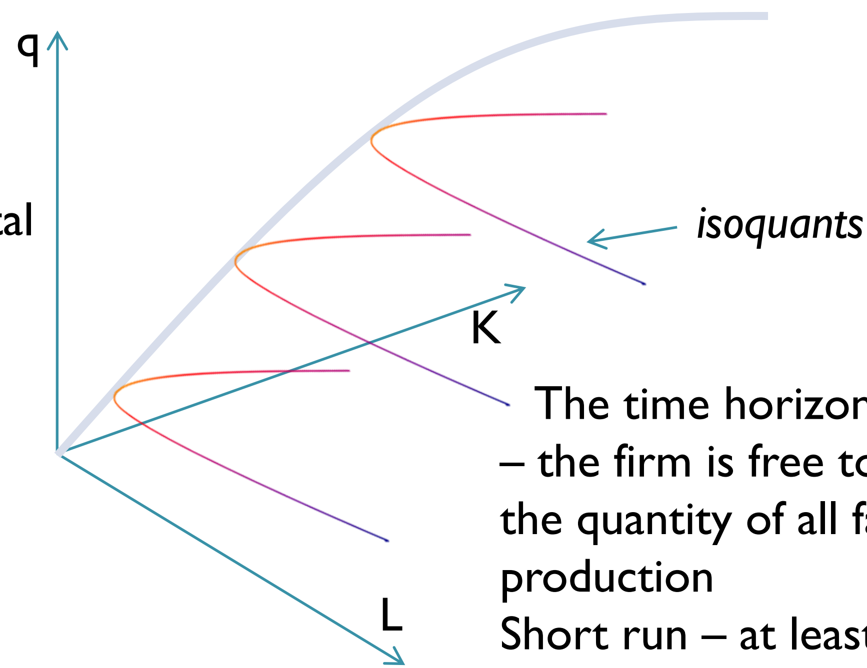
The optimal combination of factors (supply) and consumer behaviour

MICRO- AND MACROECONOMICS

The production function

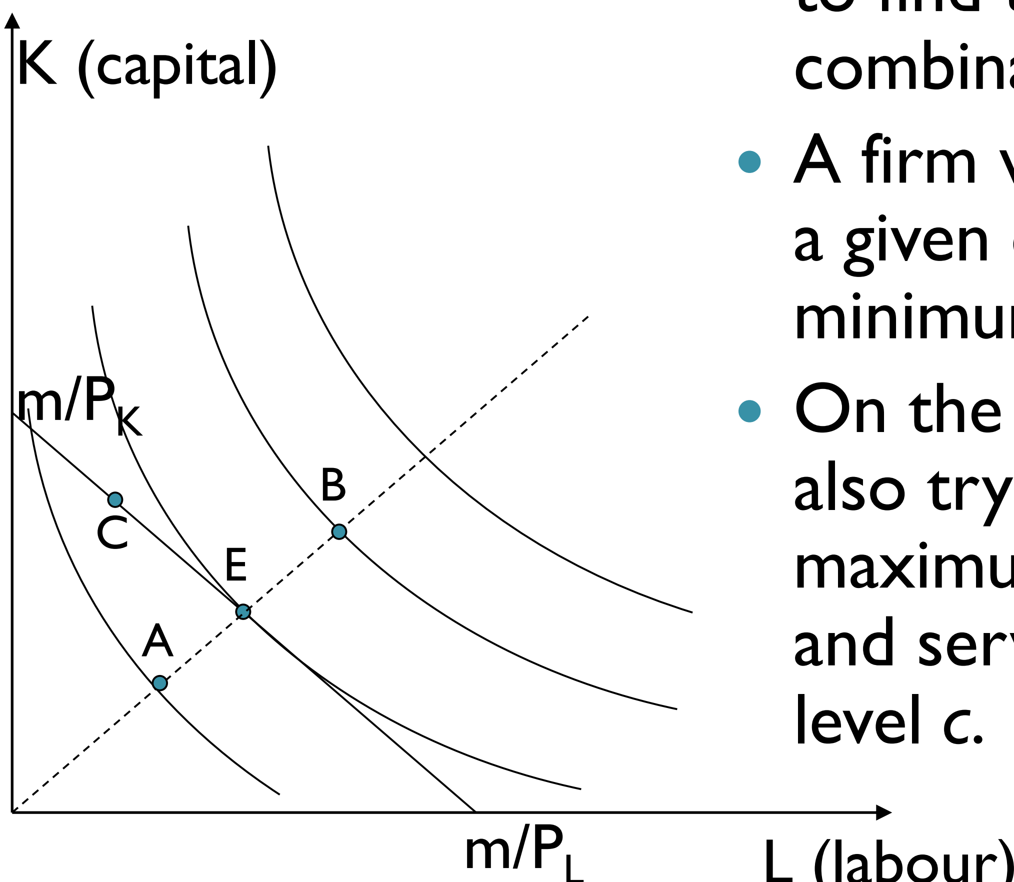
- The production function ($Q = f(x_1,x_2,\ldots)$) shows how many goods or services a firm can produce utilizing its resources (factors of production) – the maximum output possible from a given set of inputs.

In our examples
K – Capital [← das Kapital (German)]
L – Labour
q – Quantity of products



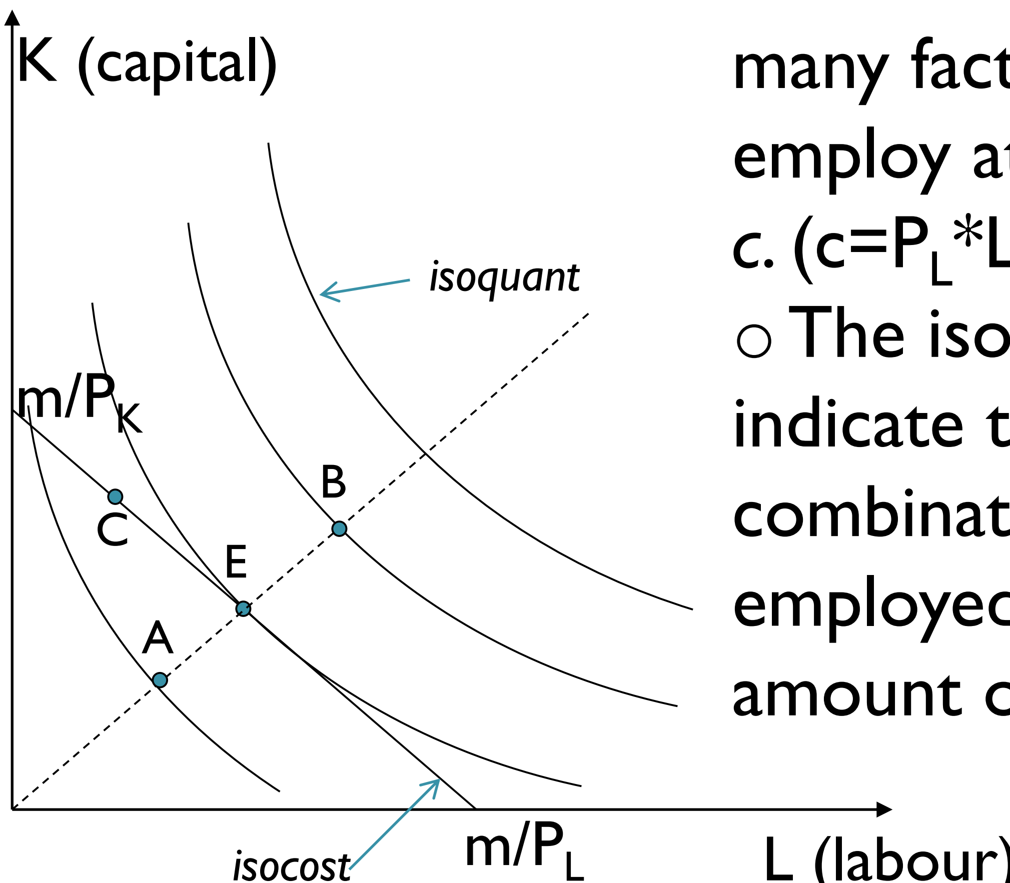
The time horizon: Long run – the firm is free to choose the quantity of all factors of production
Short run – at least one of these factors is fixed

The optimal combination of factors of production



- In the long run, the firm tries to find the optimal combination of factors:
- A firm would try to produce a given quantity „*q*" at the minimum cost (LTC(q)).
- On the other hand, it would also try to produce the maximum amount of goods and services at a given cost level *c*.

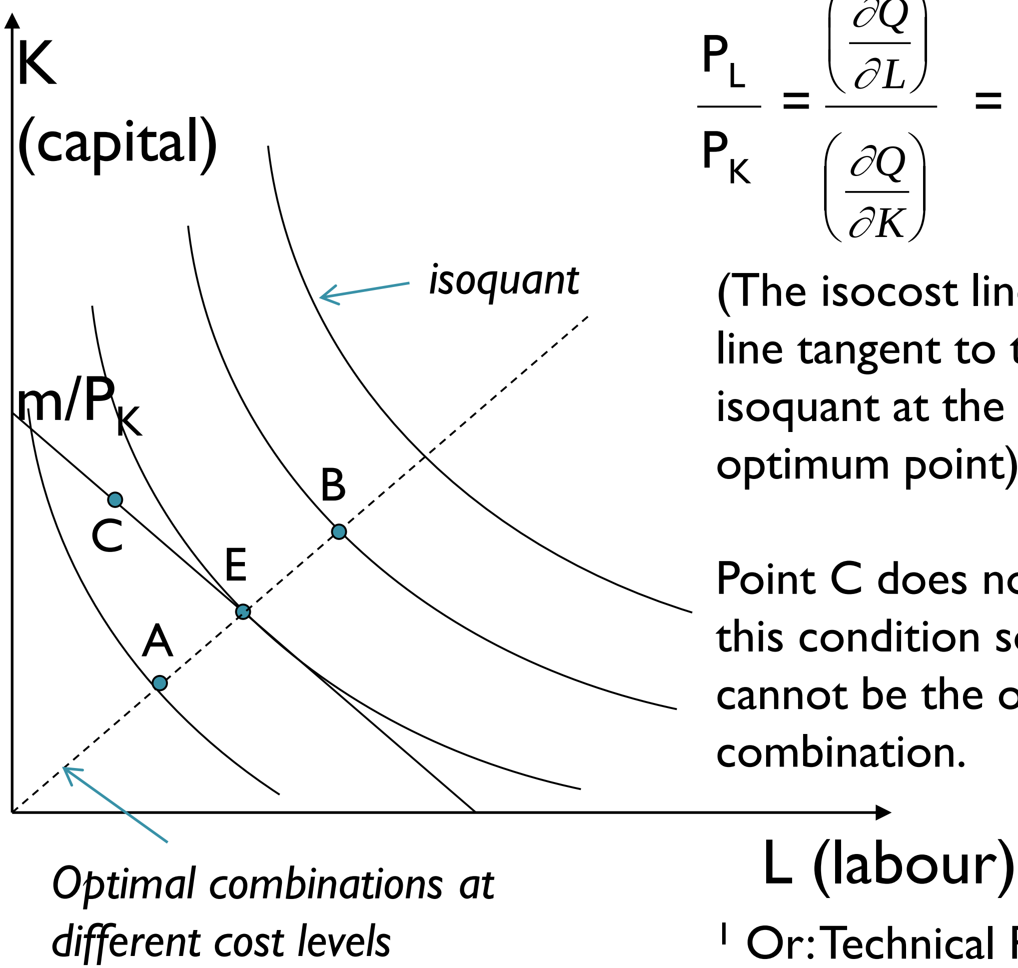
The optimal combination of factors of production II.



- Isocost lines show how many factors the firm can employ at a given cost level c. ($c=P_L*L+P_K*K$)
- The isoquant curves indicate the factor combinations that can be employed to produce a given amount of goods.

The optimal combination of factors of production III.

A necessary condition for optimality:



$$\frac{P_L}{P_K} = \frac{\left(\frac{\partial Q}{\partial L}\right)}{\left(\frac{\partial Q}{\partial K}\right)} = MRTS^*$$

(The isocost line is the line tangent to the isoquant at the optimum point)

Point C does not satisfy this condition so it cannot be the optimal combination.

*MRTS: the Marginal Rate of Technical Substitution

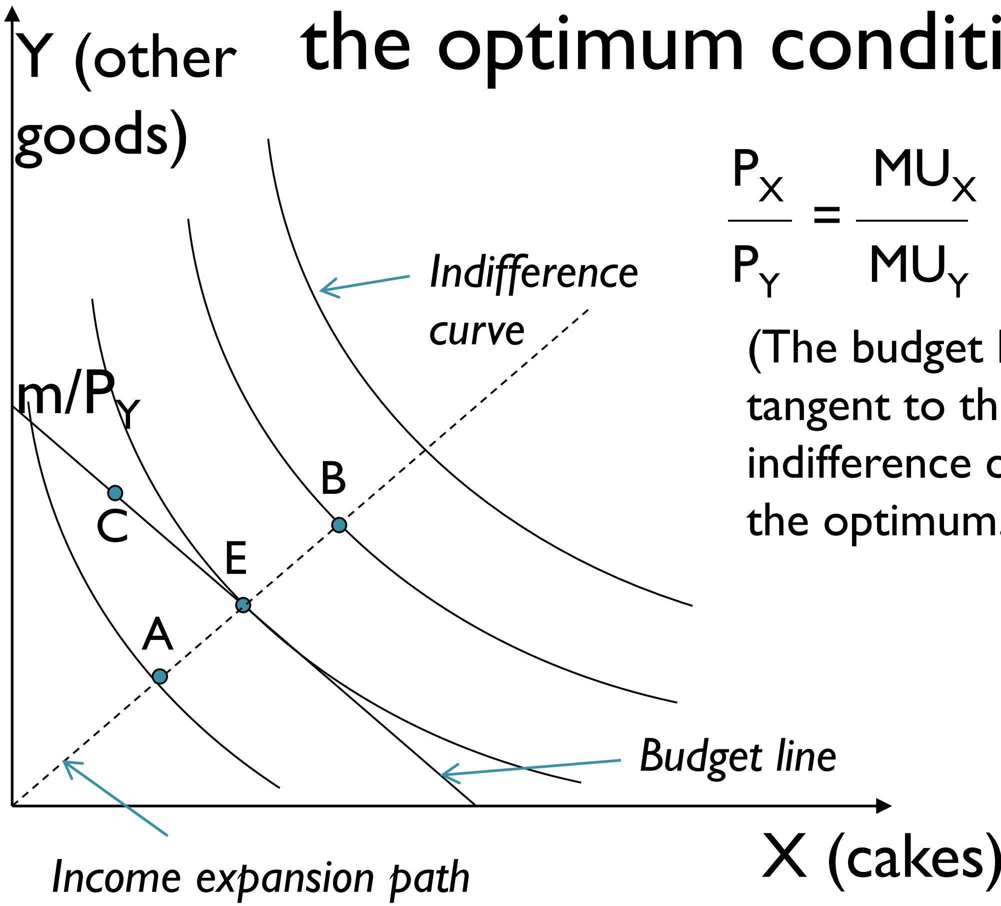
The optimum point is at „E"

[1] Or: Technical Rate of Substitution (TRS)

Consumer behaviour

Reminder

The optimum condition is similar to the optimum condition of the firm:



$$\frac{P_X}{P_Y} = \frac{MU_X}{MU_Y} = MRS^*$$

(The budget line is a tangent to the indifference curve at the optimum.)

MRS: Marginal Rate of Substitution

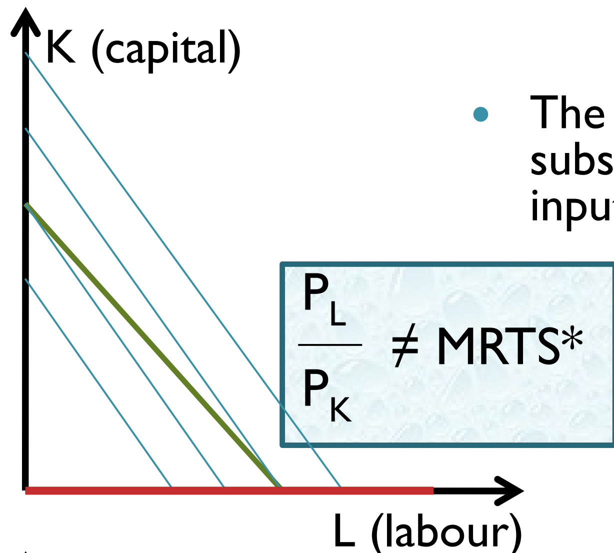
The optimum point is at "E"

“Special technologies”

isocost

isoquant

growth path

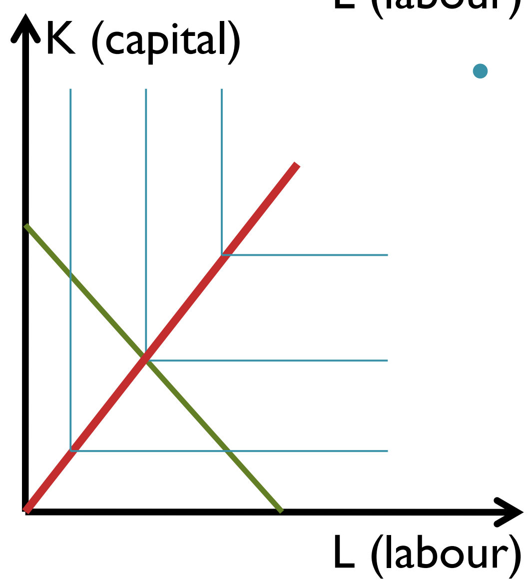


- The factors of production are perfect substitutes → the firm would only use one input type (here: labour)

  $Q=\alpha L+\beta K$

  if α/β > pL/pK, the firm would only use labour;

  if α/β < pL/pK, the firm would only use capital.



- Leontief production function: The factors of production are perfect complements → the factors must be used in fixed proportions

  $Q=\min\{\alpha L; \beta K\}$

  if the opt. condition $L=\beta/\alpha K$

  is not satisfied, the company is wasting its resources.

Leontief production function

- This type of production function is characteristic of the chemical industry and chemical reactions

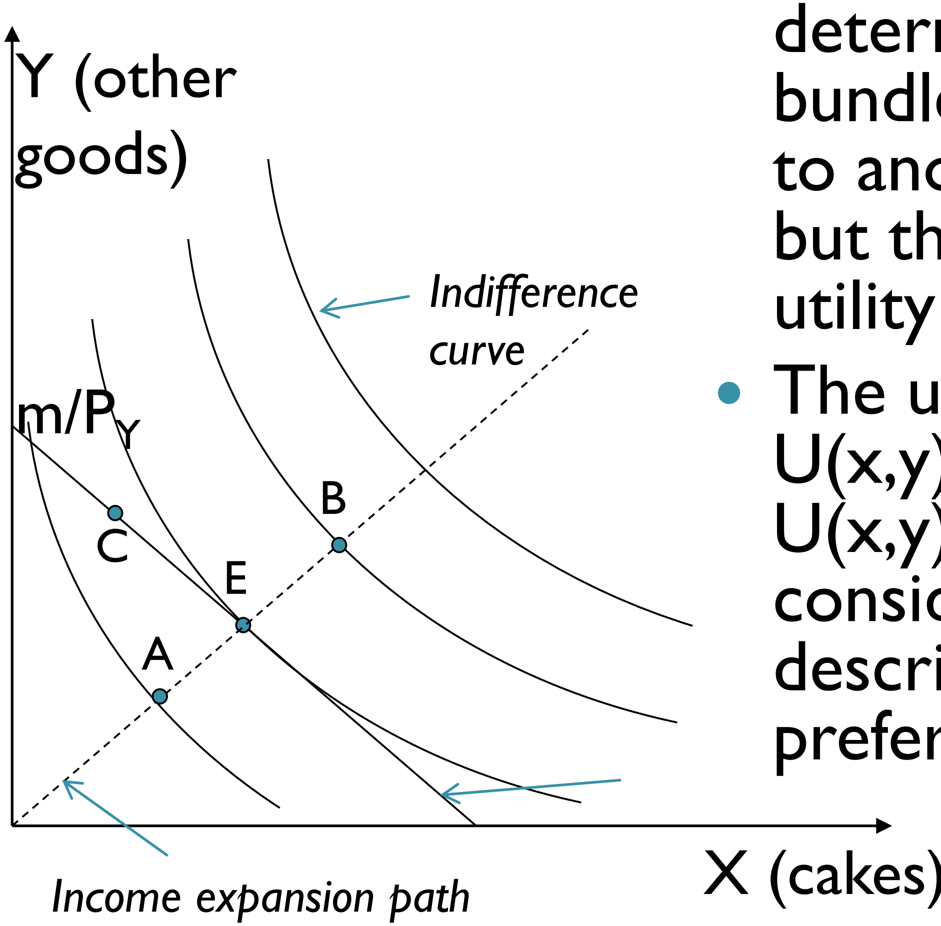
- Example: The direct synthesis of hydrogen chloride using hydrogen and pure chlorine gas

$$H_2 + Cl_2 \rightarrow 2HCl$$

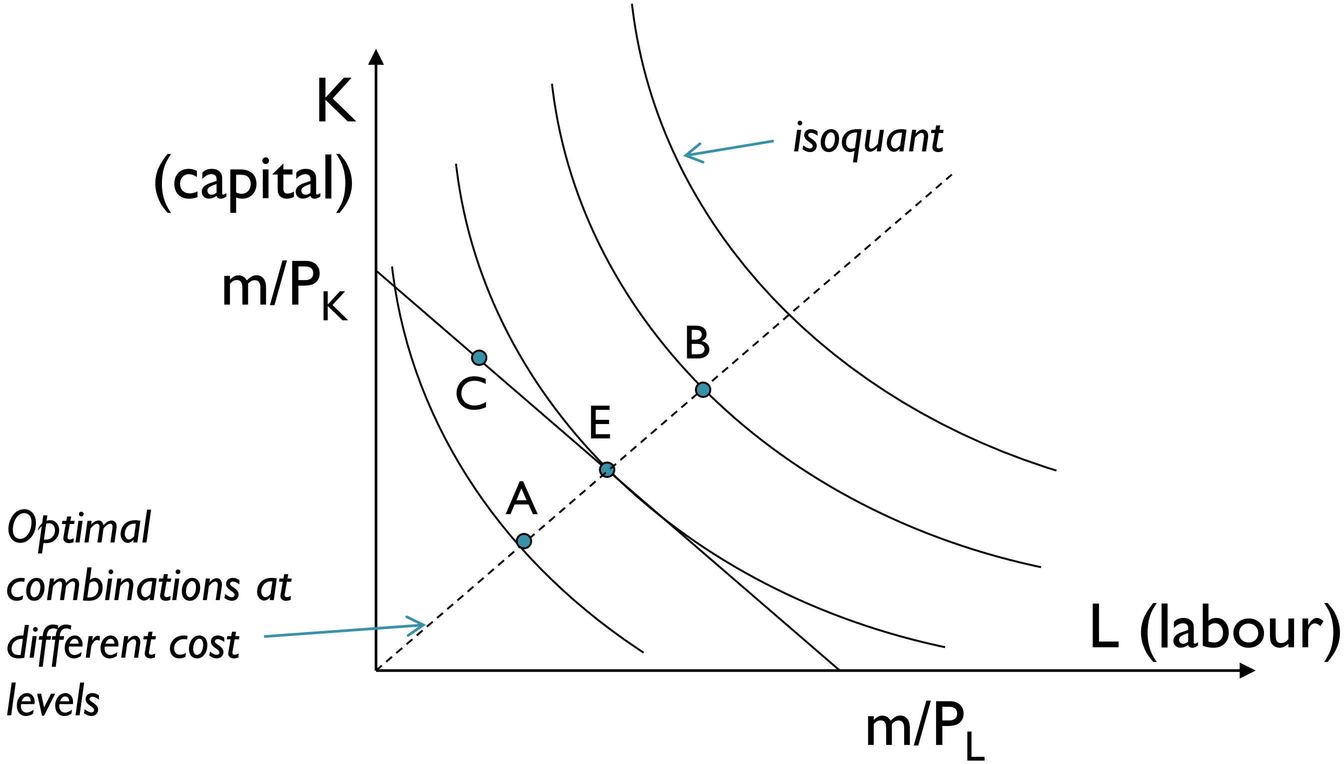
- Prod. func.: $Q_{HCl} = 2\min\{Cl_2; H_2\}$

- The inputs of this production function are hydrogen and chlorine gas, the output is hydrogen chloride (but: several other inputs might be needed, e.g. a factory, facilities (capital), chemists/technicians (labour)).

Differences between utility functions and production functions



- According to the theory of ordinal utility, we can only determine whether one bundle of goods is preferred to another (by a consumer), but the nominal value of utility has no significance.
- The utility functions $U(x,y)=xy$; $U(x,y)=(xy)^2$ and $U(x,y)=\ln(x)+\ln(y)$ are considered equivalent, describing the same preference map.



- On the other hand the isoquants of production represent the quantity of goods produced by the firm. Production functions $Q(L,K)=(KL)^{0.5}$ and $Q(L,K)=KL$ are not considered equivalent, the technology represented by the latter is more efficient and therefore preferred by the firm.

➔ Returns to scale


Thank you

Costs and Supply II

Long-run costs

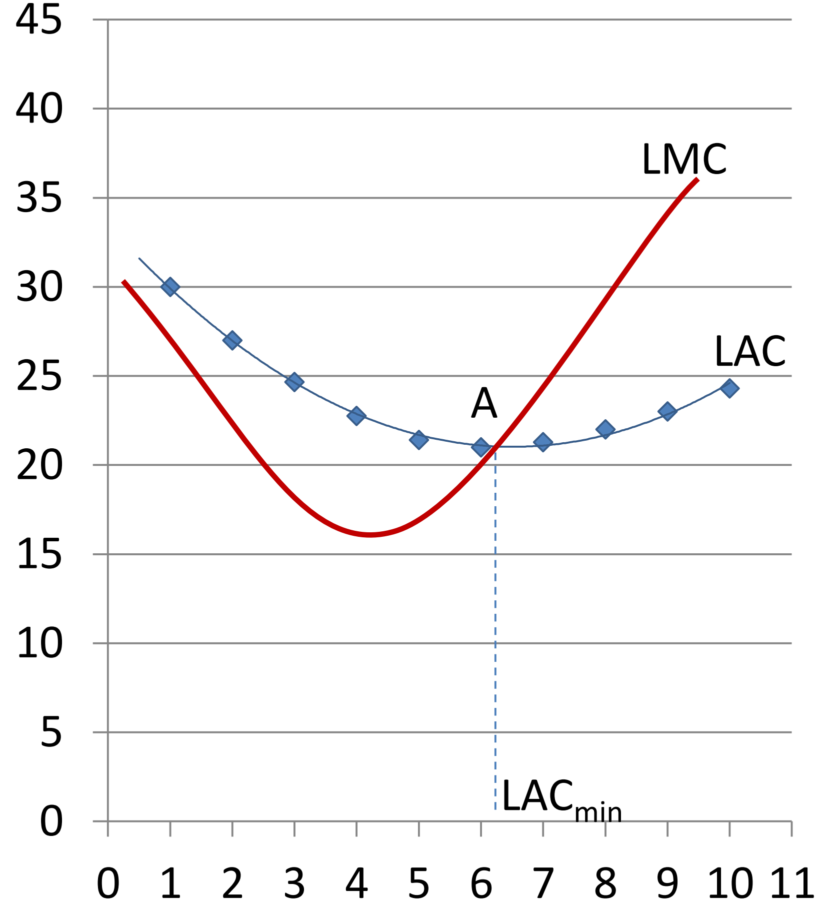
Firm decisions in the long run

Short-run costs and decisions

MICRO- AND MACROECONOMICS

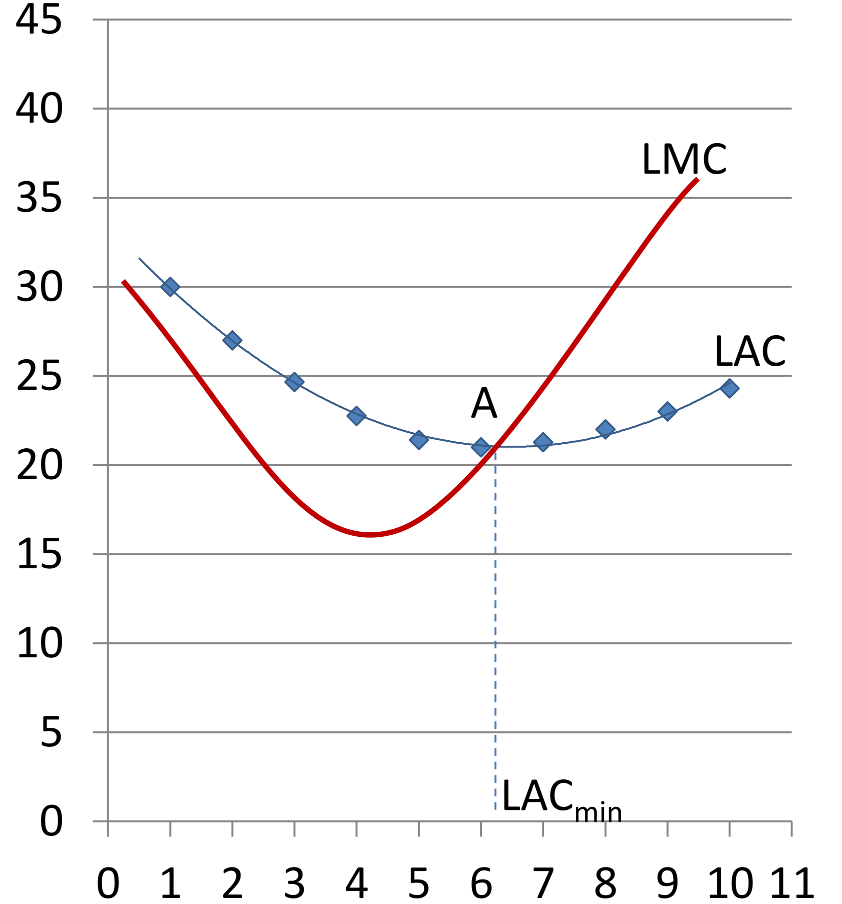
Long-run costs

(1) Output	(2) Total cost (€)	(3) Marginal cost (€)	(4) Average cost (€)
0	0		
1	30	30	30
2	54	24	27
3	74	20	24.67
4	91	17	22.75
5	107	16	21.4
6	126	19	21
7	149	23	21.29
8	176	27	22
9	207	31	23
10	243	36	24.3



Average cost and marginal cost

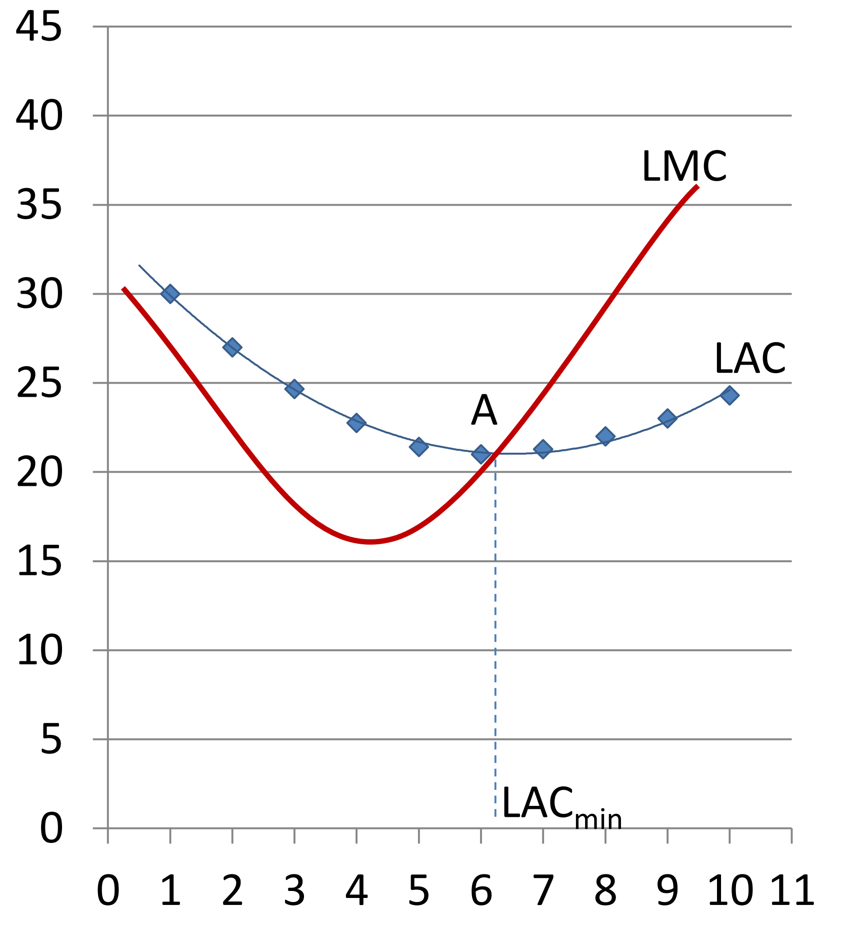
- In the figure, we connect the different cost measures (LTC, LAC, LMC), whose behaviour is closely related.
- At each output, LAC is total cost divided by output. To stress that marginal cost is incurred by moving from one output level to another, LMC is plotted at points halfway between the corresponding outputs.
- The LMC of €30 for the first unit is plotted at the output halfway between 0 and 1.



Average cost and marginal cost (2)

- Two factors stand out from the table and diagram:

1. LAC is falling when LMC is less than LAC, rising when LMC is greater than LAC.
2. LAC is at a minimum at the output at which LAC and LMC cross.



Example: marginal and average

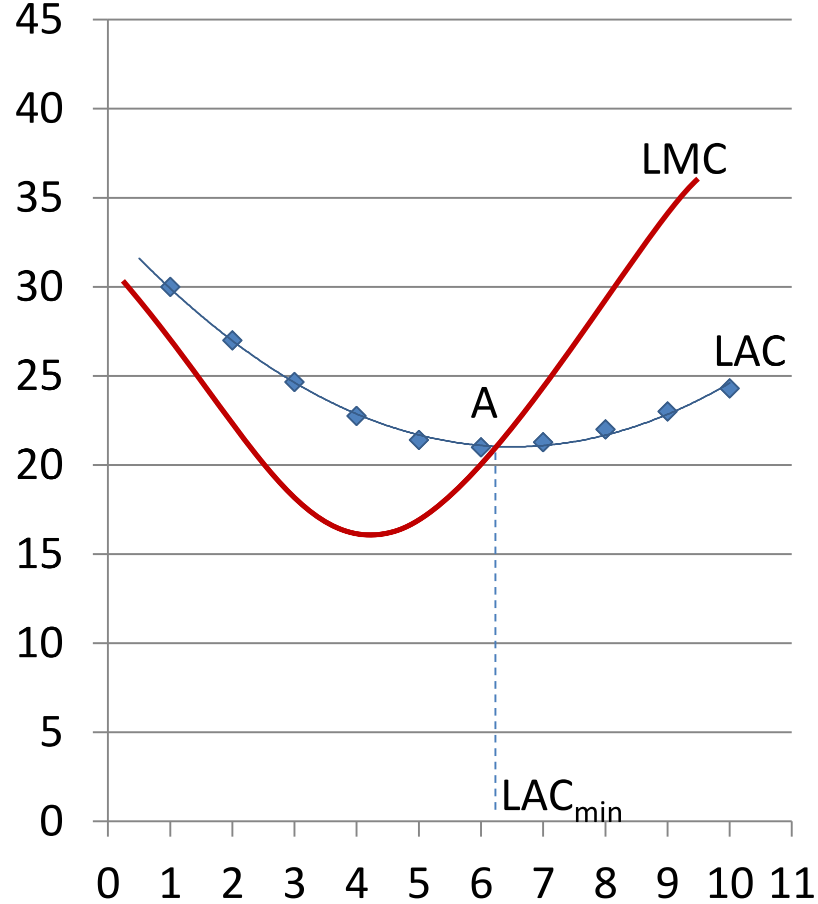
- Neither fact is an accident. The relation between average and marginal is a matter of arithmetic, as relevant for football as for production costs.
- A footballer with 4 goals in 4 games averages 1 goal a game. Two goals in the next game, implying 6 goals from 5 games, raises the average to 1.2 goals a game.
- In the 5th game the marginal goals were 2, raising total goals from 4 to 6. Because the marginal score exceeds the average score in previous games, the extra game must drag up the average.

Marginal and average cost

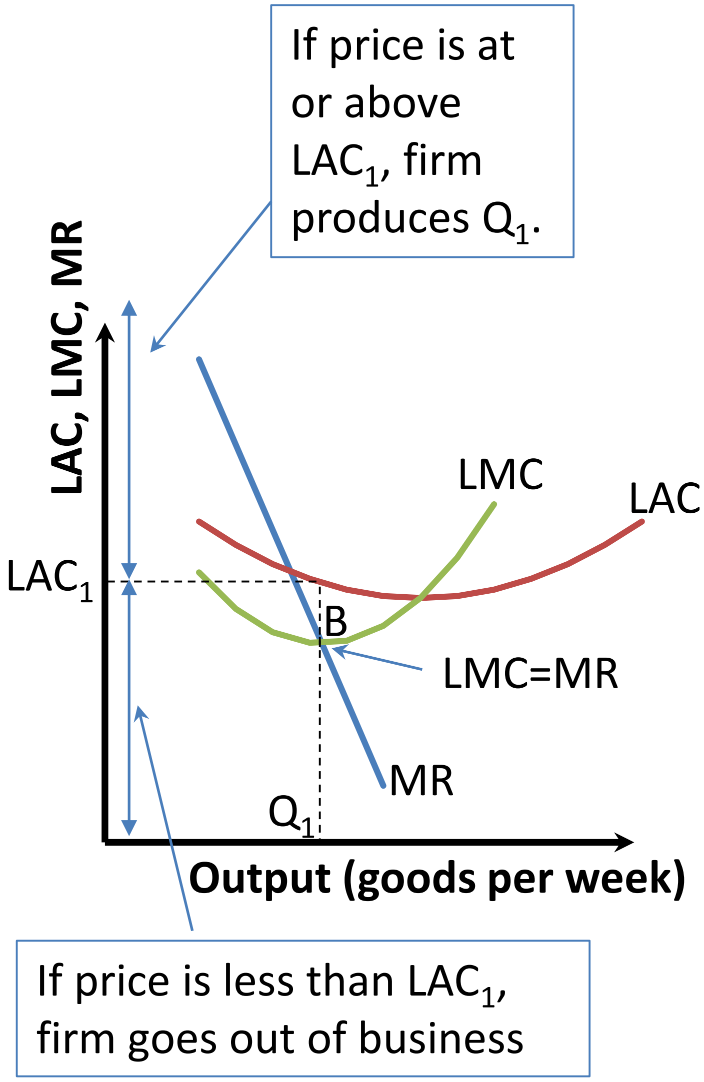
- The same holds for production costs. When the marginal cost of the next unit exceeds the average costs of the existing units, making the next unit must raise average costs.
- If the marginal cost of the next unit lies below the average cost of existing units, an extra unit of production drags down average costs.
- When marginal and average cost are equal, adding a unit leaves average cost unchanged.

- Average and marginal cost curves cross at point **A**, which must be the point of minimum average cost.
- To the left of **A**, LMC is below LAC so average cost is still falling. To the right of **A**, LMC is above LAC so average cost is rising. Average cost is lowest at **A**.
- The marginal cost curve crosses the average cost curve from below at the point of minimum average cost. It is true both for the relationship between LMC and LAC and for the relationship between short-run average cost (SAC) and short-run marginal cost (SMC)

LAC_{min} is at q, where LMC=LAC



The firm’s long-run output decision

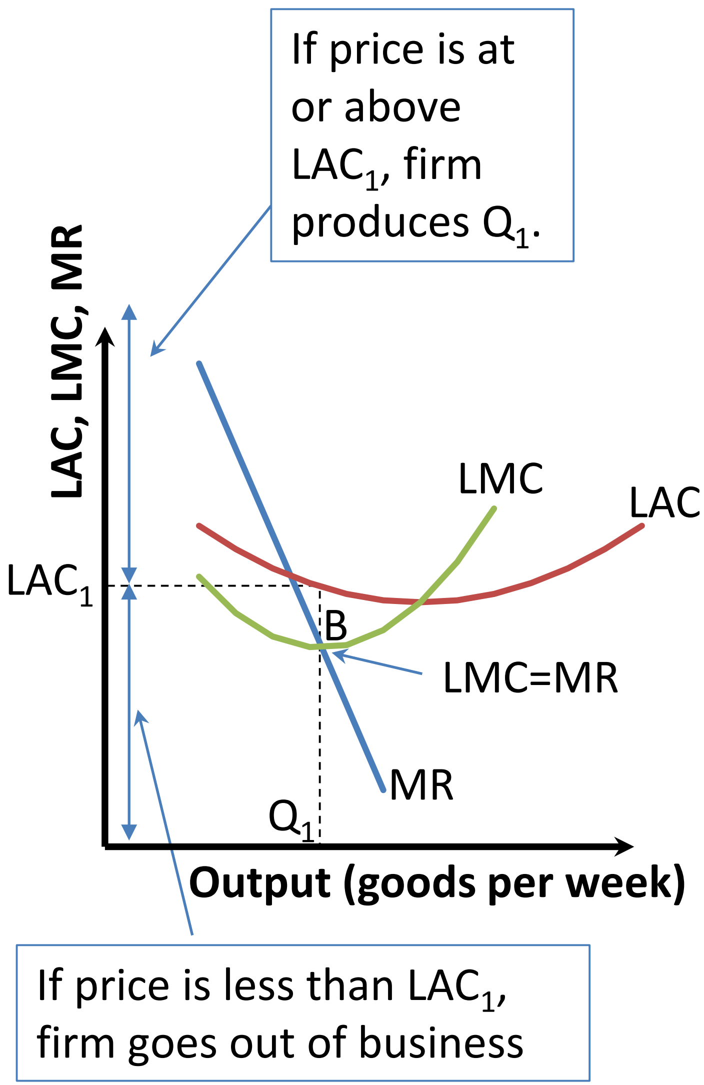


- The figure to the left shows smooth LAC and LMC curves for a firm not restricted to produce integer units of output. It also shows the firm’s marginal revenue (MR) schedule.
- We already know that the output of maximum profit, or minimum loss is at B, the output at which marginal revenue equals marginal cost.
- The firm then checks whether it makes profits or losses at this output. It should not stay in business if it makes losses for ever.

Total profit and average profit

- Total profit is average profit per unit of output, multiplied by output: $T\pi = A\pi \cdot q$
- Total profit is positive if and only if average profit is positive: $(T\pi > 0) \leftrightarrow (A\pi > 0)$
- Average profit is average revenue minus average cost: $A\pi = AR - AC$
- But average revenue is simply the price for which each unit of output is sold! $AR = P$

Break-even point



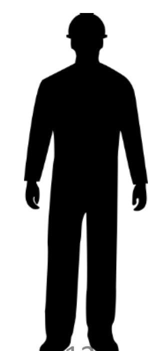
- Hence, if long-run average costs at **B** exceed the price for which output Q_1 is sold, the firm makes losses in the long run and should close down.
- If, at this output, price equals LAC, the firm just breaks even.
- If price exceeds LAC at this output, the firm makes long-run profits and happily remains in business.

The firm's long-run output decision (summary)

- First, we use the **marginal condition** (LMC=MR) to find the best output *provided* the firm stays in business.
- Then, we use the **average condition** (comparing long-run average cost at this output with the price or average revenue received) to see if the best positive output yields a profit or a loss.

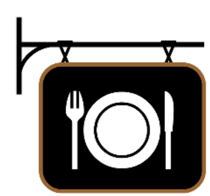
Short run: Fixed and varied factors of production

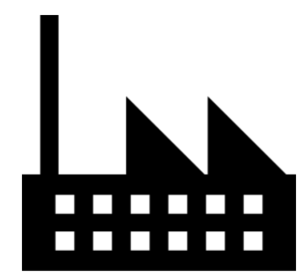
- The **short run** is the period in which the firm cannot fully adjust to a change in conditions.
- In the short run the firm has some ($k \geq 1$) fixed factors of production.
- A **fixed factor of production** is an input that cannot be varied (typically capital).
- A **variable factor** can be varied, even in the short run (typically labour).



Short run in different industries

- How long this short run lasts depends on the industry.
- It might take ten years to build a new power station but only a few months to open new restaurant premises if an existing building can be bought, converted and decorated.





Fixed costs

- The existence of fixed factors in the short run has two implications. First, in the short run the firm has some fixed costs.
- **Fixed costs** do not vary with output.
- These fixed costs must be borne even if output is zero. If the firm cannot quickly add to or dispose of its existing factory, it must still pay depreciation on the building and meet the interest cost of the money it originally borrowed to buy the factory.
- Second, because in the short run the firm cannot make all the adjustments it would like, its short-run costs must exceed its long-run costs.

Short-run costs of production

(1) Output	(2) SFC	(3) SVC	(4) STC	(5) SMC
0	30	0	30	N/A
1	30	22	52	22
2	30	38	68	16
3	30	48	78	10
4	30	61	91	13
5	30	79	109	18
6	30	102	132	23
7	30	131	161	29
8	30	166	196	35
9	30	207	237	41
10	30	255	285	48

- The table to the left presents data on short-run costs.
- The second column shows the fixed costs, which are independent of the output level.
- The third column shows the variable costs.
- The fourth column shows total costs (fixed + variable).
- The final column shows the marginal costs.

Variable costs

- **Variable costs** change as output changes.
- Variable costs are the costs of hiring variable inputs, typically labour and raw materials.
- Firms may have long-term contracts with material suppliers and workers, which reduce the speed at which these inputs can be adjusted. Yet most firms retain some flexibility through overtime and short time, hiring or non-hiring of casual and part-time workers, and raw material purchases in the open market to supplement contracted supplies.

Total and Marginal Costs

(1) Output	(2) SFC	(3) SVC	(4) STC	(5) SMC
0	30	0	30	N/A
1	30	22	52	22
2	30	38	68	16
3	30	48	78	10
4	30	61	91	13
5	30	79	109	18
6	30	102	132	23
7	30	131	161	29
8	30	166	196	35
9	30	207	237	41
10	30	255	285	48

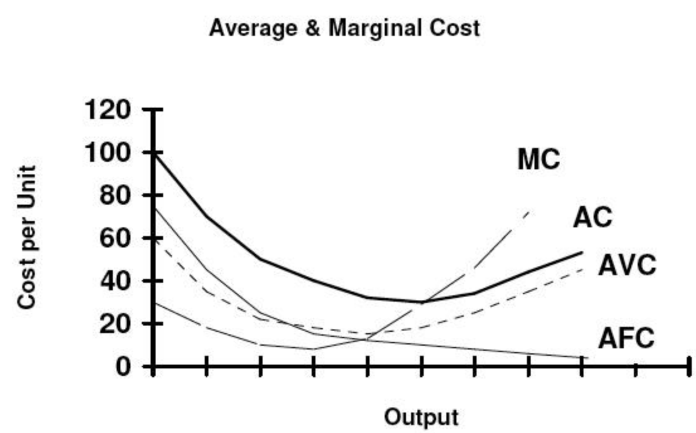
- The fourth column of the table shows short-run total costs:

  Short-run total costs (STC) = Short-run fixed costs (SFC) + Short-run variable costs (SVC)

- The final column shows short-run marginal costs SMC. Since fixed costs do not rise with output, SMC is the rise both in short-run total costs and in short-run variable costs as output is increased by one unit.

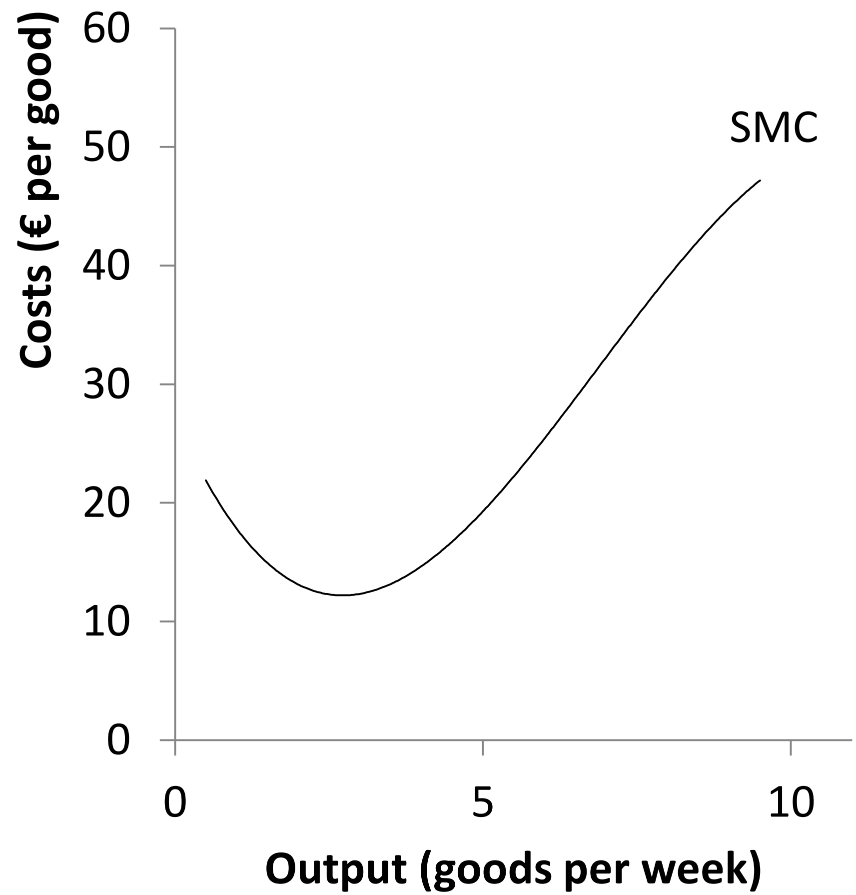
Costs and output

- Whatever the output, fixed costs are €30 per week. Marginal costs are always positive.
- Short-run total costs rise steadily as output rises. Extra output adds to total cost, and adds more the higher is the marginal cost.
- In the last column of our previous table, as output increases marginal costs first fall then rise again.

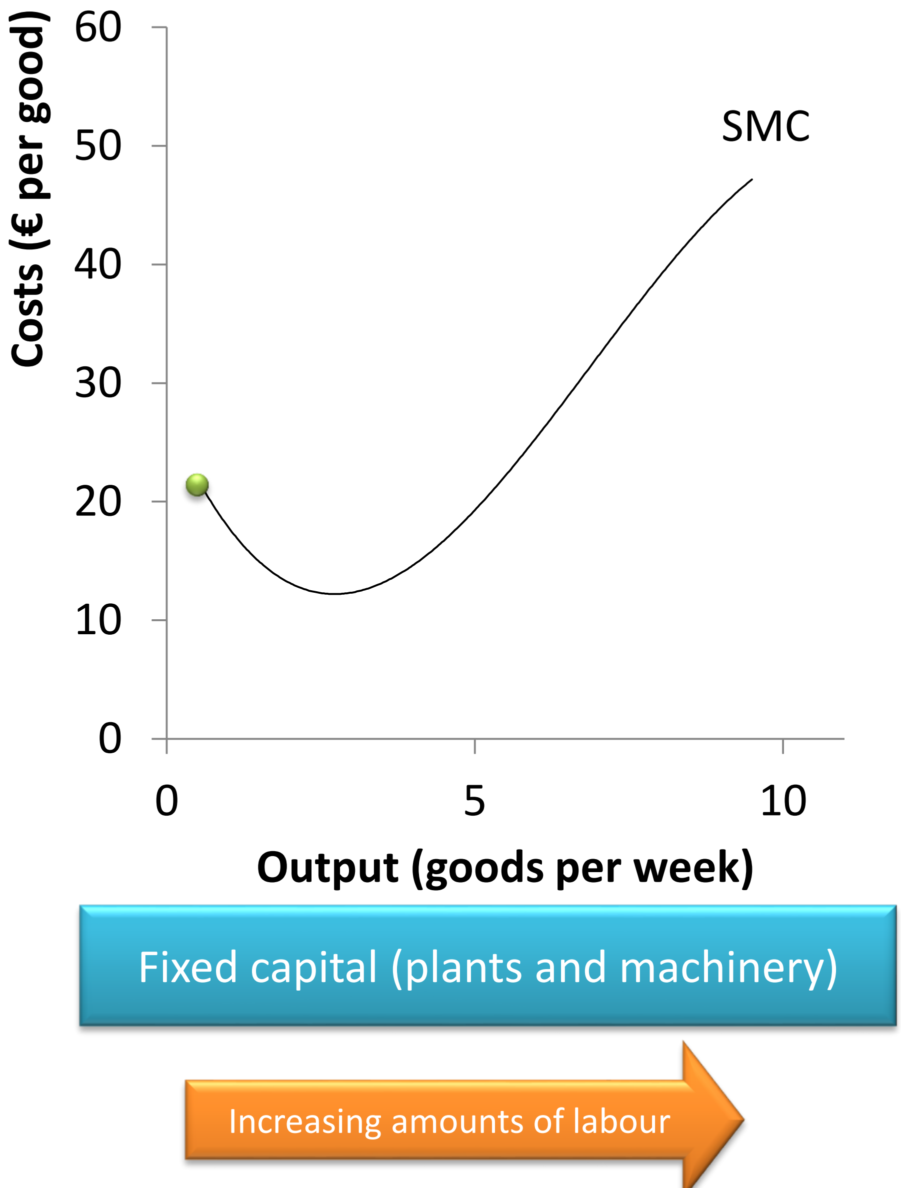


The shape of the SMC curve

- The short-run marginal cost curve has the same shape as the long-run marginal cost curve, but for a different reason.
- In the long run the firm can vary all factors freely.
- As output expands, the firm enjoys some scale economies, then diseconomies of scale set in.
- The short-run marginal cost curve assumes that there is at least one fixed factor, probably capital.



The shape of the SMC curve



- Suppose there are two inputs in the short run, fixed capital and variable labour.
- To change output as we move along the short-run marginal cost curve, the firm adds ever-increasing amounts of labour to a given amount of plant and machinery.
- This explains the shape of the short-run marginal cost curve.

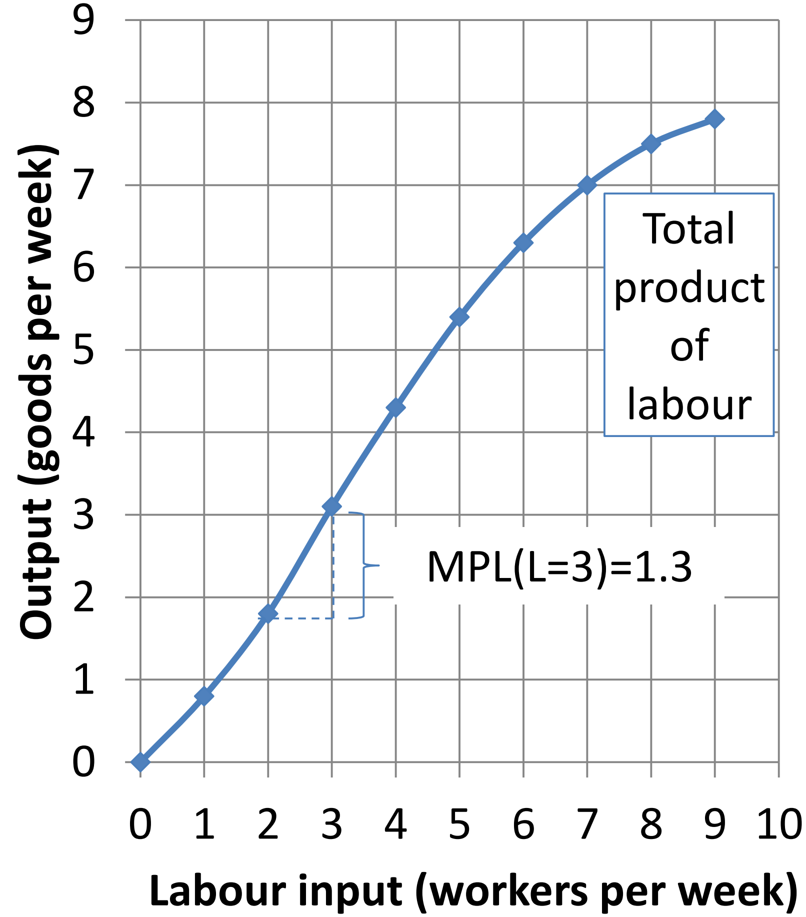
Total and marginal products of labour

Labour input (workers)	Output (total product)	Marginal product of labour
0	0	N/A
1	0.8	0.8
2	1.8	1.0
3	3.1	1.3
4	4.3	1.2
5	5.4	1.1
6	6.3	0.9
7	7.0	0.7
8	7.5	0.5
9	7.8	0.3

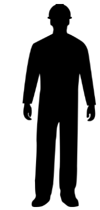
- The table to the left shows how output rises as variable labour input is added to a fixed quantity of capital.
- With no workers output is zero.
- The first worker raises output by 0.8 units.

The marginal product of labour

- The **marginal product** of a variable factor is the extra output from an extra unit of that input, holding constant all other inputs.
- The first worker has a marginal product of 0.8 units. The third worker has a marginal product of 1.3 units, since 2 workers produce 1.8 units but 3 workers produce 3.1 units.

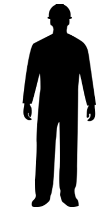


Labour input and output



- At low levels of output and labour input, the first worker has a whole factory to work with, too many tasks to produce very much. A second worker helps, and a third helps even more.
- Suppose the factory has three machines and the three workers are each specializing in fully running one of the factory’s machines. The marginal product of the fourth worker is lower.
- With only three machines, the fourth worker gets to use one only when another worker is having a rest. There is even less useful machine work for the fifth worker to do.

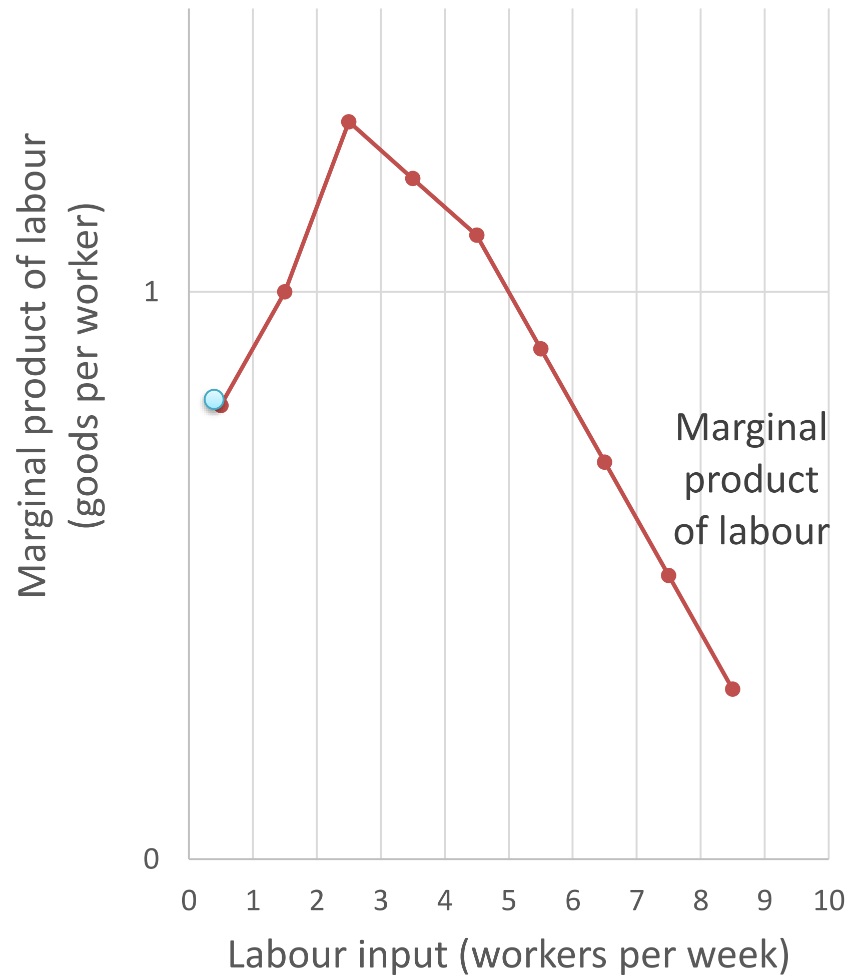
Law of diminishing returns



- Beyond 3 workers, the marginal product of each additional worker decreases steadily as the number of workers is increased. We say that there are diminishing returns to labour.
- Holding all factors constant except one, **the law of diminishing returns** says that, beyond some level of the variable input, further increases in the variable input lead to a steadily decreasing marginal product of that input.

Diminishing marginal returns

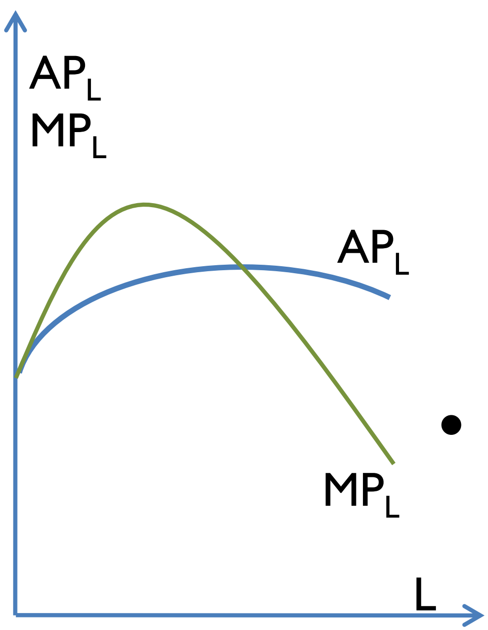
- This is a law about technology. Adding ever more workers to a fixed quantity of machinery gets less and less useful.
- The ninth worker's main role in production is to get coffee for the others. This contributes to output but not a great deal.
- The figure to the right summarizes our discussion of marginal productivity.



The marginal product of capital

- If capital was the variable factor and labour the fixed factor, adding more and more machines to a given labour force might initially lead to large increases in output but would soon encounter diminishing returns as machines become underutilized.
- Thus the figure on the previous slide, showing the marginal product of labour when labour is the variable factor, might also describe the behaviour of the marginal product of capital when capital is the variable factor.

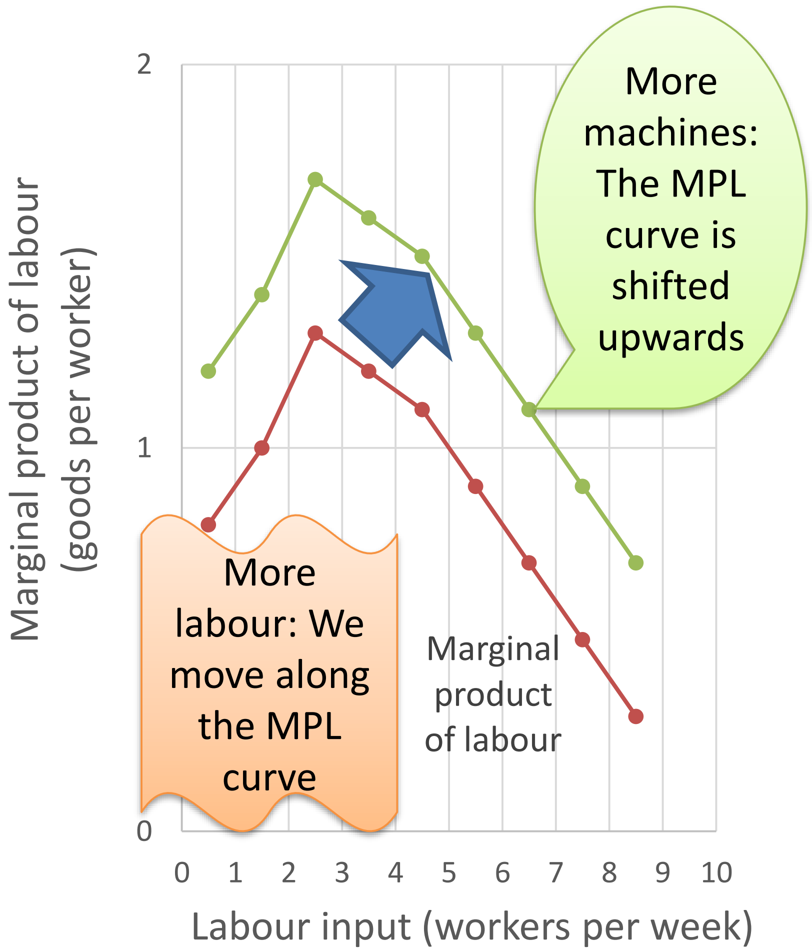
Marginal product and productivity



- Marginal product is not the everyday meaning of 'productivity' which refers to the average product. The average product of labour, what is most commonly meant by 'productivity', is total output divided by total labour input.
- If the marginal product of labour lies above the average product, adding another worker will raise the average product and 'productivity'. When diminishing returns set in, the marginal product will quickly fall below the average product and the latter will fall if further workers are added.

The marginal product curve

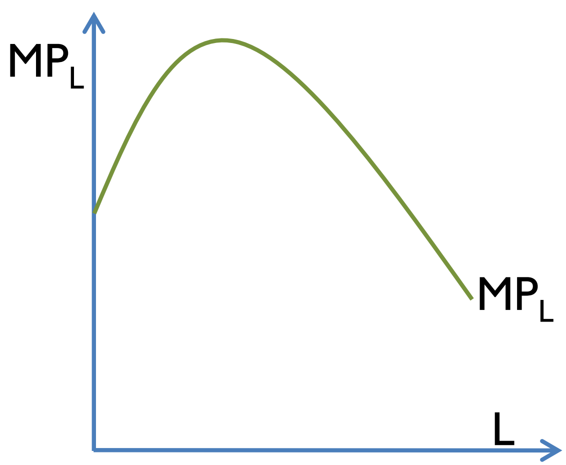
- As usual, we must distinguish between movements along a curve and shifts in a curve.
- The marginal product curve is drawn for given levels of the other factors. For a higher given level of the fixed factors, the marginal product curve would be higher.
- With more machinery to work with, an extra worker will generally be able to produce more extra output than previously.



Appendix: a more precise definition of marginal productivity

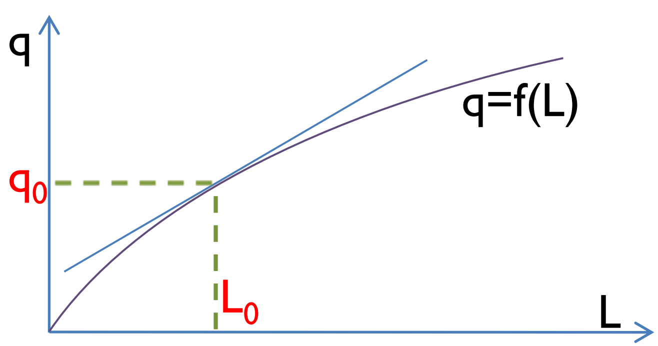
In the short run, as the quantity of at least one input (here: capital) is fixed, the output is the function of the variable input(s) (here: labour):

$$Q_S = F(\overline{K}, L) = F(L)$$



Marginal product: the partial derivative of the production function. The marginal product of labour (MP – *marginal product*):

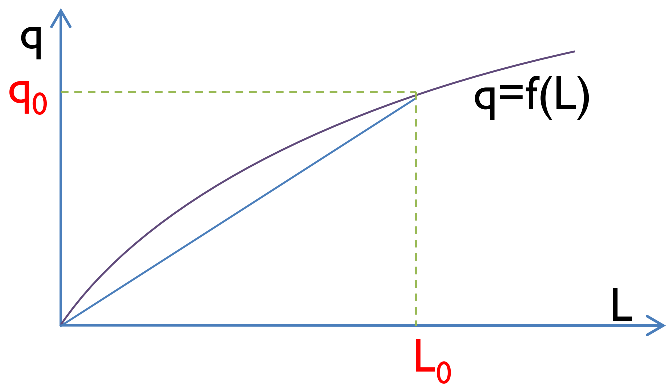
$$\boxed{MP_L = \frac{\partial Q}{\partial L}}$$



Geometrically: The slope of a tangent line to the short-run production function.

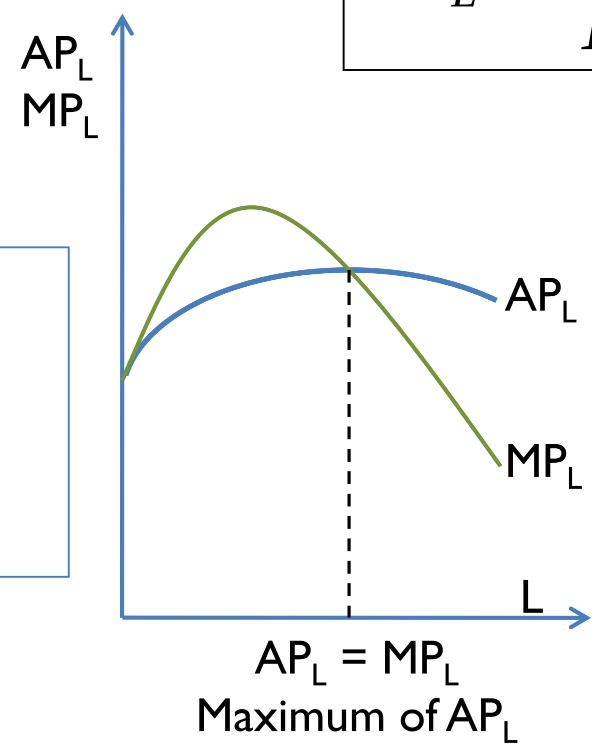
Approximately the change in the quantity of total product resulting from a unit change in a variable input, keeping all other inputs unchanged.

Appendix: marginal and average product



Average product (AP): the total output produced per unit. The average product of labour:

$$\boxed{AP_L = \frac{Q}{L}}$$

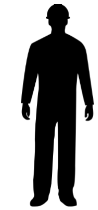


The point of intersection between the marginal product and average product curves is the peak of the average product curve.

Short-run costs of production

Q	STC (SFC + SVC)	SFC	SAFC= SFC/Q	SVC	SAVC= SVC/Q	Short-run average total cost (AFC+AVC)	Short-run marginal cost
0	30	30	–	0	–	–	–
1	52	30	30	22	22	52	22
2	68	30	15	38	19	34	16
3	78	30	10	48	16	26	10
4	91	30	7.5	61	15.25	22.75	13
5	109	30	6	79	15.8	21.8	18
6	132	30	5	102	17	22	23
7	161	30	4.29	131	18.71	23	29
8	196	30	3.75	166	20.75	24.5	35
9	237	30	3.33	207	23	26.33	41
10	285	30	3	255	25.5	28.5	48

Short-run marginal costs

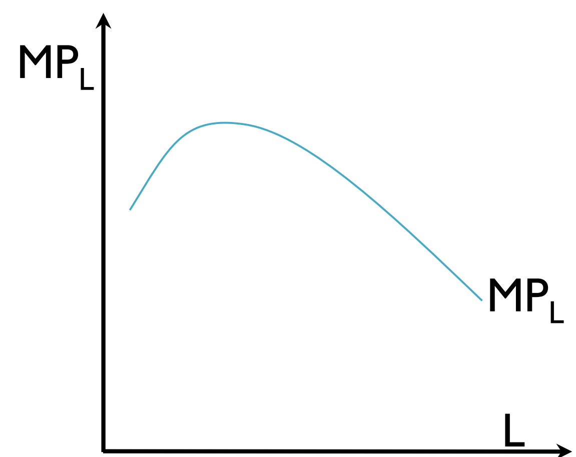


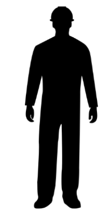
Q	SMC
0	–
1	22
2	16
3	10
4	13
5	18
6	23
7	29
8	35
9	41
10	48

- Our table shows that, as output is increased, short-run marginal costs first fall then rise.
- Every worker costs the firm the same wage. While the marginal product of labour is increasing, each worker adds more to output than the previous workers.
- Hence the extra cost of making extra output is falling. SMC is falling so long as the marginal product of labour is rising.

SMC and MP_L

- **Short-run marginal cost** (SMC) is the extra cost of making an extra unit of output in the short-run while some inputs remain fixed.
- Once diminishing returns to labour set in, the marginal product of labour falls and SMC starts to rise again. It takes successively more workers to make each extra unit of output.
- Thus the shape of the short-run marginal cost curve and hence the short-run total cost curve is determined by the shape of the marginal product curve, which in turn depends on the technology facing the firm. (With one var. input: $SMC=P_L/MP_L$)





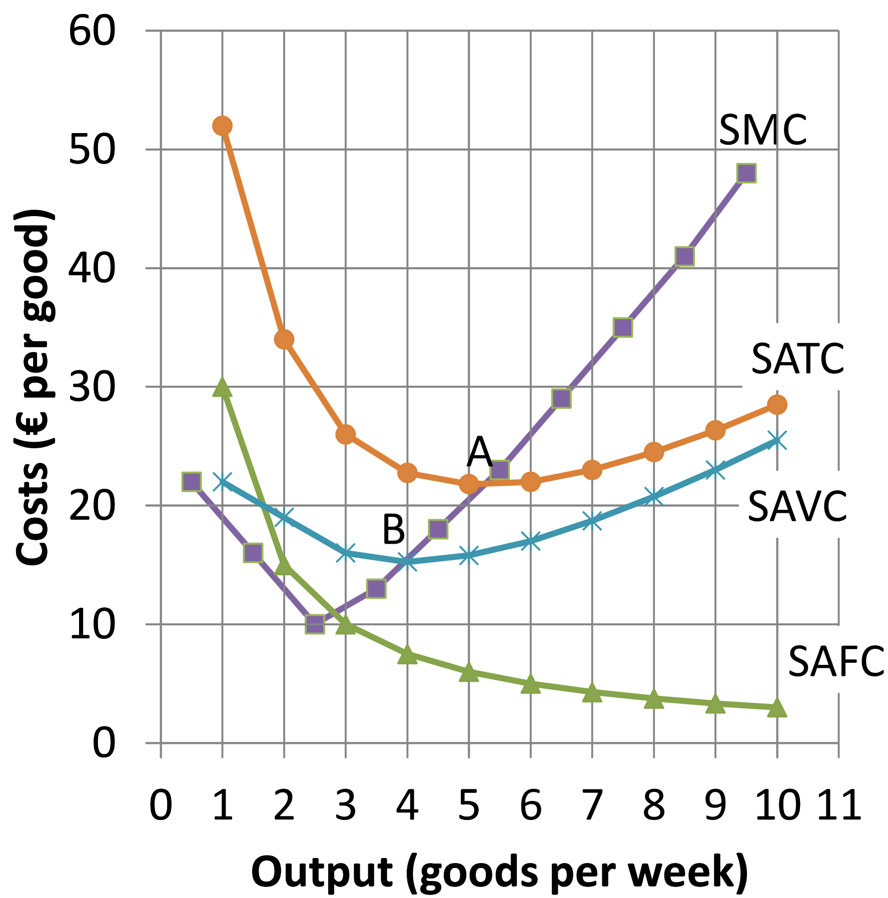
Short-run average costs

- **Short-run average fixed cost** (SAFC) equals short-run fixed cost (SFC) divided by output (Q).
- **Short-run average variable cost** (SAVC) equals short-run variable cost (SVC) divided by output (Q).
- **Short-run average total cost** (SATC) equals STC divided by output, and also equals the sum of SAFC & SAVC.
- Each number in the fourth and the sixth column of the table is obtained by dividing the corresponding number in the previous column by the output level.

Q	STC (SFC + SVC)	SFC	SAFC= $\frac{SFC}{Q}$	SVC	SAVC= $\frac{SVC}{Q}$	Short-run average total cost (AFC+AVC)	Short-run marginal cost
1	52	30	30	22	22	52	22
10	285	30	3	255	25.5	28.5	48

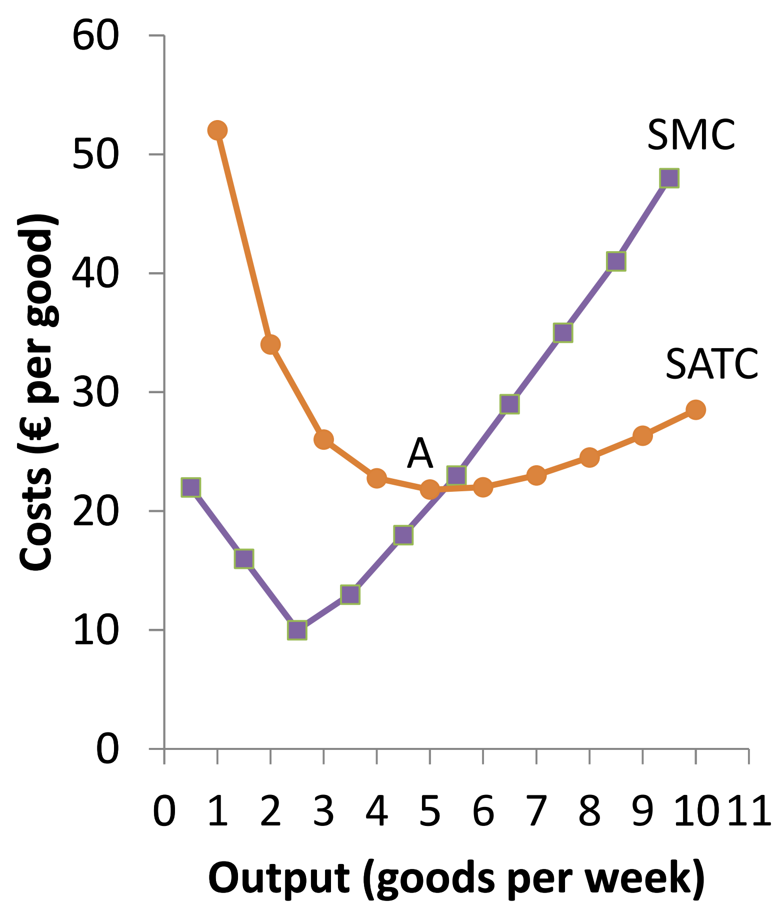
Short run average cost and marginal cost curves

- These diagrams plot the data of our previous table. SATC is equal to SAFC plus SAVC. The shape of the SATC curve is a result of the shapes of its two components. When both SAVC and SAFC are declining so is SATC. When SAVC starts rising, the shape of SATC depends on whether SAVC is rising more rapidly than SAFC is falling.
- The relationship between marginal and average cost curves established for the long run applies also to the short-run curves. The SMC curve goes through the minimum points of both the SAVC curve (at **B**) and the SATC curve (at **A**).



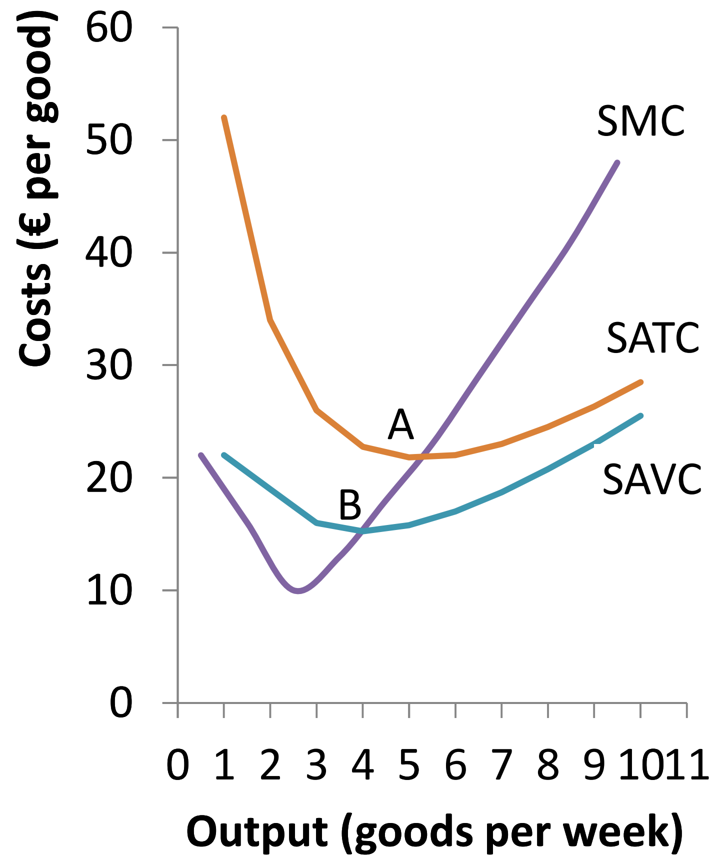
Marginal and average total cost

- The shape of the SMC curve follows from the behaviour of marginal labour productivity.
- The usual arithmetical relation between marginal and average explains why SMC passes through the lowest point **A** on the short-run average cost curve.
- To the left of this point, SMC lies below SATC and is dragging it down as output expands. To the right of **A** the converse holds. That explains the shape of the SATC curve.



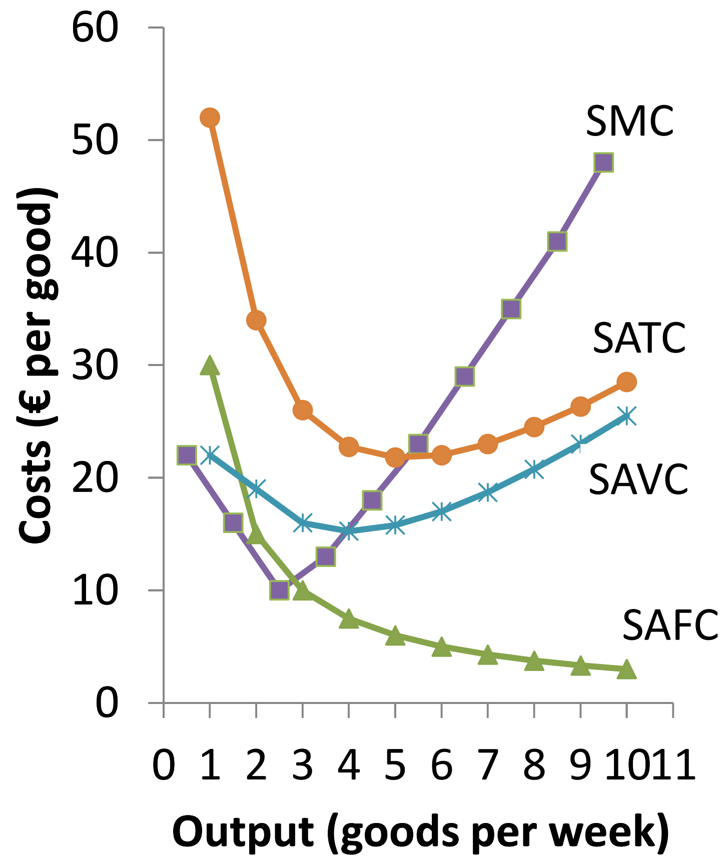
Marginal and average variable cost

- Variable cost is total cost minus fixed cost. Fixed cost does not change with output. Hence marginal cost also shows how much *variable* cost is changing.
- The usual arithmetic between marginal cost and average *variable* cost must hold. Hence, SMC goes through the lowest point **B** on SAVC. To the left of **B**, SMC is below SAVC and SAVC is falling.
- To the right of **B**, SAVC is rising. Finally, since average total cost exceeds average variable cost by average fixed cost, SAVC lies below SATC. Point **B** must lie to the left of point **A**. That explains the shape of SAVC and its relation to SATC.



Short-run average fixed costs

- In our figure, SAFC falls steadily, because total fixed costs ('overheads') are spread over ever larger output levels, thus reducing average fixed costs.
- At each output level, SATC = SAVC + SAFC. (This follows from dividing each term in equation 'STC = SVC + SFC' by the output level.)



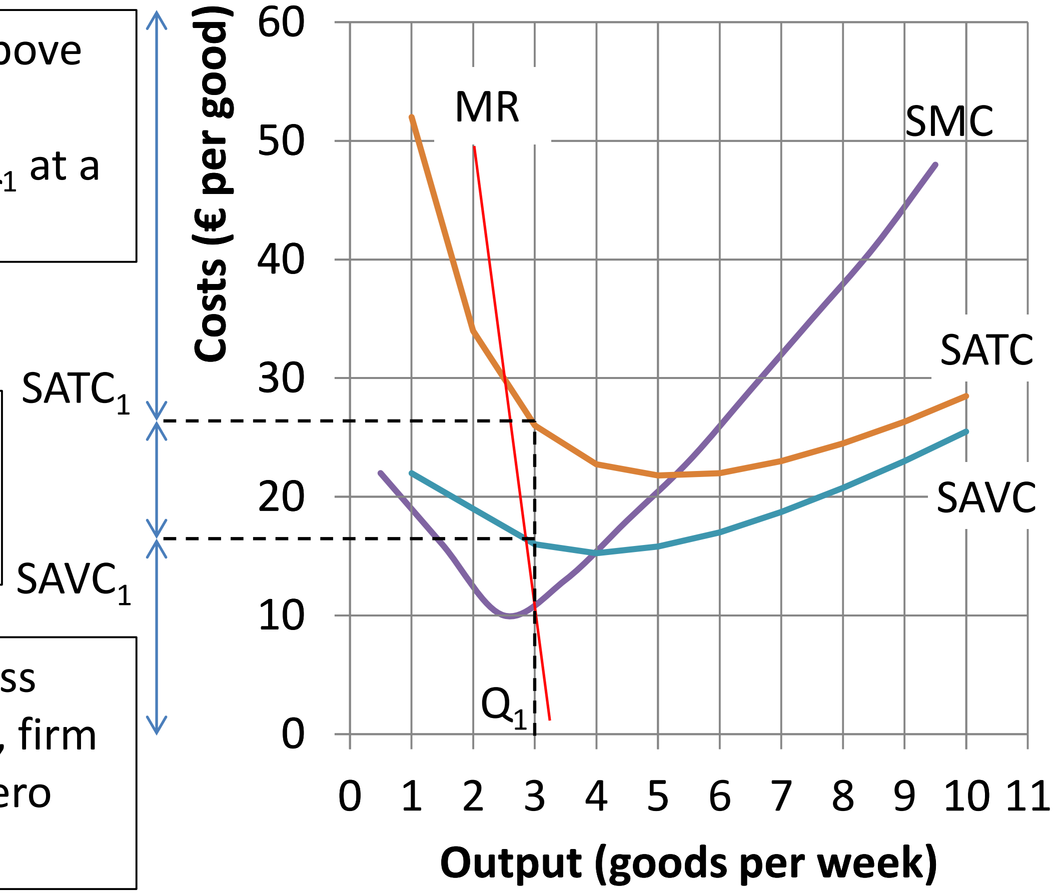
The firm's short-run output decision

The firm sets output at Q_1, where short-run marginal costs equal marginal revenue. Then it checks whether it should produce at all.

If price is above $SATC_1$, firm produces Q_1 at a profit.

If price is between $SATC_1$ and $SAVC_1$, firm produces Q_1 at a loss.

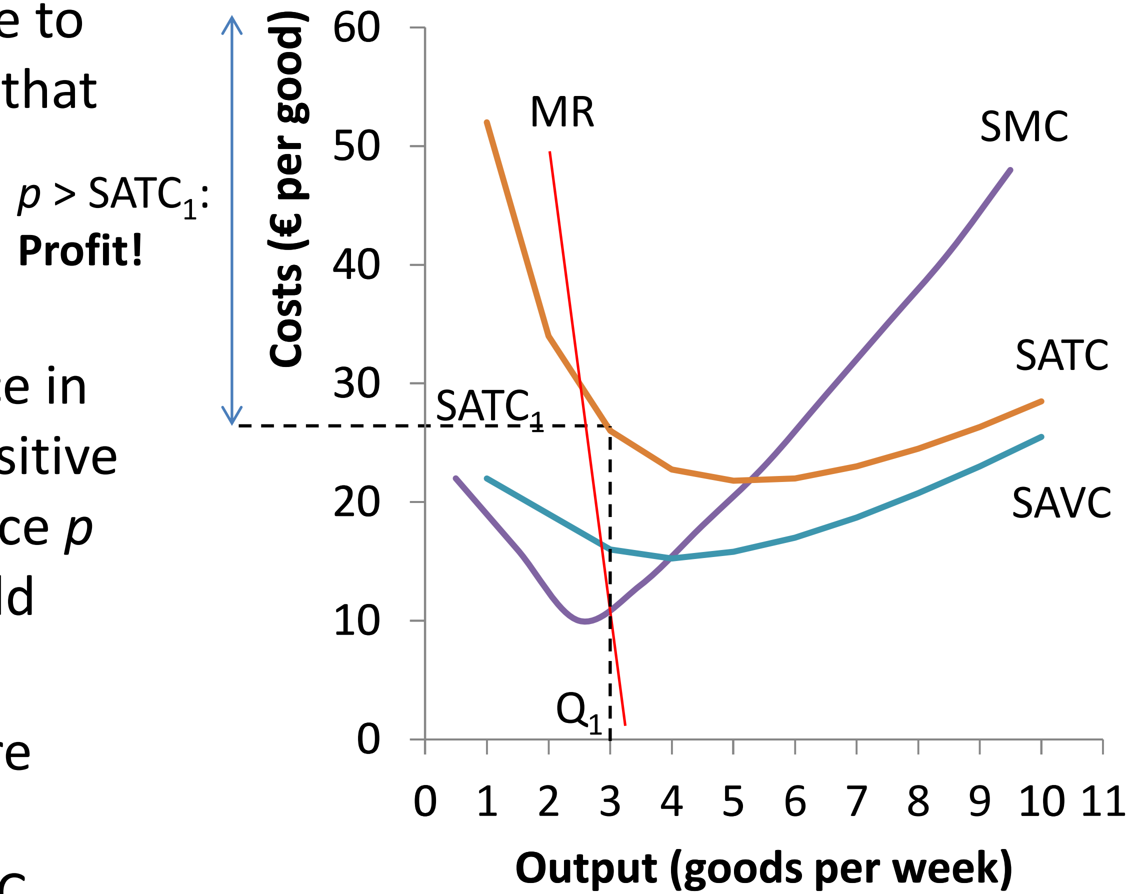
If price is less than $SAVC_1$, firm produces zero output.



At those prices, the firm is not even covering its variable costs.

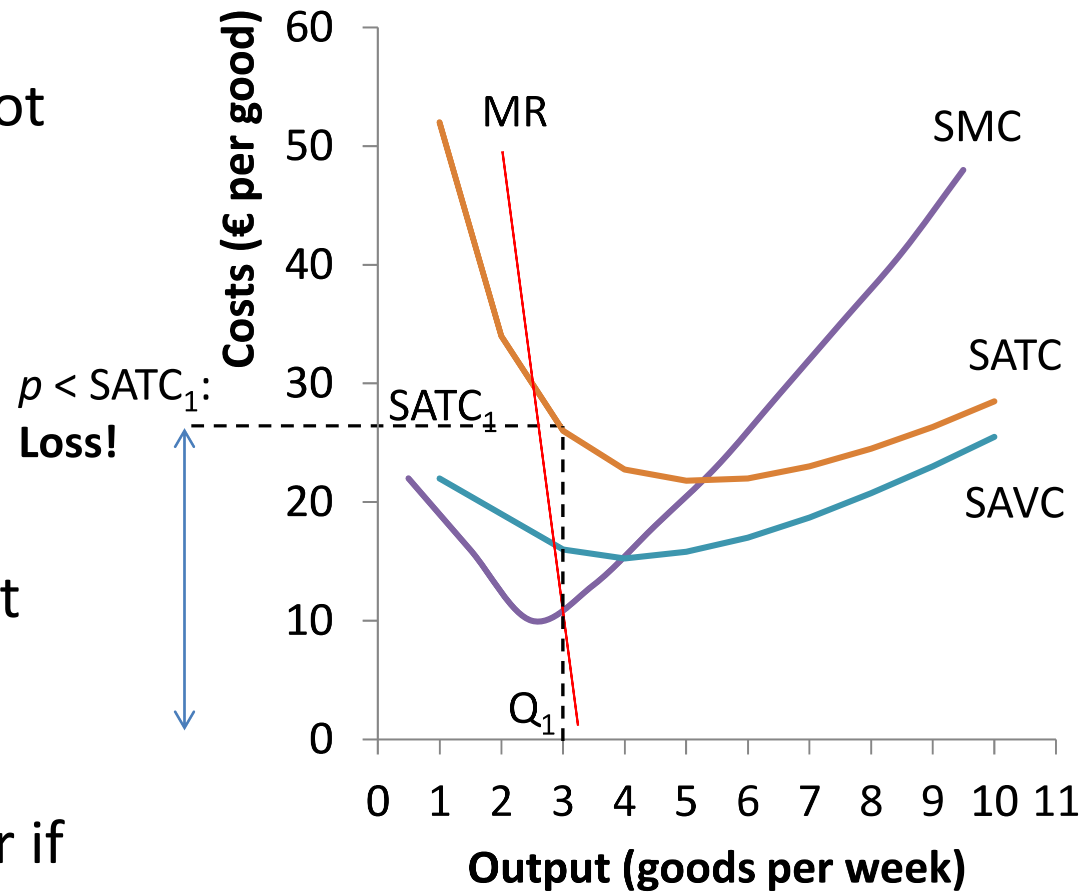
Short-run profit

- Short-run marginal cost is set equal to marginal revenue to determine the output Q_1 that maximizes profits or minimizes losses.
- Next, the firm decides whether or not to produce in the short run. Profit is positive at the output Q_1 if the price p at which this output is sold covers average total cost.
- It is the short-run measure $SATC_1$ at output Q_1 that is relevant. If p exceeds $SATC_1$, the firm makes profit in the short run and produces Q_1.



Short-run losses

- Suppose p is less than $SATC_1$. The firm is losing money because p does not cover costs.
- In the long run the firm closes down if it keeps losing money.
- In the short run, even at zero output the firm must pay its fixed costs.
- The firm needs to know whether losses are bigger if it produces at Q_1 or produces zero.



Overhead and variable costs

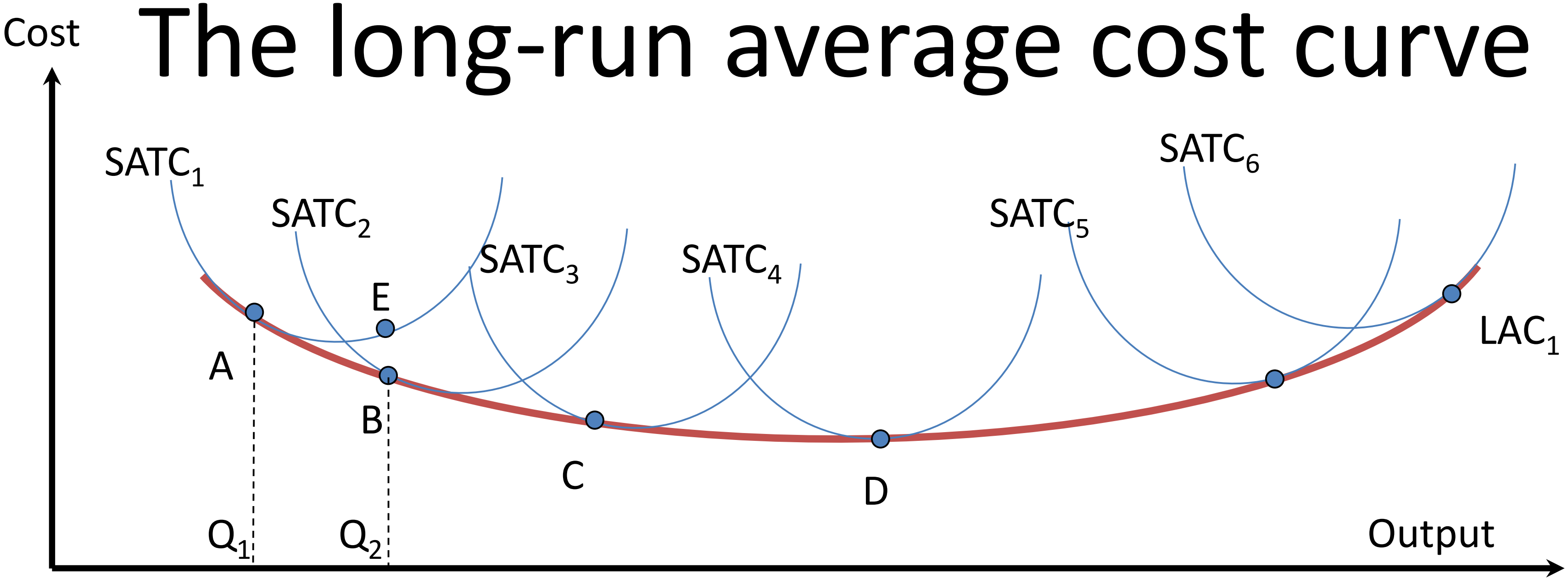
- If revenue exceeds variable cost the firm is earning something towards its overheads.
- It produces Q_1 if revenue exceeds variable cost even though Q_1 may involve losses.
- The firm produces Q_1 if p exceeds $SAVC_1$.
- If not, it produces zero.

The firm's output decisions (summary)

	Marginal condition	Check whether to produce
Short run	Choose the output at which MR = SMC	Produce this output if p > SAVC. Otherwise, produce zero.
Long run	Choose the output at which MR = LMC	Produce this output if p > LAC. Otherwise, produce zero.

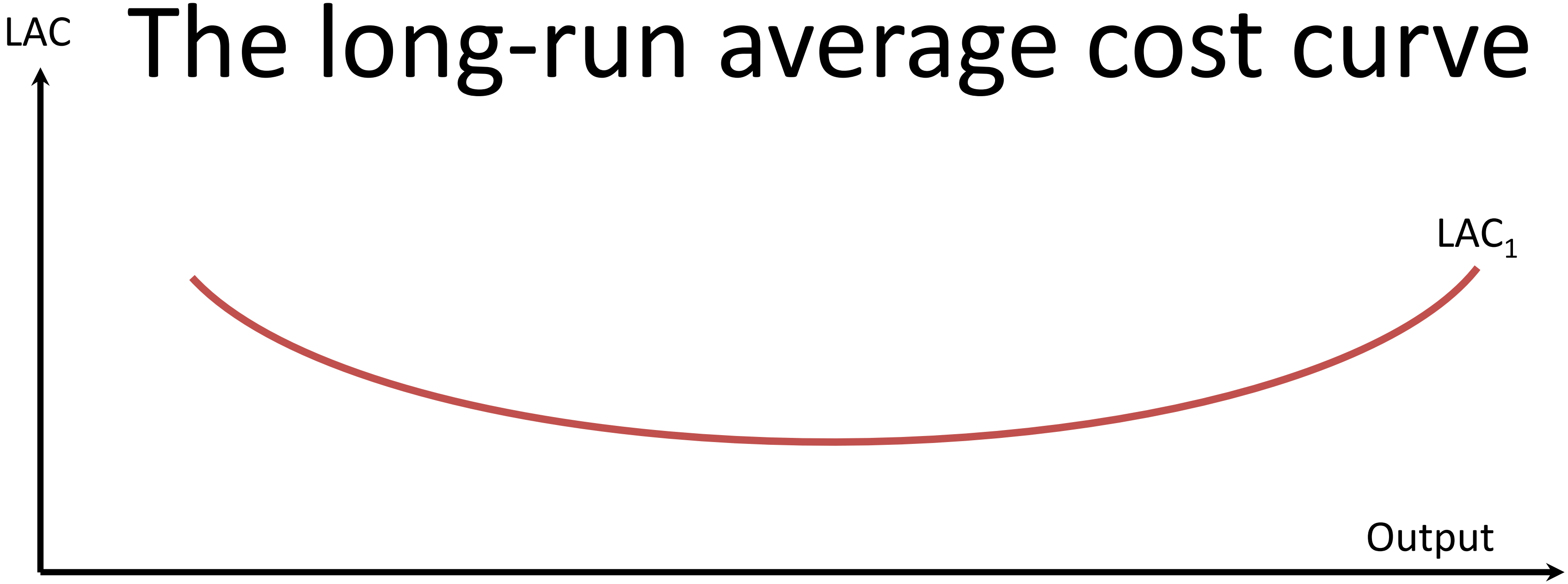
Even if making losses in the short run, a firm stays in business if it covers its variable costs. In the long run it must cover all its costs to remain in business. A firm may reduce its costs in the long run, converting a short-run loss into a long-term profit.

The long-run average cost curve



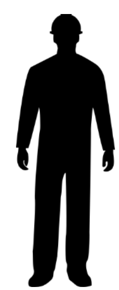
Suppose the plant size is fixed in the short run. For each plant size we obtain a particular SATC curve. But in the long run, even plant size is variable. To construct the LAC curve we select at each output the plant size which gives the lowest SATC at this output. Thus points such as **A**, **B**, **C** and **D** lie on the LAC curve. Notice the LAC curve does not pass through the lowest point on each SATC curve. Thus the LAC curve shows the minimum average cost way to produce a given output when all factors can be varied, not the minimum average cost at which a given plant can produce.

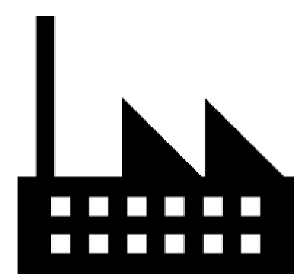
The long-run average cost curve



- The diagram shows a U-shaped LAC curve.
- At each point on the curve the firm is producing a given output at minimum cost.
- The LAC curve describes a time scale sufficiently long that the firm can vary all factors of production, even those that are fixed in the short run.

The LAC curve

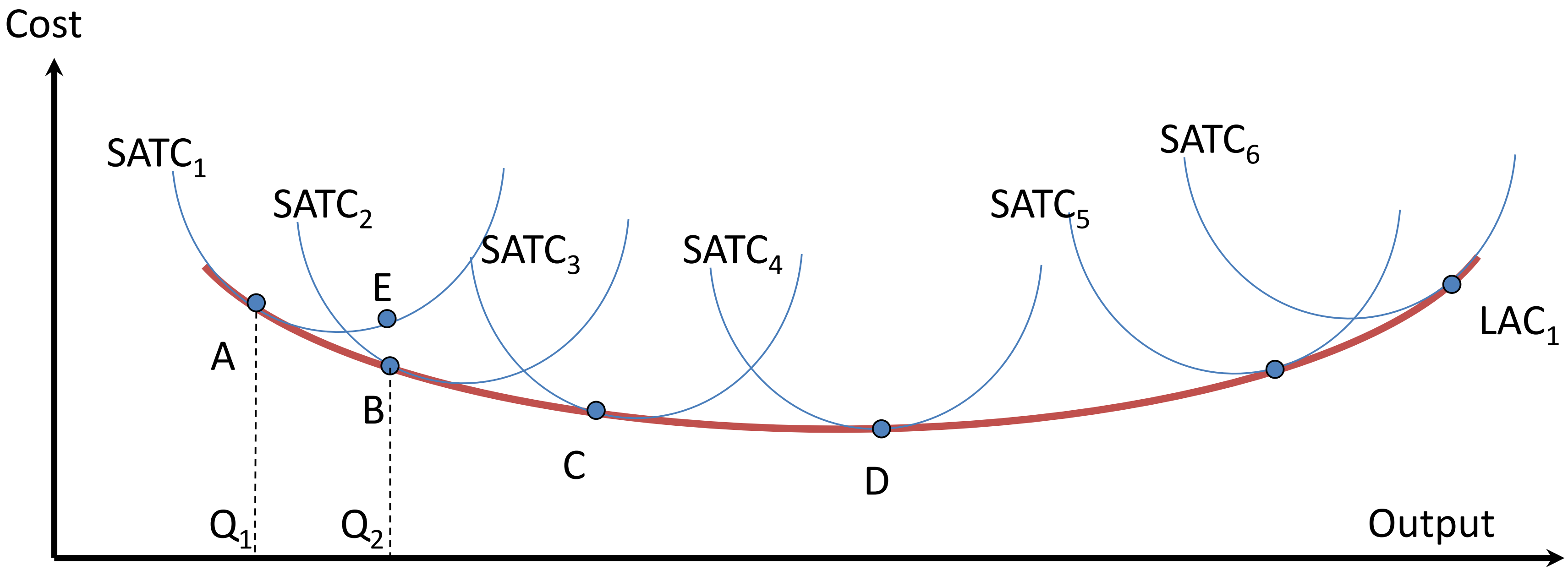




‘Plant’ as a fixed factor

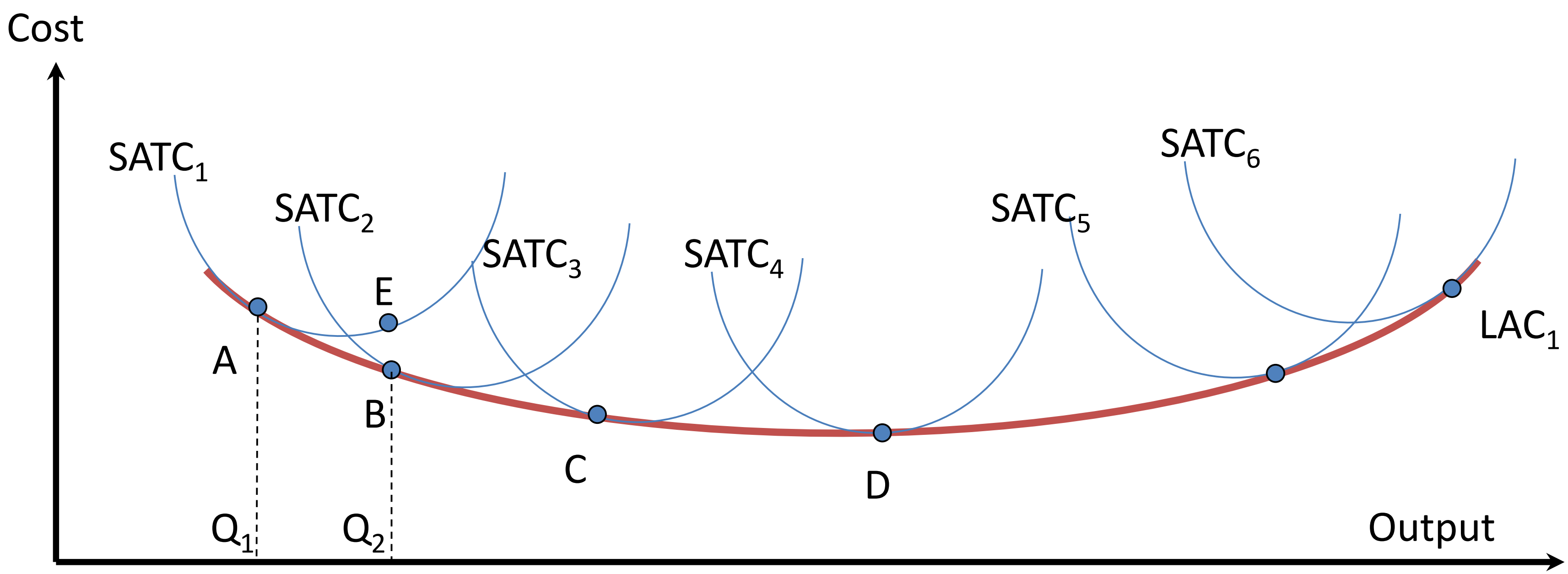
- Suppose, for convenience, that ‘*plant*’ is the fixed factor in the short run. Each point on the LAC curve involves a particular quantity of *plant*.
- Holding constant this quantity of *plant*, we can draw the short-run average total cost curve for this plant size.
- $SATC_1$ corresponds to the plant size at point **A** on the LAC curve, and $SATC_2$ and $SATC_3$ correspond to the plant sizes at points **B** and **C** on the LAC curve.
- In fact, we could draw an SATC curve corresponding to the plant size at each point on the LAC curve.

LAC(Q) is always lower than SATC(Q)



- By definition, the LAC curve shows the least-cost way to make each output when all factors can be varied.
- **B** is the least-cost way to make an output Q_2. It *must* be more costly to make Q_2 using the wrong quantity of *plant*, e.g. the quantity corresponding to point **E**.
- For the plant size at **A**, $SATC_1$ shows the cost of producing each output including Q_2. Hence SATC must lie above LAC at every point except **A**, the output level for which this plant size is best.

Short run and long run compared



- This argument can be repeated for other plant sizes. Hence SATC$_2$ and SATC$_3$, reflecting plant sizes at **C** and **D**, must lie above LAC except at points **C** and **D** themselves.
- In the long run the firm can vary all its factors and can generally produce a particular output more cheaply than in the short run, when it is stuck with the quantities of fixed factors it was using previously.
- A firm currently suffering losses because demand has fallen may make future profits once it has had time to build a plant more suitable to its new output.


Thank you

Perfect competition and pure monopoly

Part I: The perfectly competitive firm

MICRO- AND MACROECONOMICS

Perfect competition –
the competitive firm’s supply decision

Part 1

Industries and the number of firms

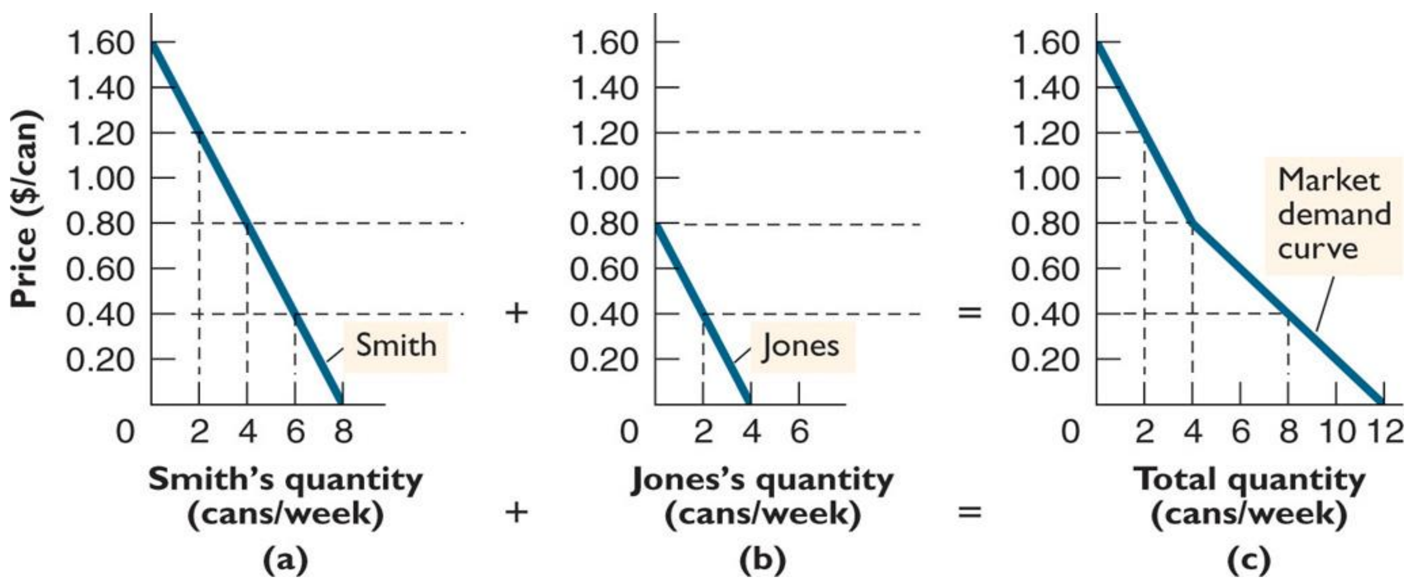
- An industry is the set of all firms making the same product. The output of an industry is the sum of the outputs of its firms.
- Yet different industries have very different number of firms. Eurostar is the only supplier of train journeys from London to Paris. In contrast, the UK has hundreds of thousands of farms and tens of thousands of grocers.
- Why do some industries have many firms but others only one?

Perfect competition and monopoly

- First it is useful to establish two benchmark cases, extremes between which all other types of market structure must lie. These limiting cases are *perfect competition* and *monopoly*.
- In a **perfectly competitive** market, both buyers and sellers believe that their own actions have no effect on the market price.
- In contrast, a **monopolist**, the only seller or potential seller in the industry, sets the price.

Competitive demand

- We focus on how the number of sellers affects the behaviour of sellers.
- Buyers are in the background. We simply assume that there are many buyers whose individual downward-sloping demand curves can be aggregated into the market demand curve.
- Thus, we assume that the demand side of the market is competitive, but contrast the different cases on the supply side.



Quantities demanded and supplied and perfect competition

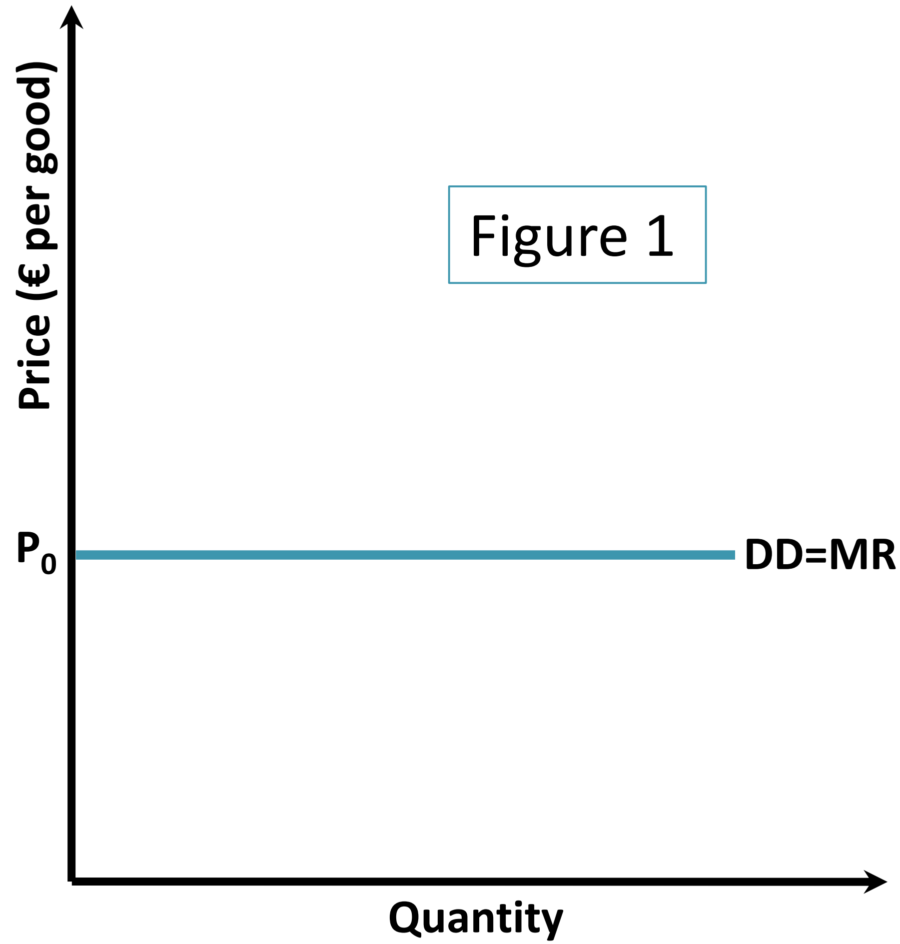
- Perfect competition means that each firm or household, recognizing that its quantities supplied or demanded are trivial relative to the whole market, assumes its actions have no effect on the market price.
- This assumption was also built into our earlier model of consumer choice. Each consumer's budget line took market prices as given, unaffected by the quantities then chosen.
- Changes in market conditions, applying to all firms and consumers, change the equilibrium price and hence individual quantities demanded, but each consumer neglects any feedback from his own actions to market price.

Competition in theory and everyday usage

- This concept of competition, which we now extend to firms and supply, differs from everyday usage. Ford and VW are fighting each other vigorously for the European car market, but an economist would not call them perfectly competitive. Each has such a big share of the market that changes in its quantity supplied affect the market price.
- VW and Ford each take account of this in deciding how much to supply. They are not *price-takers*.
- Only under perfect competition can individuals make decisions that treat the price as independent of their own actions.

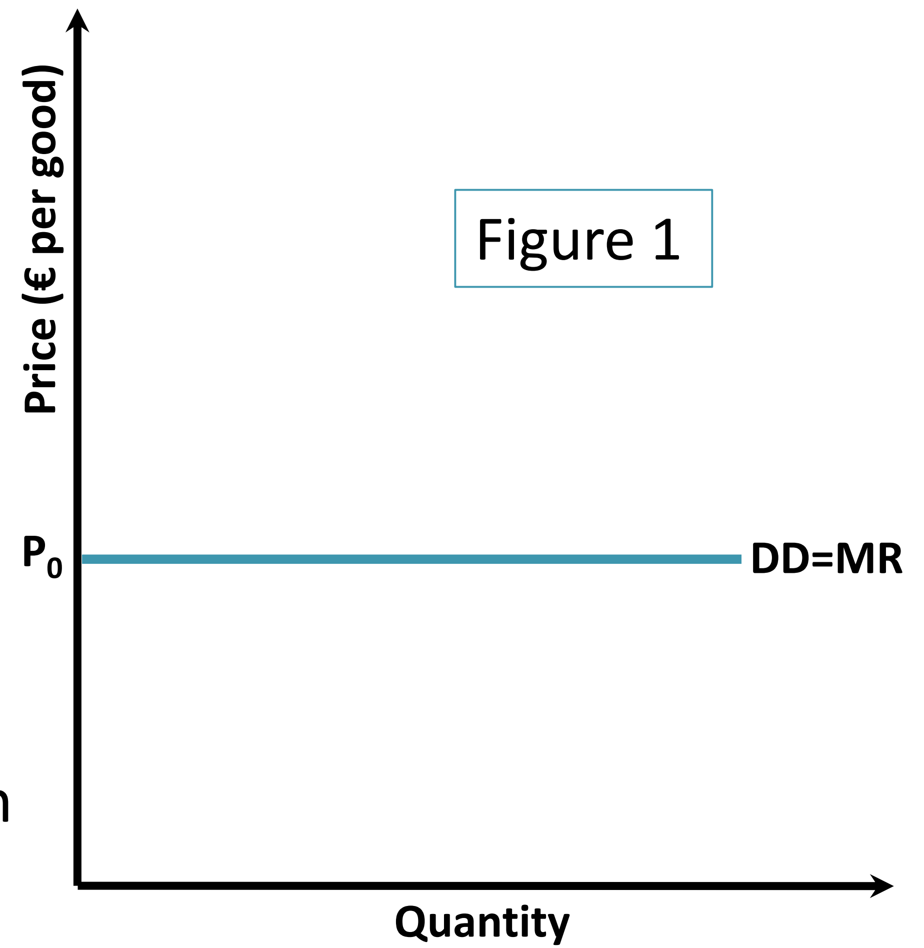
The competitive firm's demand curve

- A competitive firm can sell as much as it wants at the market price P_0.
- Its demand curve *DD* and marginal revenue curve *MR* are horizontal at this price.



Horizontal demand curve

- If an individual's action does not affect the price, a perfectly competitive industry must have many buyers and many sellers.
- Each firm in a perfectly competitive industry faces a horizontal demand curve as in figure 1.
- However much the firm sells, it gets the market price. If it charges a price above P_0 it will not sell any output: buyers will go to other firms whose product is just as good. Since the firm can sell as much as it wants at P_0, it will not charge less than P_0. The individual firm's demand curve is *DD*.



Features of perfectly competitive firms

- A horizontal demand curve is the key feature of a perfectly competitive firm. To be a plausible description of the demand curve facing the firm, the industry must have four attributes.
- First, there must be many firms, each one *trivial* (= tiny) relative to the entire industry.
- Second, the product must be standardized.

Homogeneous and heterogeneous products

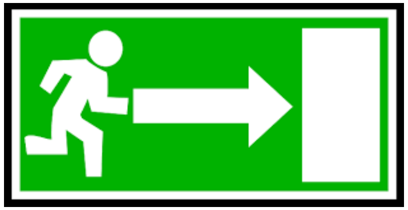
- Even if the car industry had many firms it would not be a perfectly competitive industry.
- A Ford Mondeo is not a perfect substitute for an Opel Vectra. The more imperfect they are as substitutes, the more it makes sense to view Ford as the sole supplier of Mondeos and Opel (GM) as the sole supplier of Vectras.
- Each producer then ceases to be trivial relative to the relevant market, and cannot act as a price-taker. In a perfectly competitive industry, all firms must be making the same product, *for which they all charge the same price*.

Perfect and imperfect information

- Even if all firms in an industry made *homogeneous* (=identical) goods, each firm may have some discretion over the price it charges if buyers have imperfect information about the quality or characteristics of products.
- To rule this out in a competitive industry, we must assume that buyers have almost *perfect information* about the products being sold. They know the products of different firms in a competitive industry really are identical.

Free entry

- Why don’t all the firms in a PC industry do what OPEC did in 1973-74, collectively restricting supply, to increase the price of their output by moving the industry up its market demand curve?
- The fourth crucial characteristic of a perfectly competitive industry is *free entry and exit*. Even if existing firms could organize themselves to restrict total supply and drive up the market price, the consequent rise in profits would simply attract new firms into the industry, thereby increasing total supply again and driving the price back down.



Free exit

- Conversely, as we shall shortly see, when firms in a competitive industry are losing money, some firms will close down and, by reducing the number of firms remaining in the industry, reduce the total supply and drive the price up, thereby allowing the remaining firms to survive.

To sum up, each firm in a competitive industry faces a horizontal demand curve at the going market price. To be a plausible description of the demand conditions facing a firm, the industry must have:

1. many firms, each trivial relative to the industry;
2. a homogeneous product, so that buyers would switch between firms if their prices differed;
3. perfect customer information about product quality, so that buyers know that the products of different firms really are the same; and
4. free entry and exit, to remove any incentive for existing firms to collude.

The firm's supply decision

- Earlier, we developed a general theory of supply.
- The firm uses the marginal condition (MC = MR) to find the best positive output; then it uses the average condition to check if the price for which this output is sold covers average cost.

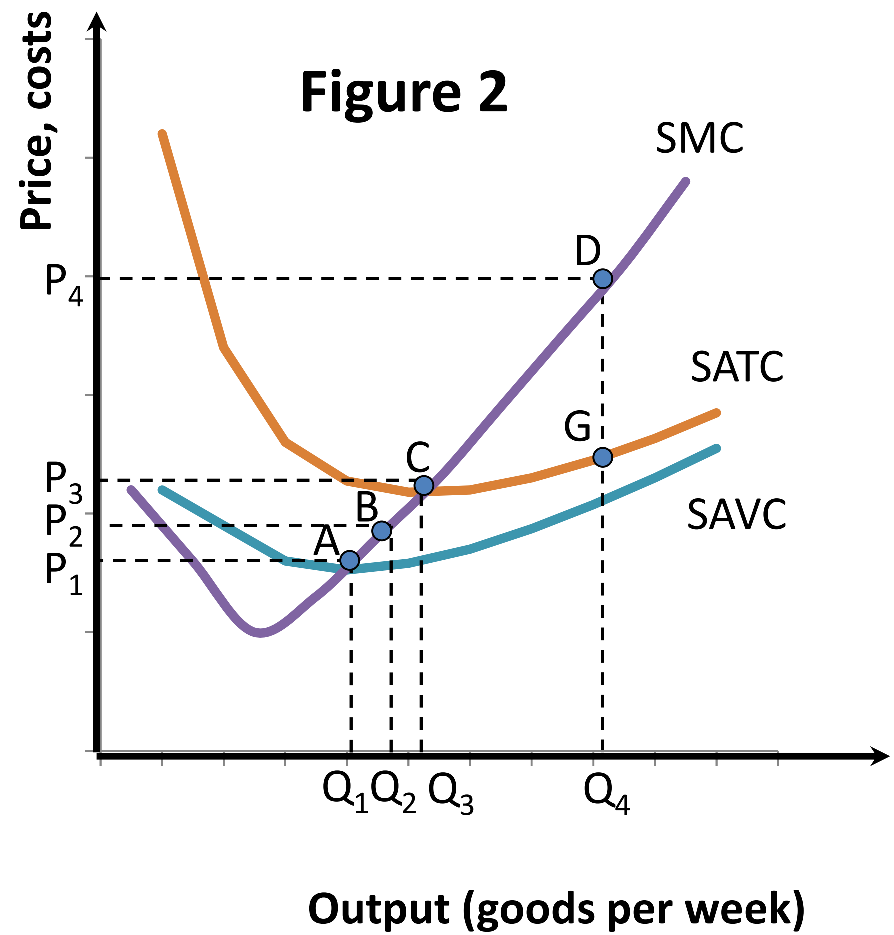
The special case of perfectly competitive firms

- This general theory must hold for the special case of perfectly competitive firms.
- *The special feature of perfect competition is the relationship between marginal revenue and price*.
- A competitive firm faces a horizontal demand curve. Making and selling extra output does *not* bid down the price for which existing output is sold. The extra revenue from selling an extra unit is simply the price received.
- A perfectly competitive firm's marginal revenue ***is*** its output price, $MR = P$ (Eq. 1)

The firm's short-run output decision

– The perfectly competitive firm produces at that level of output at which price is equal to marginal cost, provided it makes more profit by producing some output than none at all.

– The firm's short-run supply curve is the SMC curve above the point A, the shutdown point below which the firm cannot cover average variable costs SAVC in the short run.

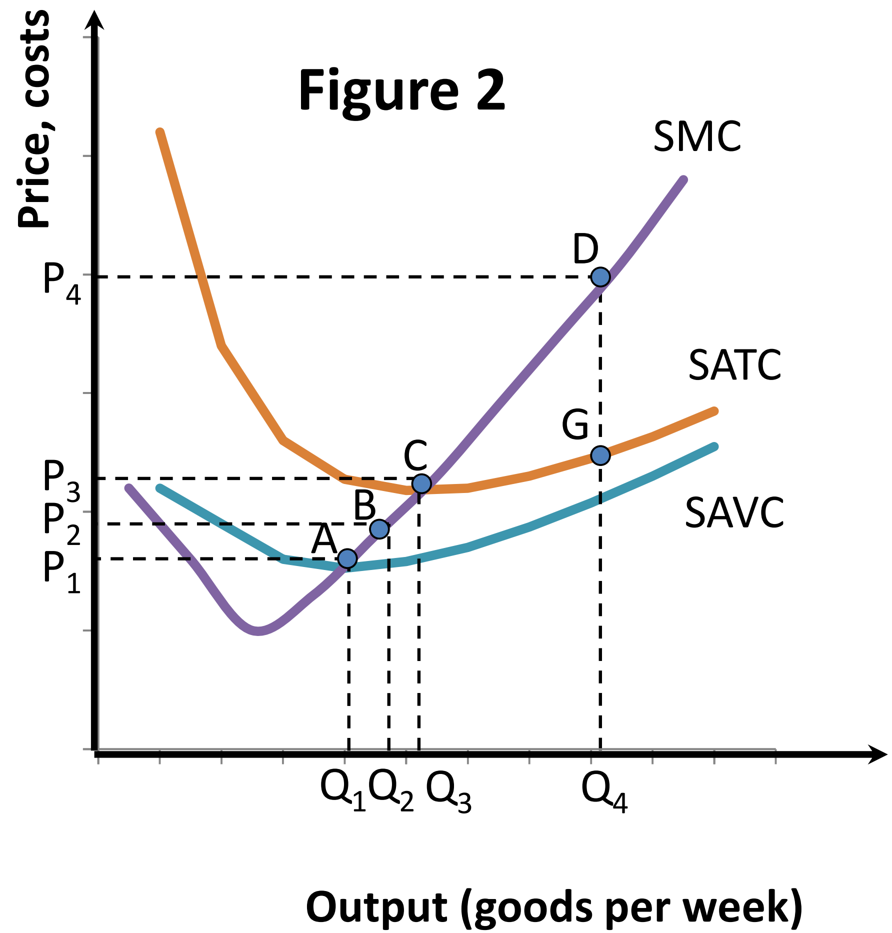


A firm's short run supply curve

- Figure 2 shows again the short-run cost curves – marginal cost *SMC*, average total cost *SATC*, and average variable cost *SAVC* – from our earlier lecture. Any firm chooses the output at which marginal cost equals marginal revenue.
- Equation (1) means that a perfectly competitive firm chooses the output at which:

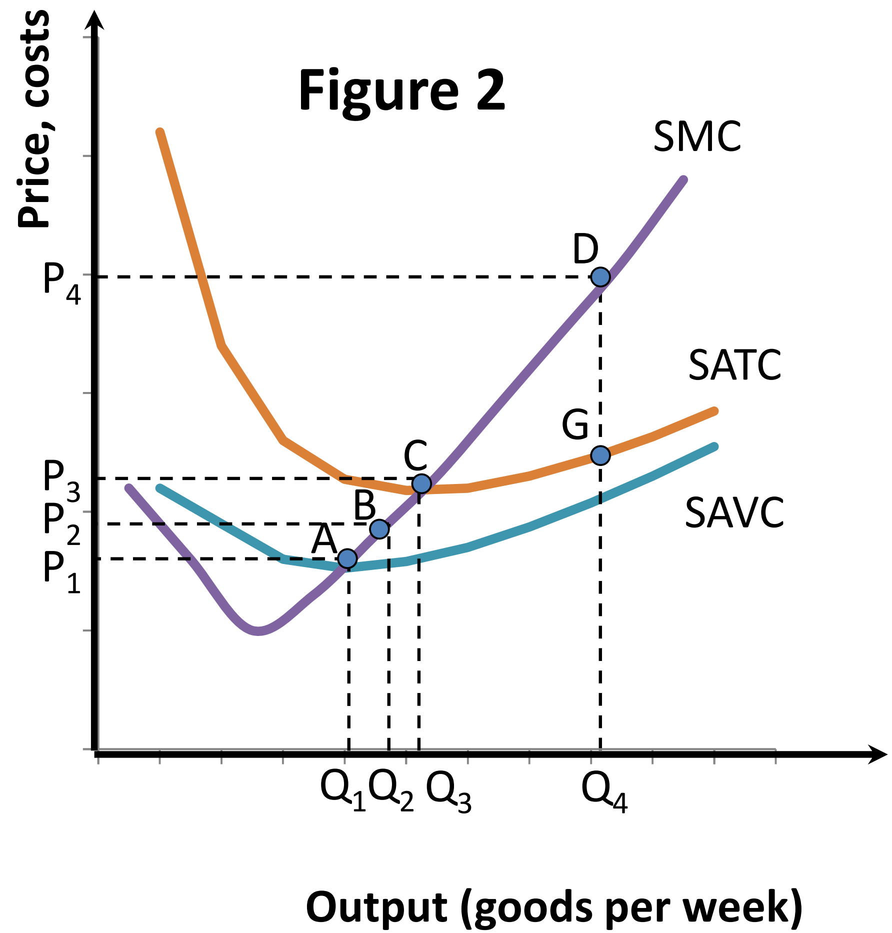
$$SMC = MR = P \quad \text{(Eq. 2)}$$

- Suppose the firm faces a horizontal demand curve at the price P_4 in figure 2. From equation (2) the firm chooses the output Q_4 to reach point ***D***, at which price equals marginal cost.



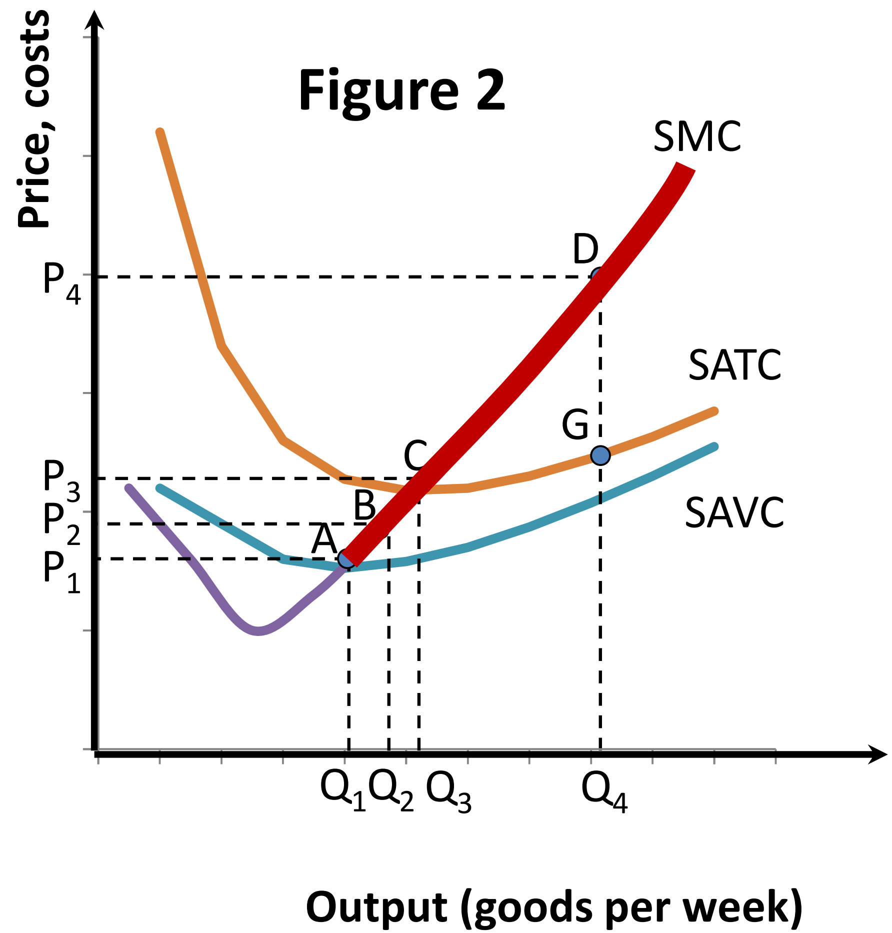
Shutdown condition

- Next, the firm checks whether it would rather shut down in the short run.
- It will shut down if the price P_4 fails to cover short-run variable costs at this output. In figure 2 P_4 exceeds *SAVC* at the output Q_4.
- The firm supplies Q_4 and makes profits. Point ***D*** lies above point ***G***, the short-run average total cost (including overheads) of producing Q_4.



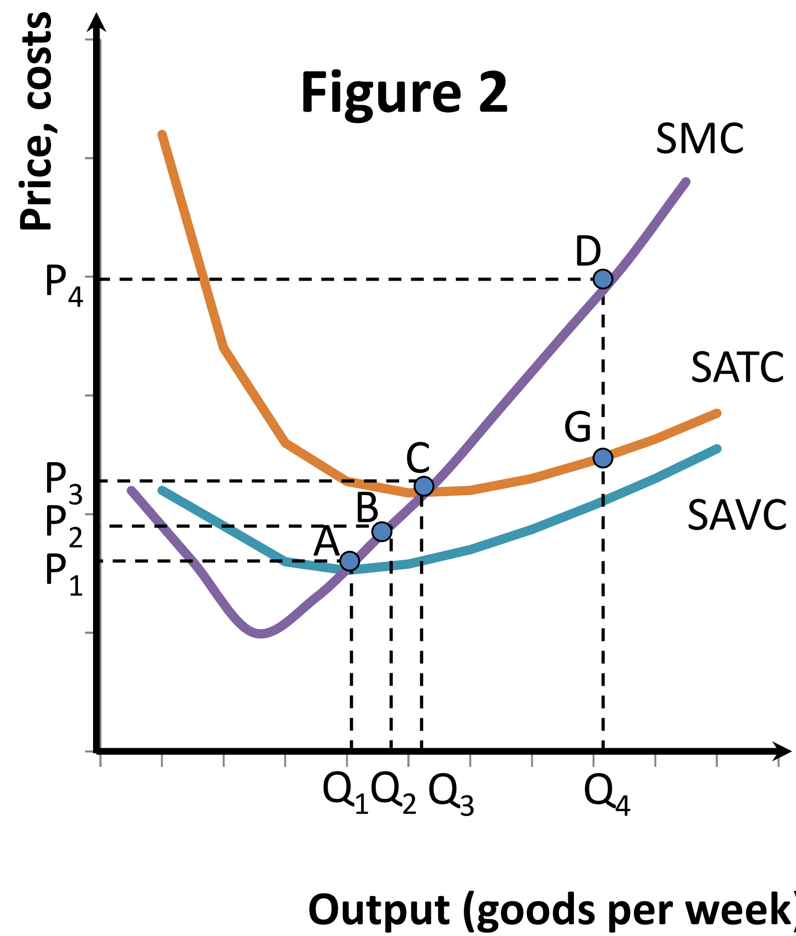
The short-run supply curve

- In the short run, the firm supplies positive output for any price above P_1. At a price P_2, the firm makes Q_2, the output at which price equals marginal cost (although $\pi < 0$).
- Any price below P_1 is below the minimum point on the *SAVC* curve. The firm cannot find an output at which price covers *SAVC*.
- The **short-run supply curve** is the *SMC* curve above point ***A***, at which the *SMC* curve crosses the lowest point on the *SAVC* curve.



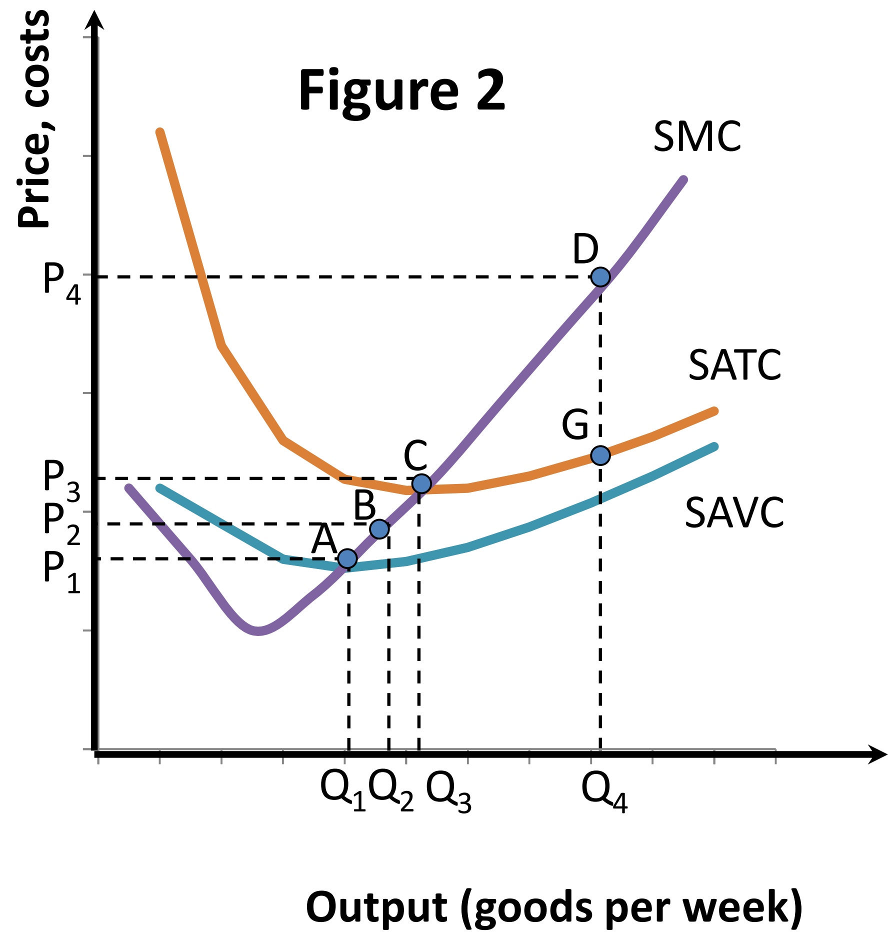
Short-run losses and profits

- Between points ***A*** and ***C*** the firm is making short-run losses, but recouping some of its overheads.
- At any price above P_3, at which the *SMC* curve crosses the lowest point on the *SATC* curve, the firm is making short-run profits.
- At the price P_4 the profit per unit output (average profit) is the distance ***DG***, price minus average total costs per unit.

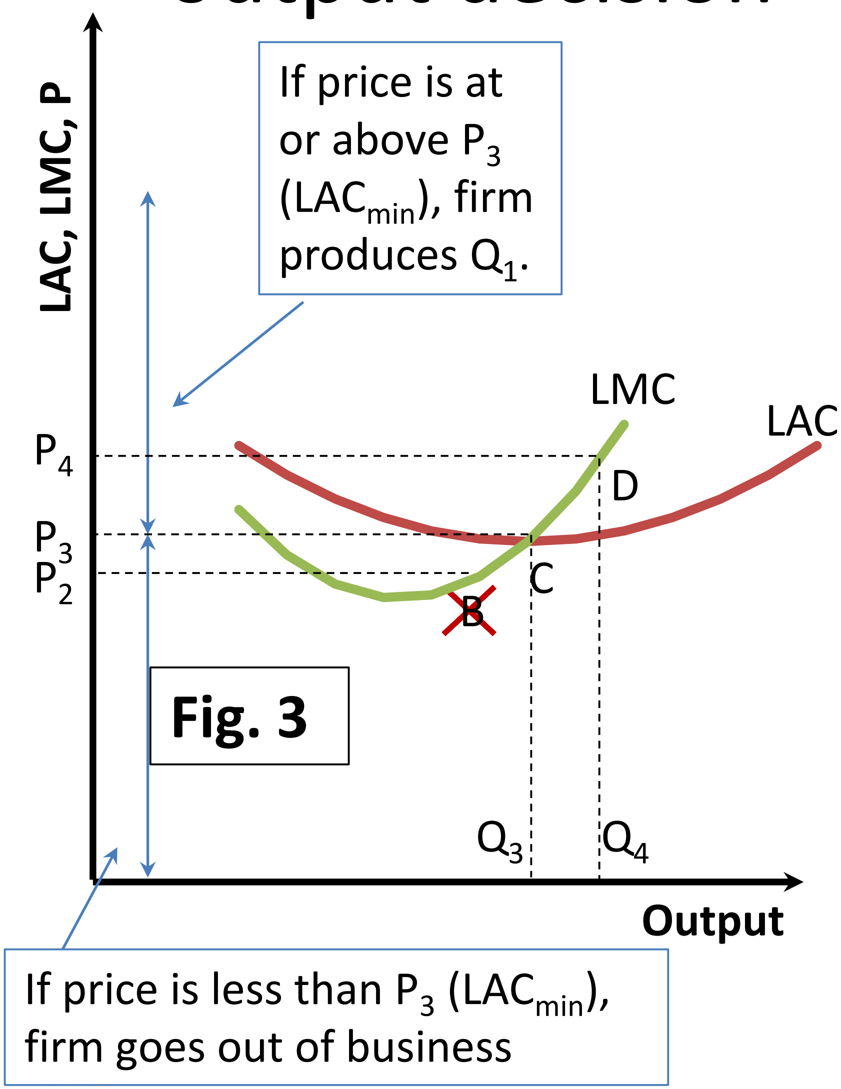


Economic costs and shutdown price

- Remember that these are economic or supernormal profits after allowing for the economic costs, including the opportunity costs of the owners’ financial capital and work effort, summarized in the *SAVC* and *SATC* curves.
- The price P_1 is the **shutdown price**, below which the firm cuts its losses by making no output.



The firm's long-run output decision



- The perfectly competitive firm produces at the level of output at which *P* is equal to marginal cost, provided it makes more profit by producing some output than none at all.
- At any price above P_3 the firm makes profits because price is above long-run average cost (*LAC*). At any price below P_3, such as P_2, the firm makes losses because price is below long-run average cost. It therefore will not produce any output at prices below P_3. The long-run supply curve is the *LMC* curve above point ***C***.

A firm's long-run supply curve

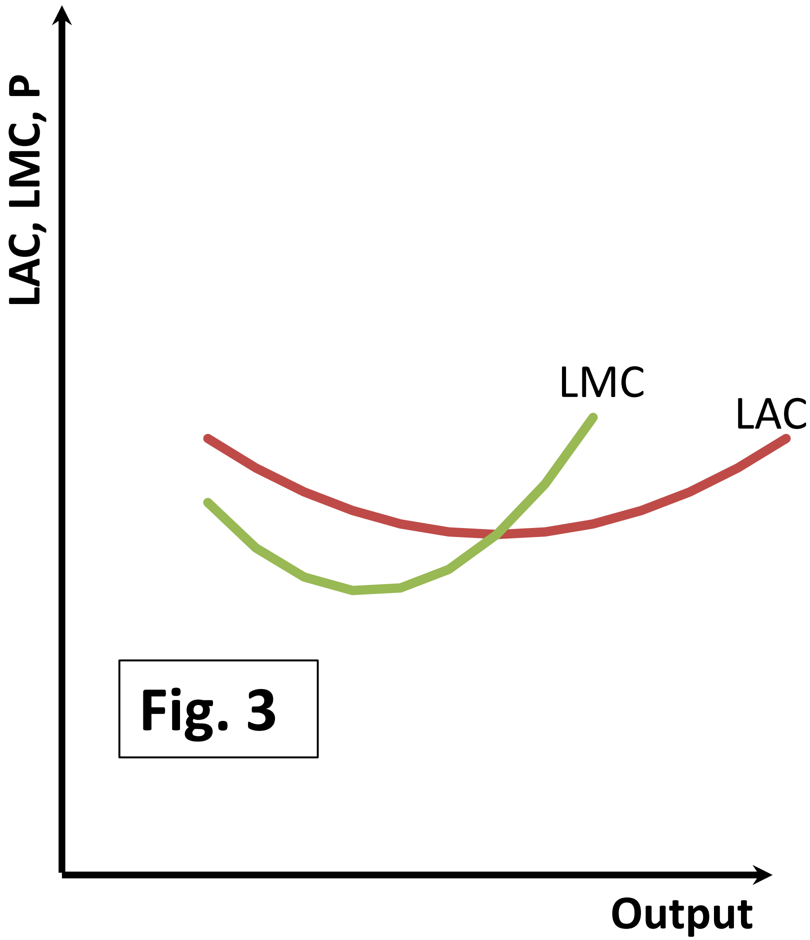
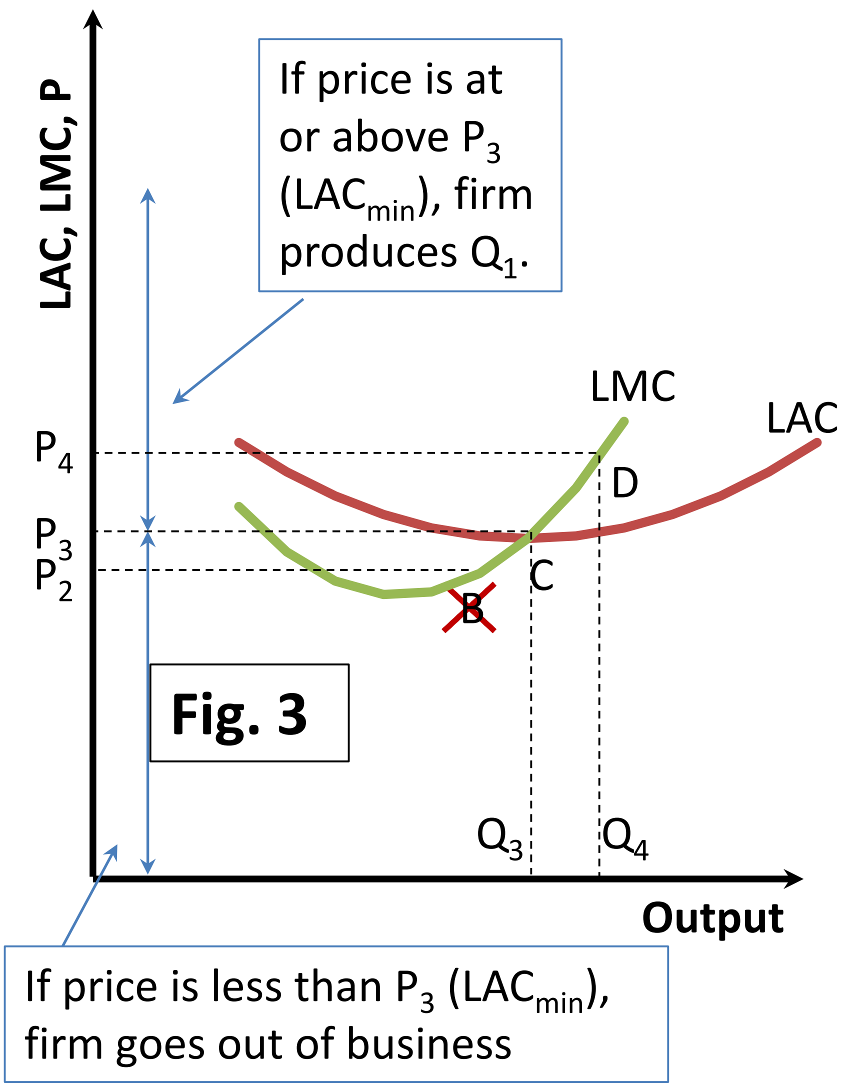


Fig. 3

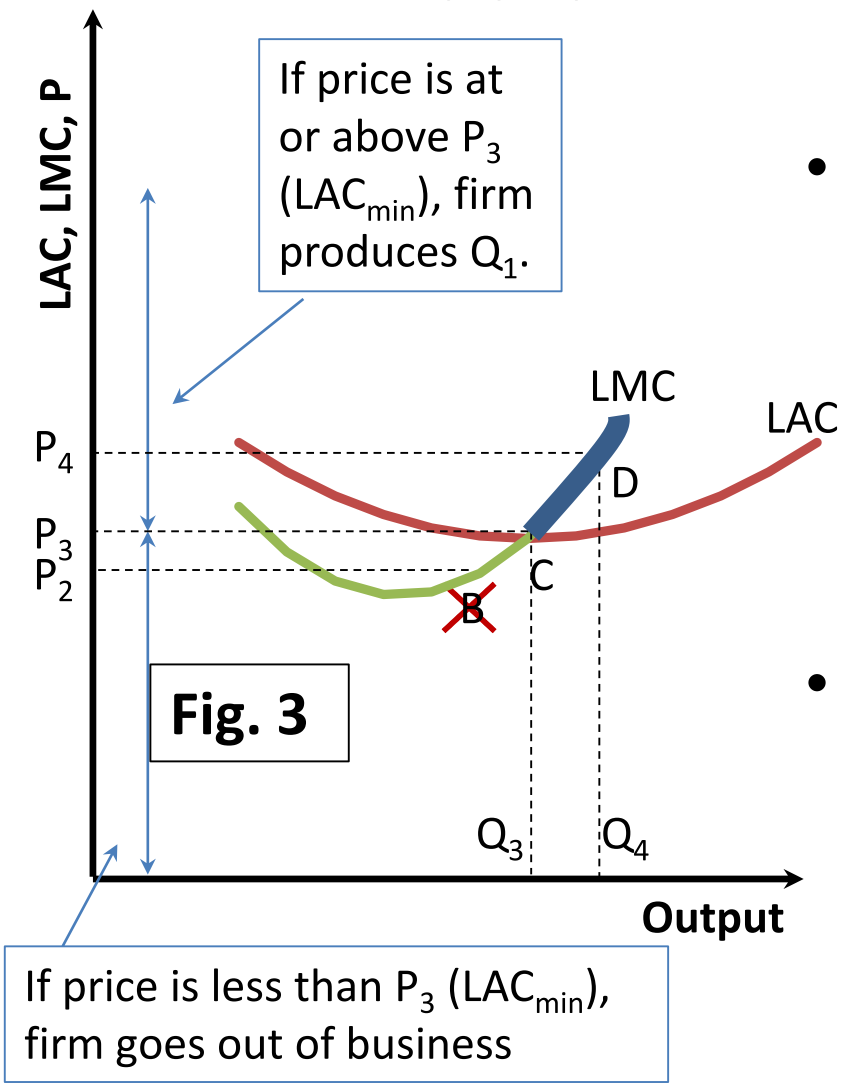
- Figure 3 shows the firm's average and marginal costs in the long run.
- The long-run marginal cost curve LMC is flatter than the short-run marginal cost curve SMC since the firm can adjust all inputs in the long run.

Exit condition in the long run



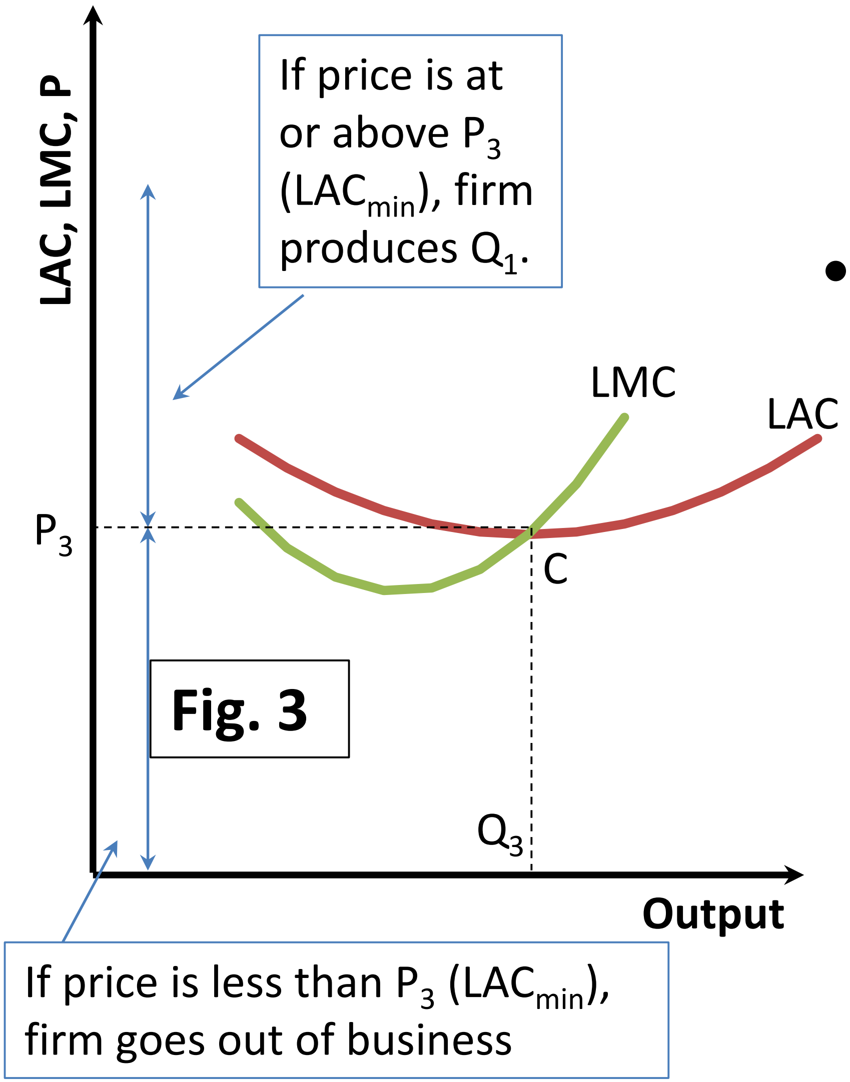
- Facing a price P_4, the firm chooses the long-run output Q_4 at point ***D***, then checks if it is better to shut down than to produce this output.
- In the long run, shutting down means leaving the industry altogether. The firm exits the industry if price fails to cover long-run average cost LAC at the best positive output. At the price P_2 the best positive output is at point ***B*** in figure 3, but the firm makes a loss and should exit the industry in the long run.

A firm's long-run supply



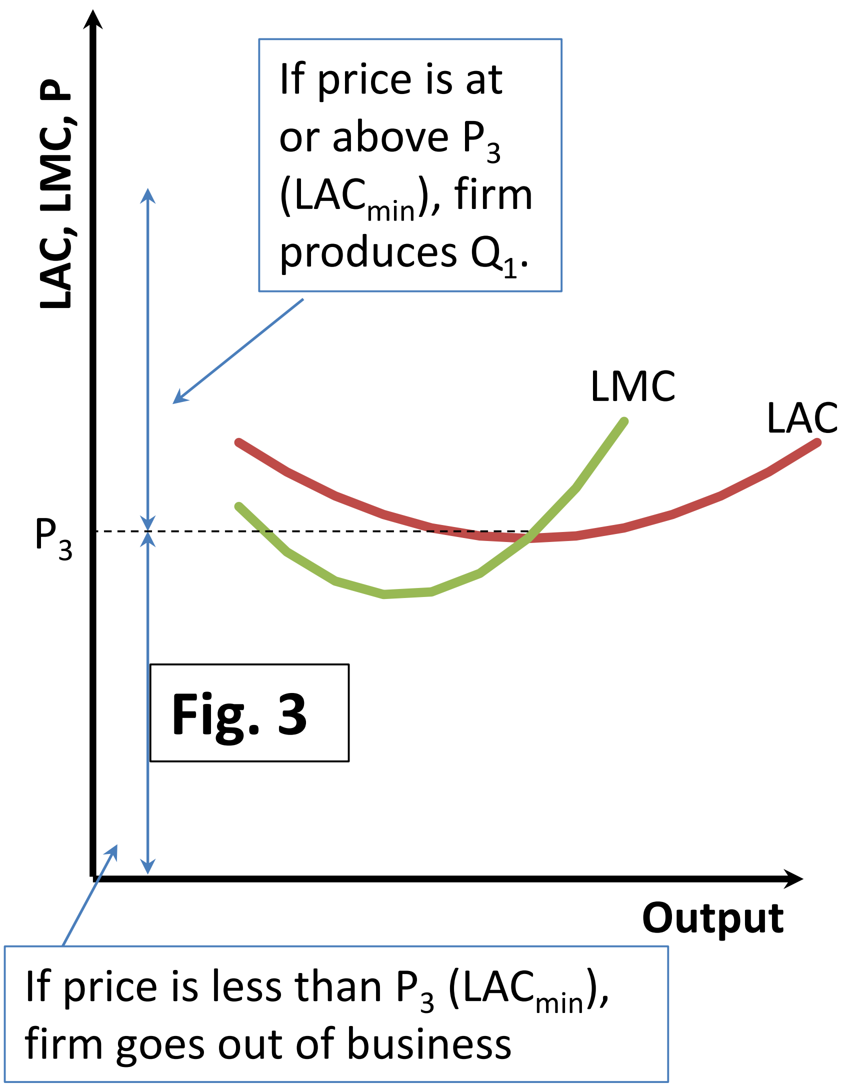
- A firm's **long-run supply curve**, relating output supplied to price in the long run, is that part of its *LMC* curve above its *LAC* curve.
- At any price below P_3 the firm exits the industry. At the price P_3 the firm produces Q_3 and just breaks even after paying all its economic costs. It makes only normal profits.
- When economic profits are zero the firm makes **normal profits**. Its accounting profits just cover the opportunity cost of the owner's money and time.

Entry or exit price



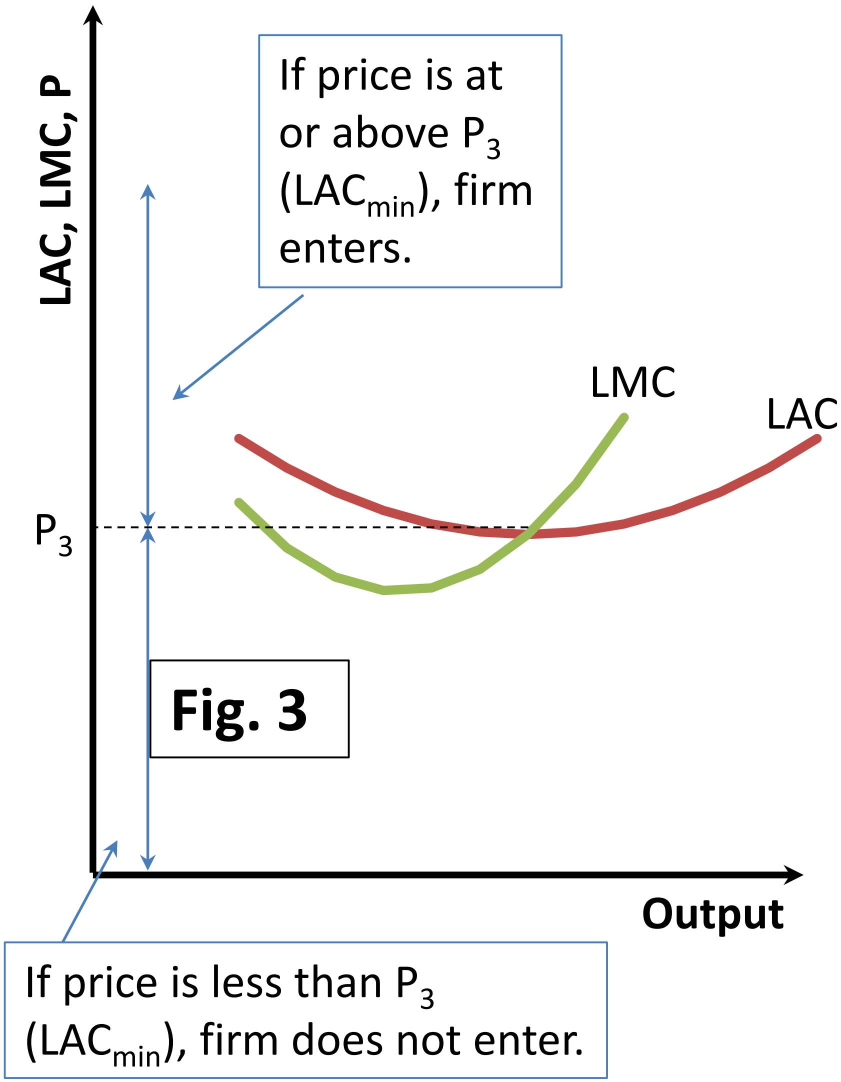
- The price P_3 corresponding to the lowest point on the *LAC* curve is the *entry or exit price*.
- At this price firms make only normal profits. There are no incentives to enter or leave the industry. The resources tied up in the firm are earning just as much as their opportunity costs, what they could earn elsewhere.

Entry and exit

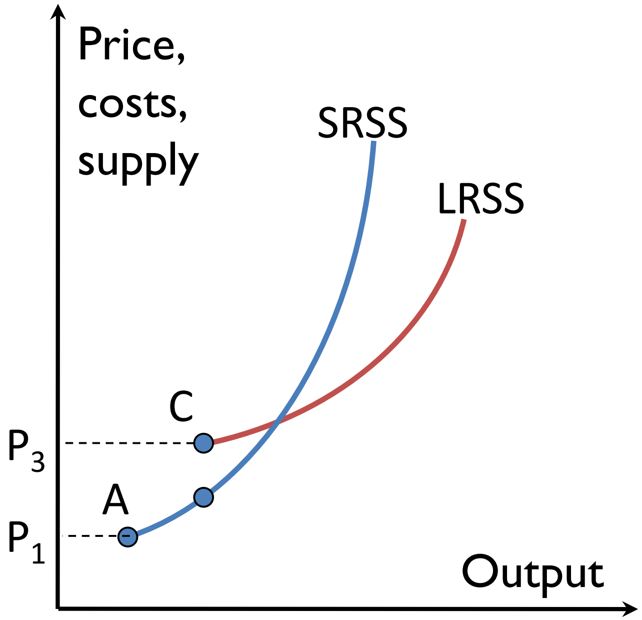


- **Entry** is when new firms join the industry.
- **Exit** is when existing firms leave.
- Any price below P_3 induces a firm to exit the industry in the long run.
- P_3 is the minimum price required to keep the firm in the industry.

The decision facing an entrant

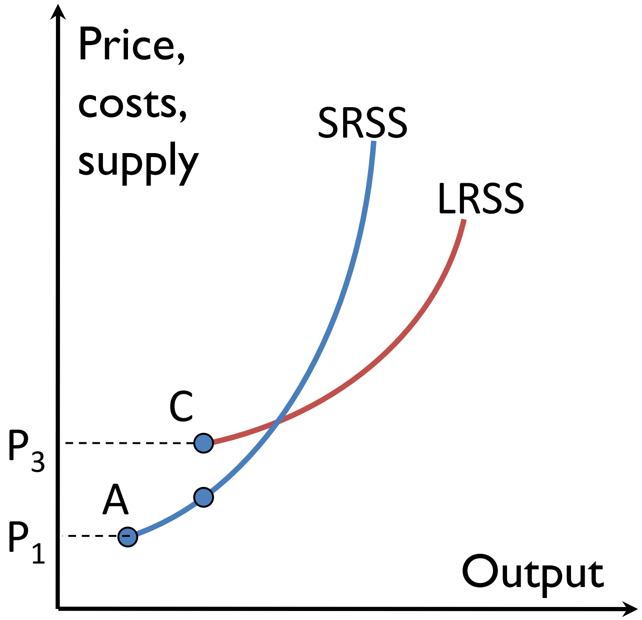


- We can also interpret figure 3 as the decision facing a potential entrant to the industry.
- The cost curves now describe the post-entry costs. P_3 is the price at which entry becomes attractive.
- Any price above P_3 yields supernormal profits and encourages entry of new firms.



Supply decisions of a competitive firm (figure 4)

- Figure 4 summarizes the preceding discussion.
- For each level of fixed factors there is a different *SMC* curve and short-run supply curve *SRSS*.
- The long-run supply curve *LRSS* is flatter than *SRSS* because extra factor flexibility in the long run makes the *LMC* curve flatter than the *SMC* curve.



Short-run and long-run supply curves of the competitive firm (figure 4)

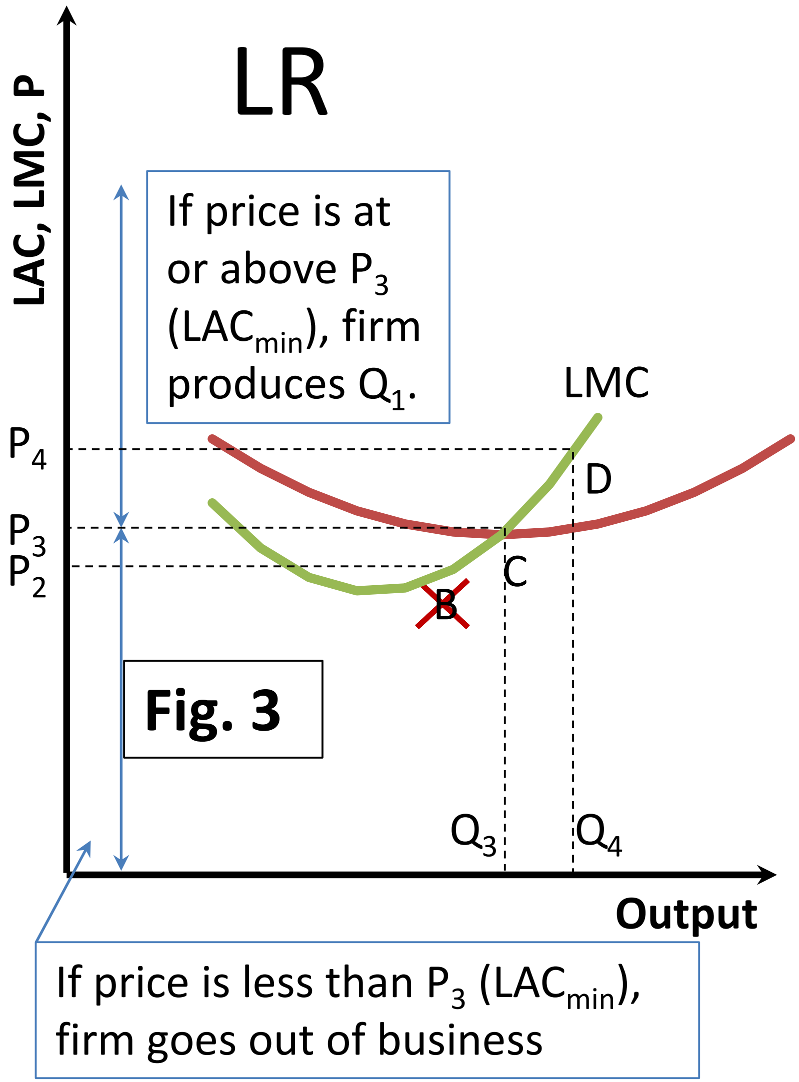
Taken from the two previous figures, the short-run supply curve *SRSS* is the firm's *SMC* curve above ***A*** and the long-run supply curve *LRSS* is the firm's *LMC* curve above ***C***. P_1 is the shutdown price in the short run and P_3 the entry and exit price in the long run. If the firm happens to begin with the stock of fixed factors it would choose at the lowest point on its *LAC* curve, then ***C*** will actually lie on the *SRSS* curve.

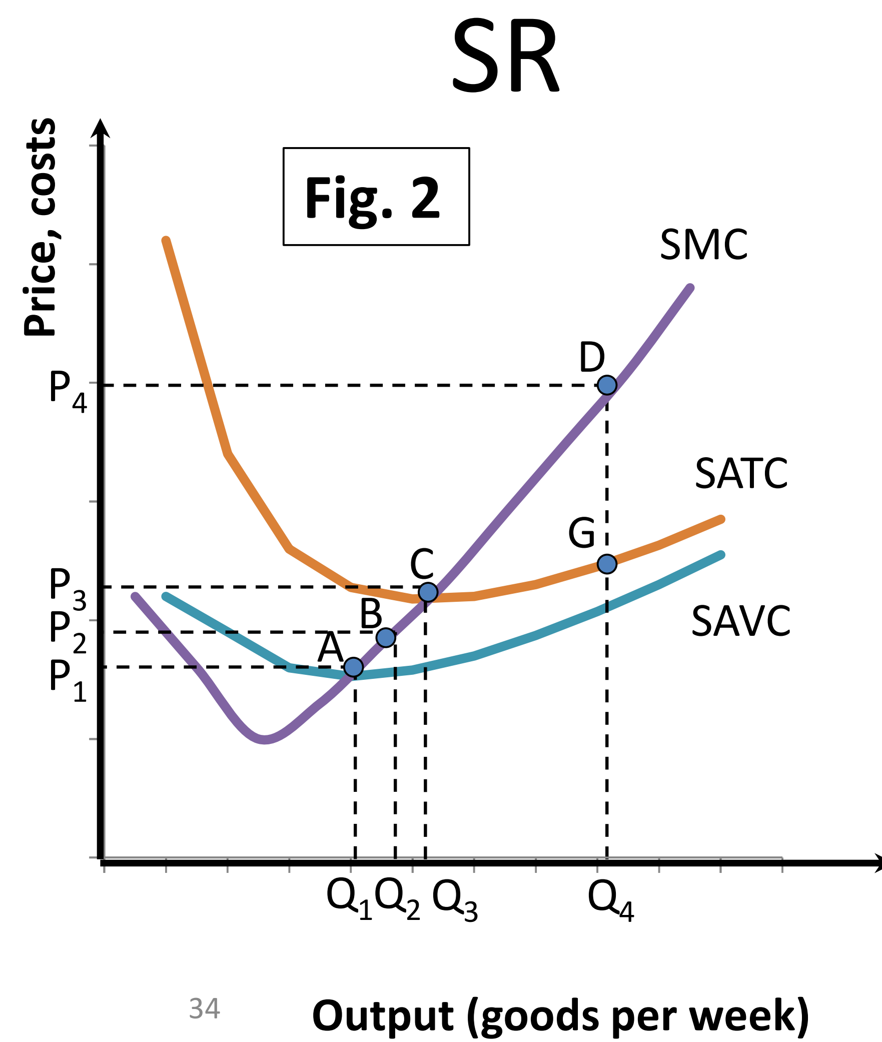
Supply decisions of a competitive firm

- The *SRSS* curve starts from a lower shutdown price because, in the short run, a firm will produce if it can cover average variable costs.
- In the long run all costs are variable and must be covered if the firm is to stay in the industry.
- In either case, a competitive firm's supply curve is the part of its marginal cost curve above the point at which it is better to make no output at all. The table below sets out this principle.

Marginal condition	Average condition	
	Short run	Long run
Produce output Where P = MC	If P < SAVC shut down temporarily	If P < LAC exit industry

Marginal condition	Average condition	
	Short run	Long run
Produce output Where P = MC	If P < SAVC shut down temporarily	If P < LAC exit industry






Thank you

Perfect competition and pure monopoly

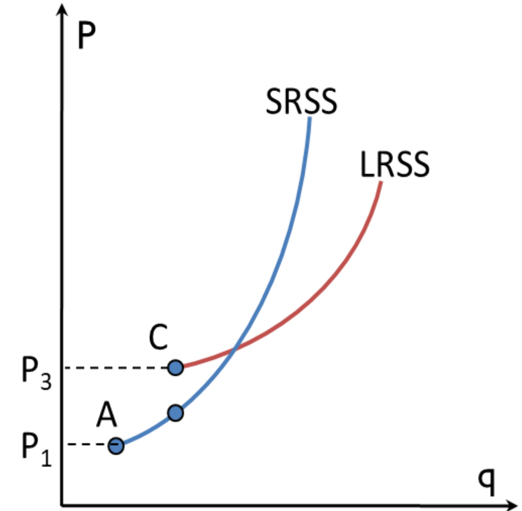
Part II: Industry supply curves

MICRO- AND MACROECONOMICS

Perfect competition – Industry supply curves

Part 2

Industry supply curves



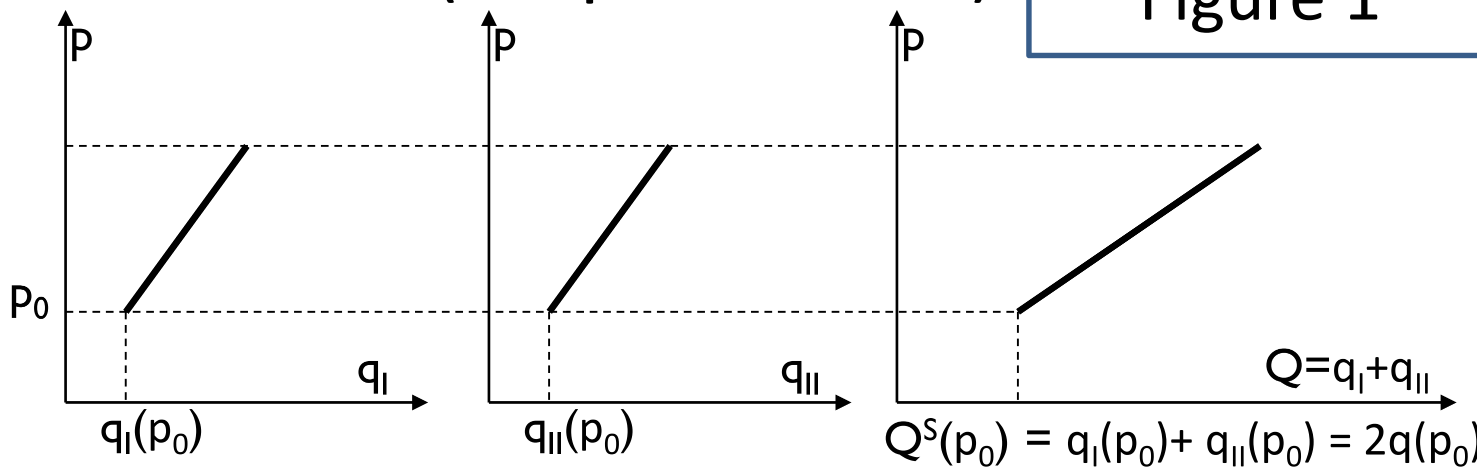
- A competitive industry comprises many firms. In the short run two things are fixed: the quantity of fixed factors used by each firm, and the number of firms in the industry.
- In the long run, each firm can vary all its factors of production, but the number of firms can also change through entry and exit from the industry.

If all firms were identical…

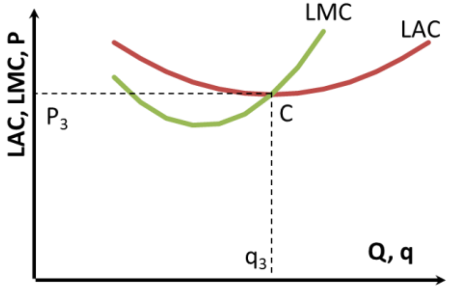
- If all firms had the same cost function (the same (perfect) information about the available technologies, equally advantageous locations etc.) the total quantity supplied would be the quantity supplied by one firm multiplied by the number of firms.
- Since the demand curve facing the firm is also the same (horizontal at the market price), the individual supply curves would be identical.

Aggregating the supply curves (simplified case)

Figure 1



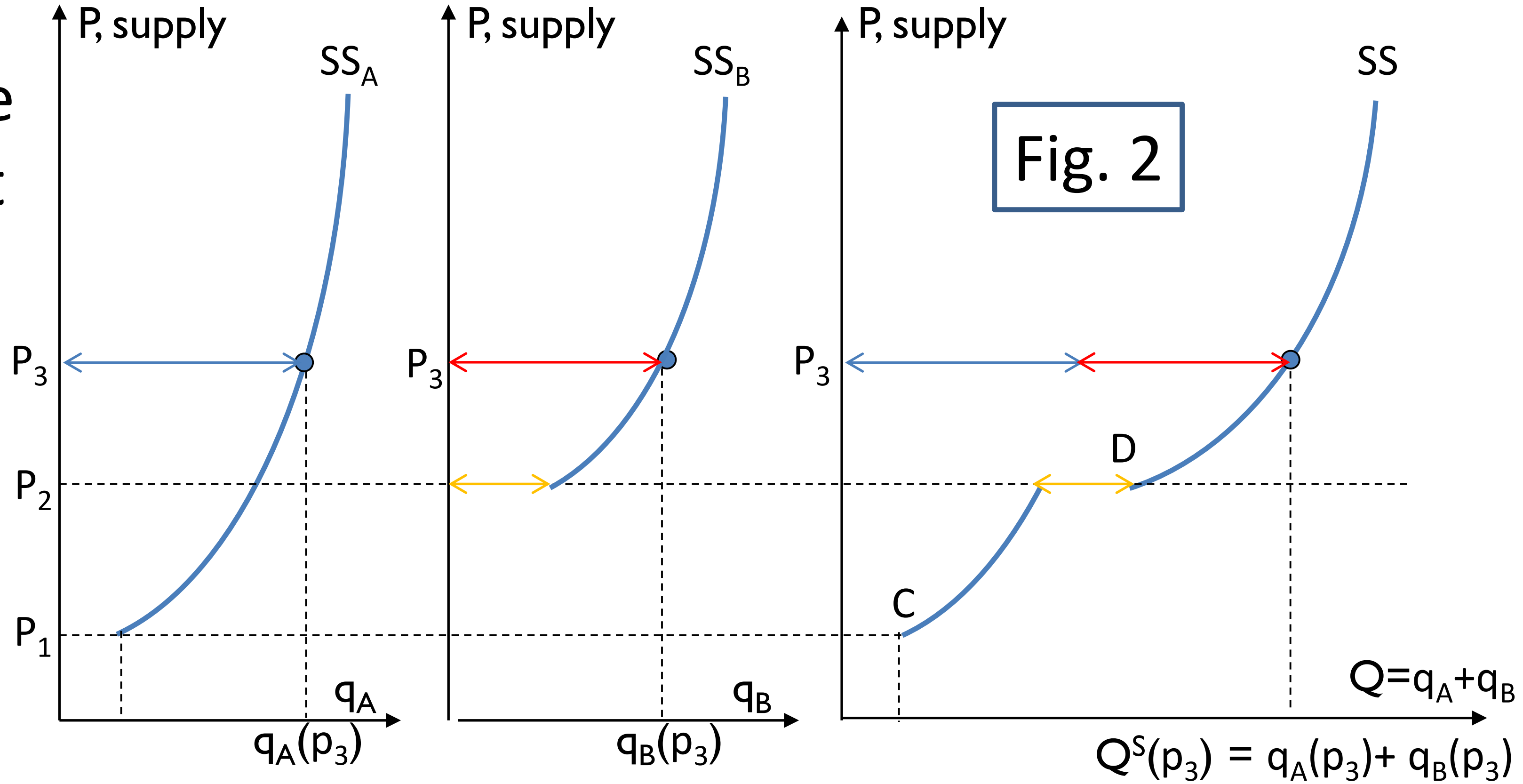
- The industry supply curve is obtained by adding at each price the quantity supplied by each firm in the industry.
- If more firms enter the industry, the market supply curve will become flatter (the equilibrium market price will decrease); if firms exit the industry, the market supply curve will become steeper. (Since firms are relatively small and a large number of them are in the industry – if only one of them enters (exits) the market the change in the market price will not be significant.)



Perfect competition in the long run (simplified case)

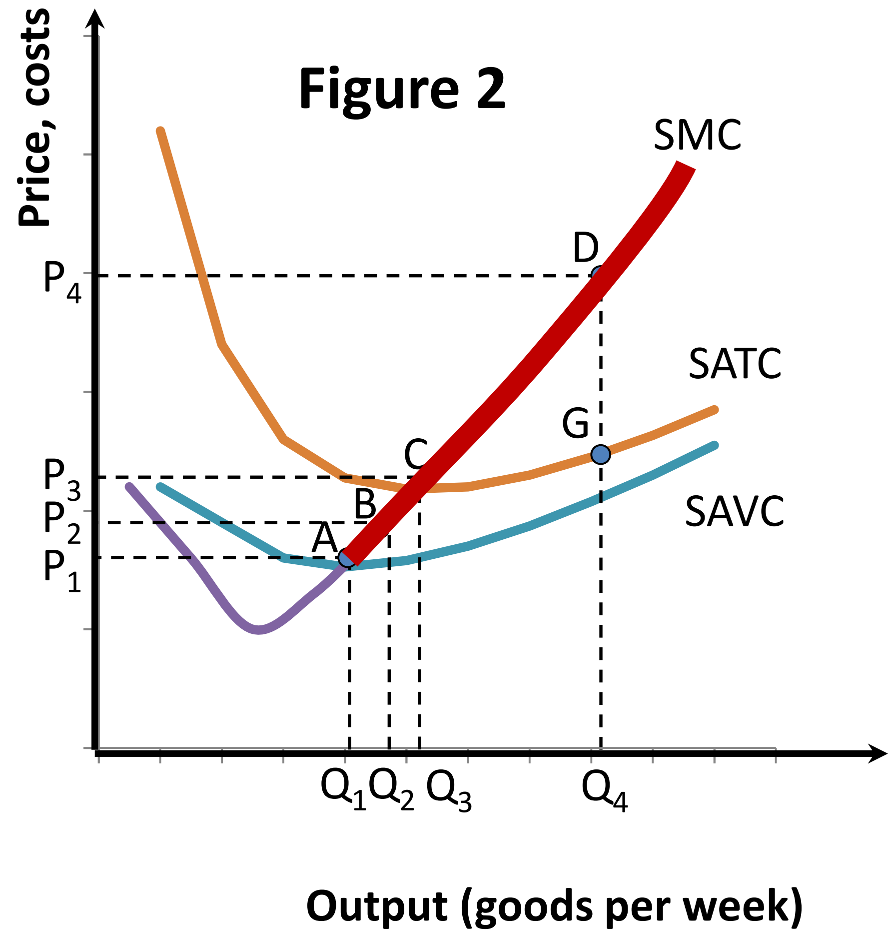
- If there are no barriers to entry, each firm will realize zero economic profit in the long run. (All firms would be at their break-even points: LAC(q*)=LMC(q*)=P*.)
- The number of firms in the industry: n=Q/q, where Q is the equilibrium quantity ($Q^* = Q^S(p^*) = Q^D(p^*)$) and q is the output level of an individual firm.
- If the firms in the industry realized positive economic profits, other firms would enter the market, driving the market price down.
- If the firms in the industry realized negative economic profits, some firms would exit and the market price would rise making the remaining firms more profitable.

Firms are different



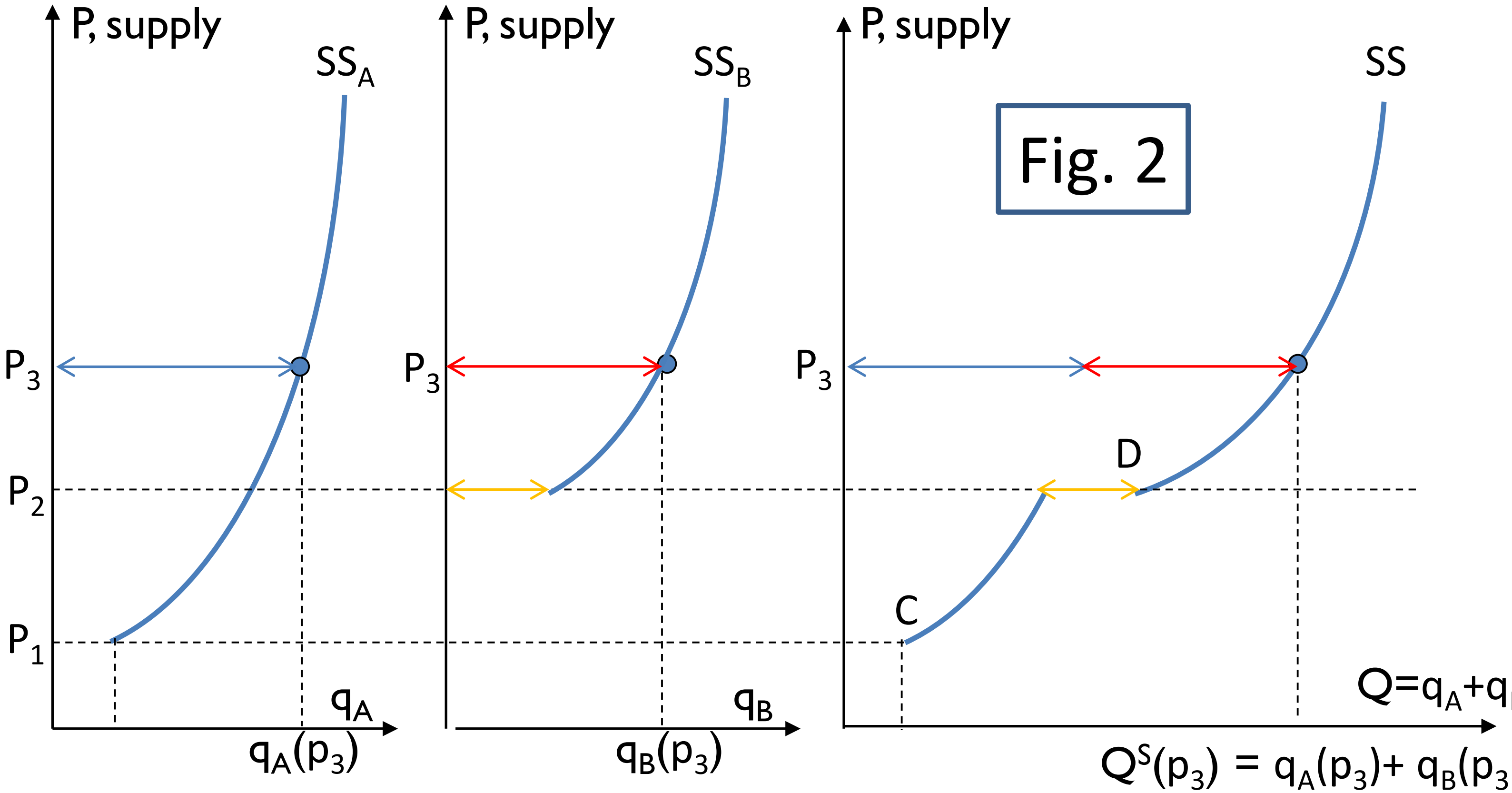
- The industry supply curve *SS* shows the total quantity supplied at each price by all firms. With only two firms (**A** and **B**) figure 2 shows how at each price such as P_3 we add $q_A(P_3)$ and $q_B(P_3)$ to obtain *Q* on the industry supply curve.
- Since firms have different shutdown prices or entry and exit prices, the industry supply curve can have step jumps at points such as ***C*** and ***D*** where an extra firm starts production.
- However, with many firms in the industry, each trivial relative to the industry as a whole, the step jumps in the industry supply curve when another starts production are so small that we can effectively think of the upward-sloping industry supply curve as smooth.

- In the short run, the number of firms in the industry is given.
- Suppose there are two firms, **A** and **B**.
- Each firm's short run supply curve is the part of its *SMC* curve above the shutdown price.



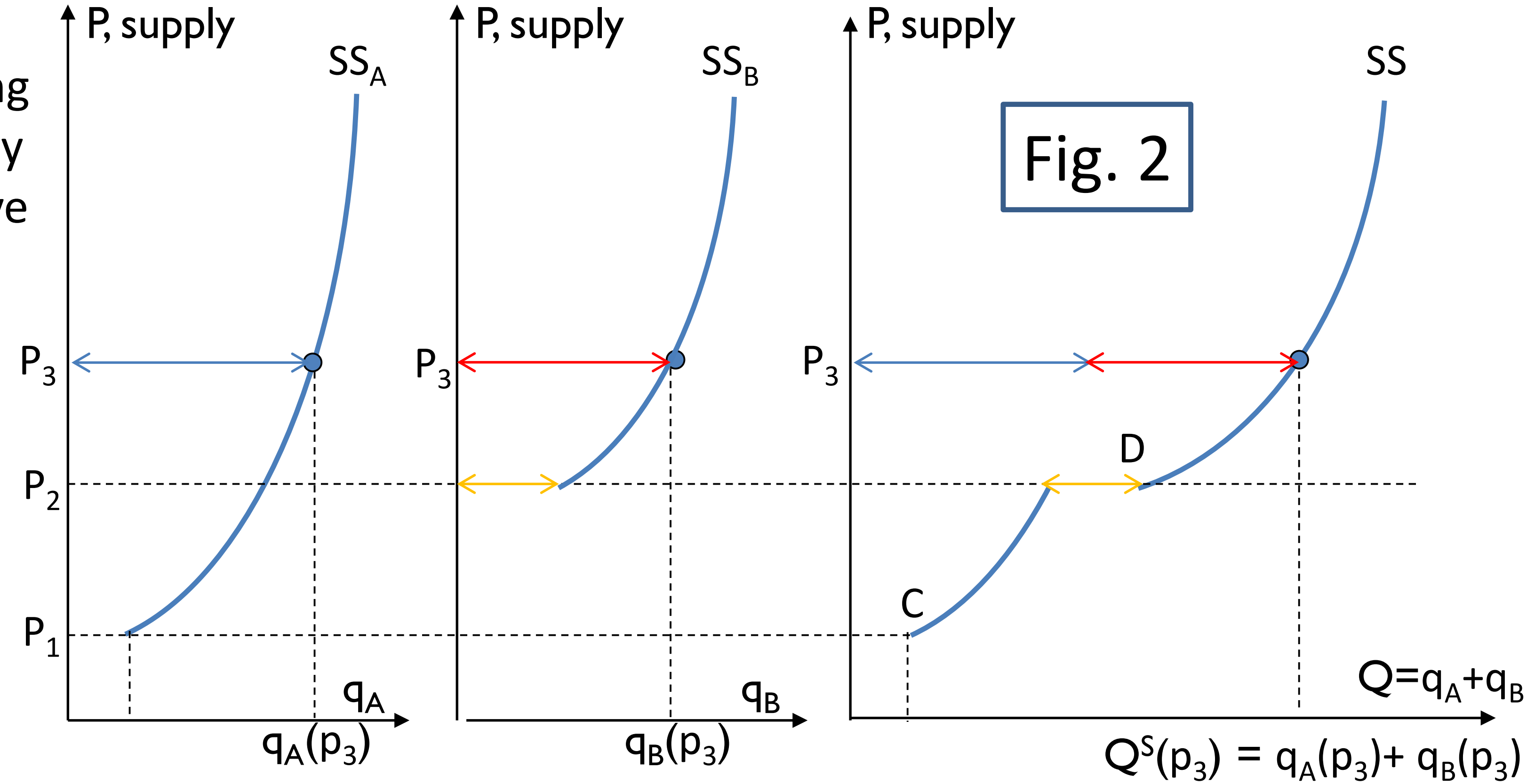
In the short run (different firms)

Different firms, short-run supply curve



- In figure 2, firm **A** has a lower shutdown price than firm **B**. Firm **A** has a lower *SAVC* curve. It may have a better location or better technical know-how.
- Each firm's supply curve is horizontal at the shutdown price. At a lower price, no output is supplied.

Constructing the industry supply curve

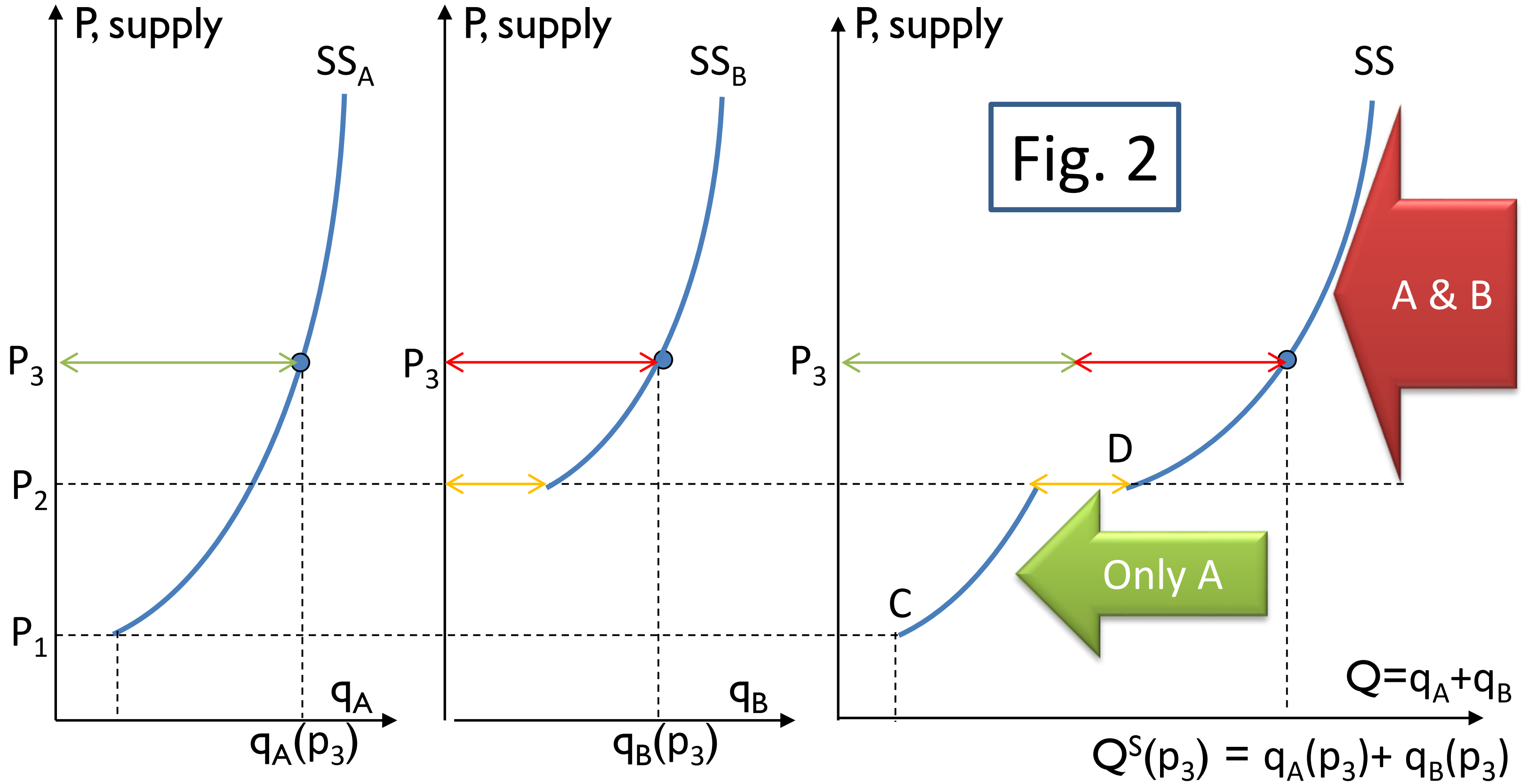


- At each price, the industry supply Q is the sum of q_A, the supply of firm **A**, and q_B, the supply of firm **B**.
- Thus if P_3 is the price:

$$Q(P_3) = q_A(P_3) + q_B(P_3)$$

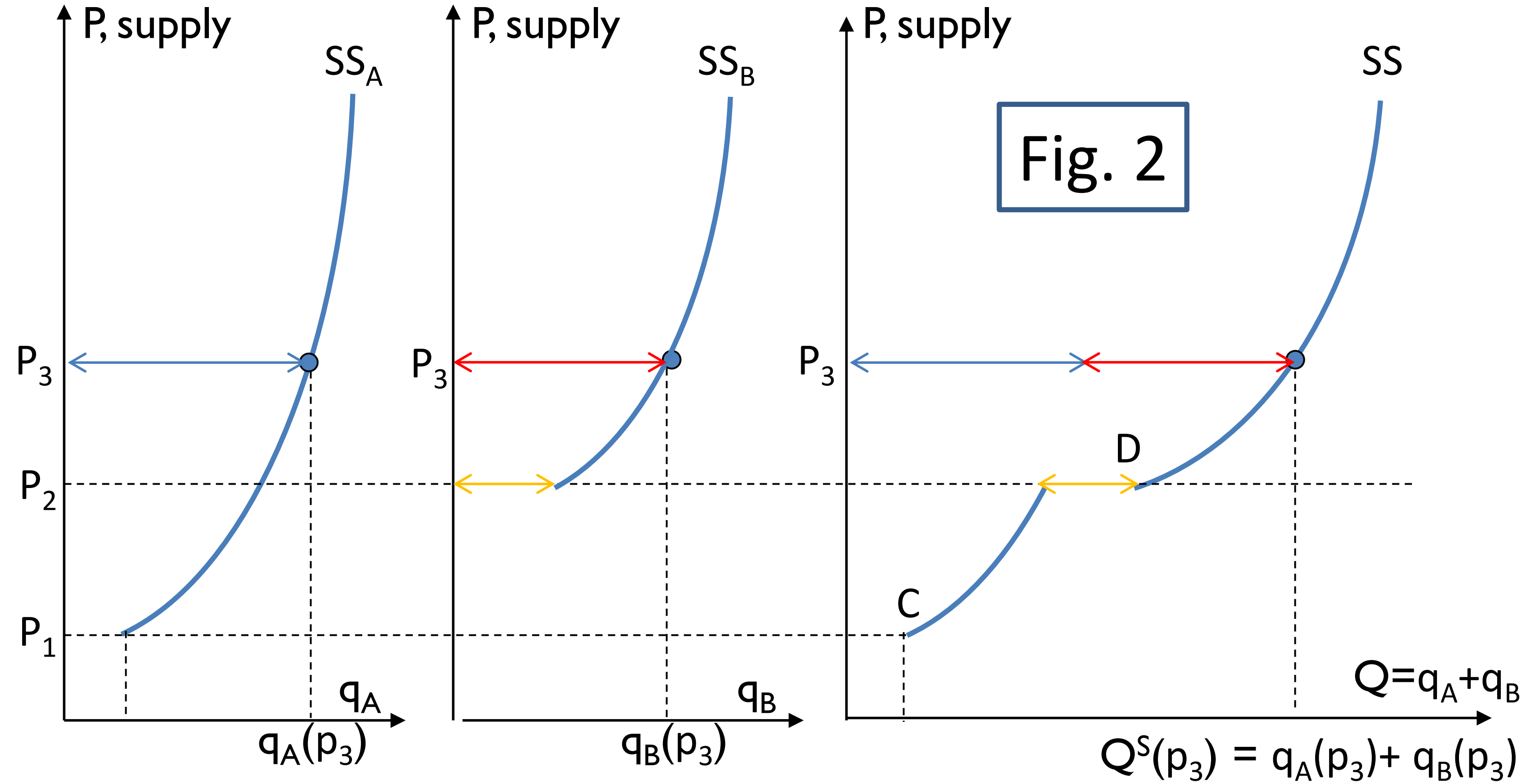
- The industry supply curve is the horizontal sum of the separate supply curves.

Discontinuities



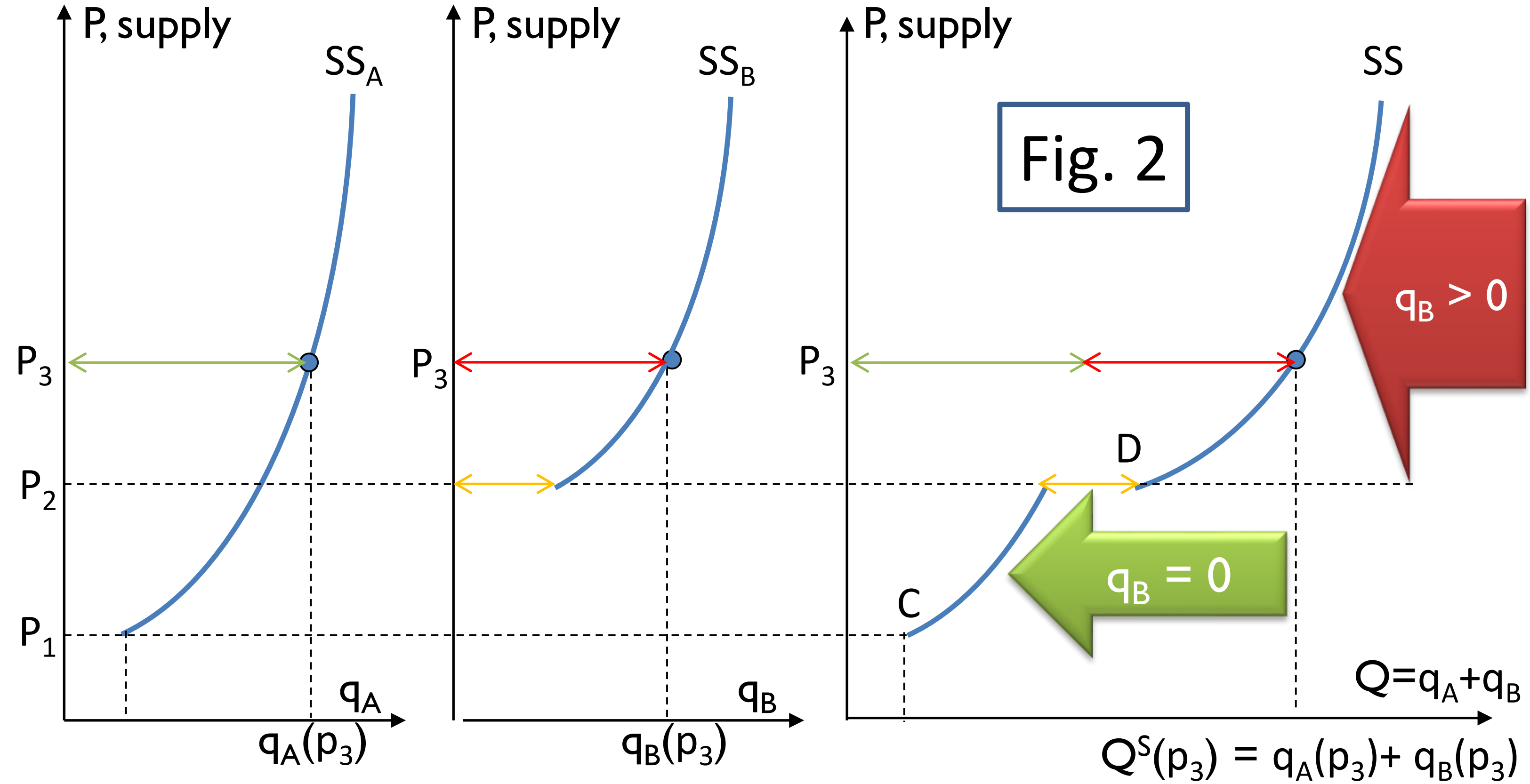
- The industry supply curve is discontinuous at the price P_1.
- Between P_1 and P_2 only the lower-cost firm **A** is producing.
- At P_2 firm **B** starts to produce as well.
- With many firms, each with a different shutdown price, there are many tiny discontinuities as we move up the industry supply curve. Since each firm in a competitive industry is trivial relative to the total, the industry supply curve is effectively smooth.

The long-run industry supply curve



- Figure 2 may also be used to derive the long-run industry supply curve. For each firm the individual supply curve is the part of its *LMC* curve above its entry and exit price.
- Unlike the short run, the number of firms in the industry is no longer fixed. Existing firms can leave the industry, and new firms can enter.
- Instead of horizontally aggregating at each price the quantities supplied by the existing firms in the industry, we must horizontally aggregate the quantities supplied by existing firms *and firms that might potentially enter the industry*.

In the long run



- Suppose that SS_A, SS_B and SS in figure 2 are long-run supply curves.
- At a price below P_2 firm **B** is not in the industry in the long run.
- At prices above P_2 firm **B** is in the industry.
- As the market price rises, total industry supply rises in the long run not just because each existing firm moves up its long-run supply curve, but also because new firms join the industry.

The number of firms

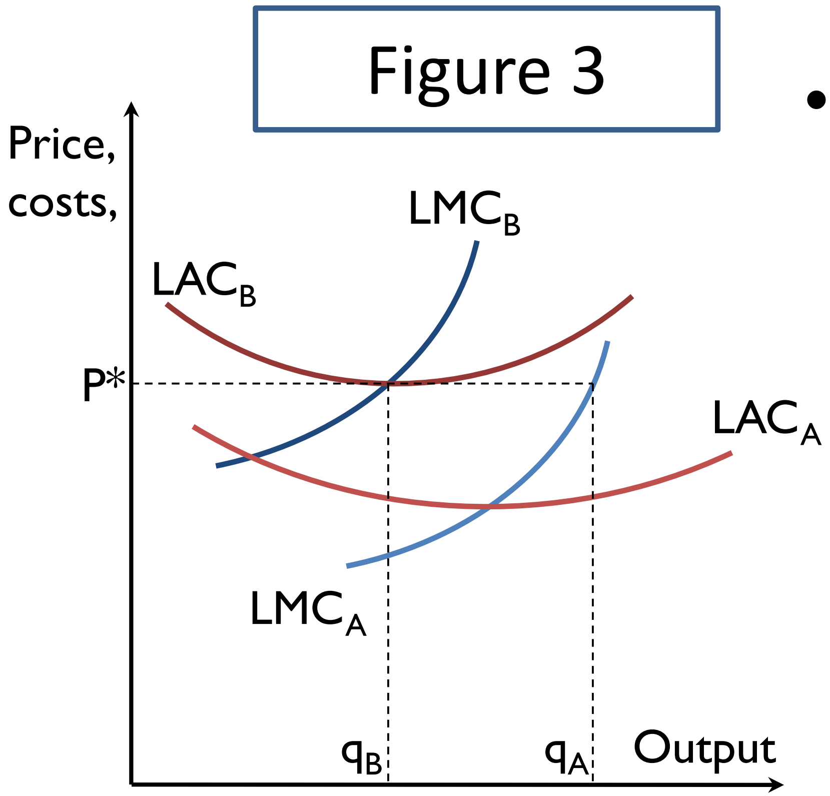
- Conversely, at low prices, high-cost firms lose money and leave the industry. Entry and exit in the long run are analogous to shutdown in the short run.
- In the long run, entry and exit affect the number of producing firms whose output is horizontally aggregated to get the industry supply.
- In the short run, the number of firms in the industry is given, but some are producing while others are temporarily shut down. Again, the industry supply curve is the horizontal sum of those outputs produced at the given market price.

Long run and short run compared

- The long-run supply curve is flatter than its short-run counterpart. Each firm can vary its factors more appropriately in the long run and has a flatter supply curve.
- On top of that, higher prices attract extra firms into the industry. Industry output rises by more than the extra output supplied by the firms already in the industry.

- Conversely, if the price falls, firms initially move down their (relatively steep) short-run supply curves. If short-run average variable costs are covered, firms may not reduce output very much.
- In the long run each firm reduces output further since all factors of production can now be varied. In addition, some firms exit the industry since they are no longer covering long-run average costs.
- A price cut reduces industry output by more in the long run than in the short run.

The marginal firm in the industry

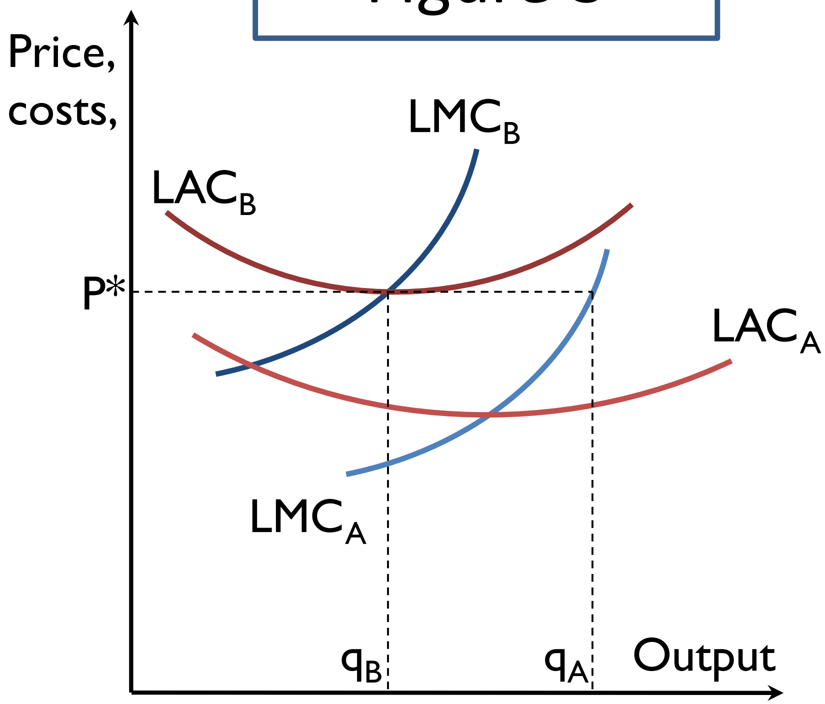


- Suppose firms have different cost curves. Firm **A**, the lowest-cost firm in the industry, has long-run average costs LAC_A and marginal costs LMC_A. Firm **B** faces much higher costs LAC_B and LMC_B. Other firms have intermediate costs.

- At the price P^* firm **A** produces q_A and makes profits. Firm **B** produces q_B and just breaks even. Firm **B** is the marginal firm, the highest-cost producer that can remain in the industry in the long run.

The marginal firm

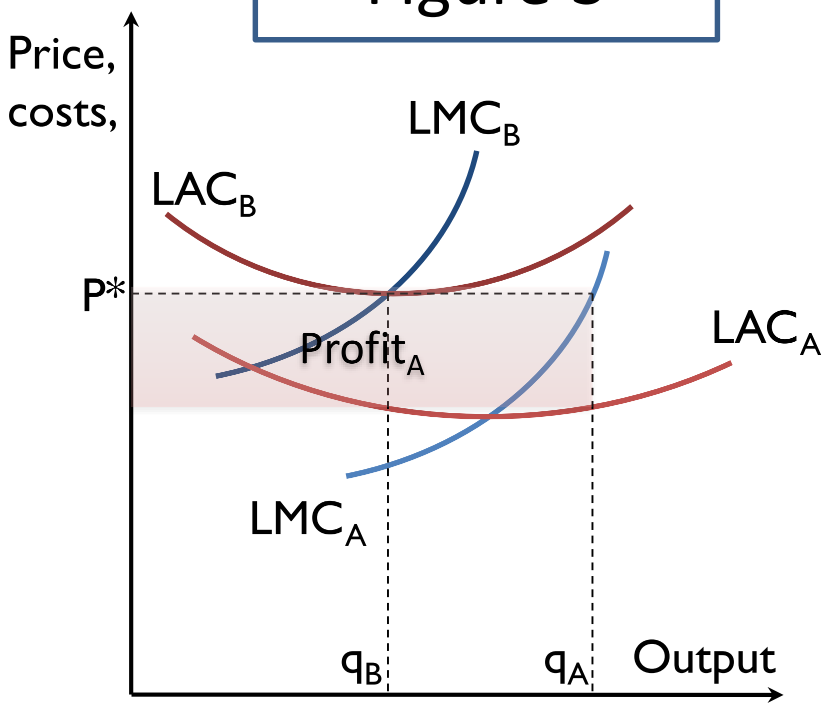
Figure 3



- Suppose there are many firms, each making the same product for sale at some price but having slightly different cost curves.
- Figure 3 shows cost curves for a low-cost firm **A** and a high-cost firm **B**. Some firms have costs lying between **A** and **B**, others have even higher costs than **B**.

The survival of the fittest

Figure 3

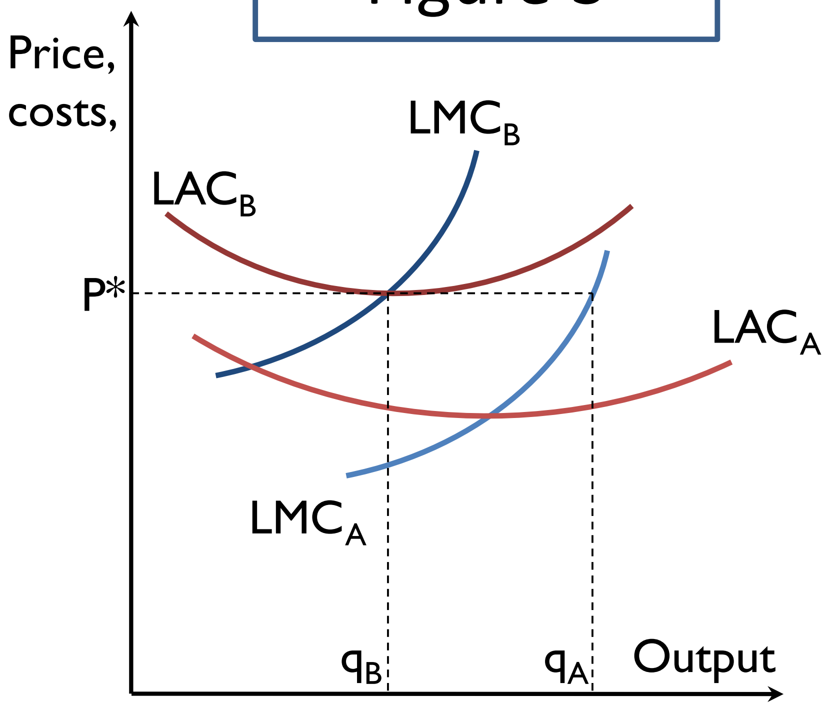


$\text{Profit}_A = (P^* - LAC_A)q_A > 0$
$\text{Profit}_B = (P^* - LAC_B)q_B = 0$

- The long run is the period in which adjustment – both inputs and number of firms – is complete. There is no more entry and exit.
- Suppose the long-run price is P^* in figure 3. The low-cost firm **A** makes q_A and earns profits, since P* exceeds LAC_A at the output q_A. Slightly higher-cost firms are making slightly less profit. Firm **B** is the last firm that can survive in the industry.

The marginal firm and the marginal firm waiting to enter the industry

Figure 3

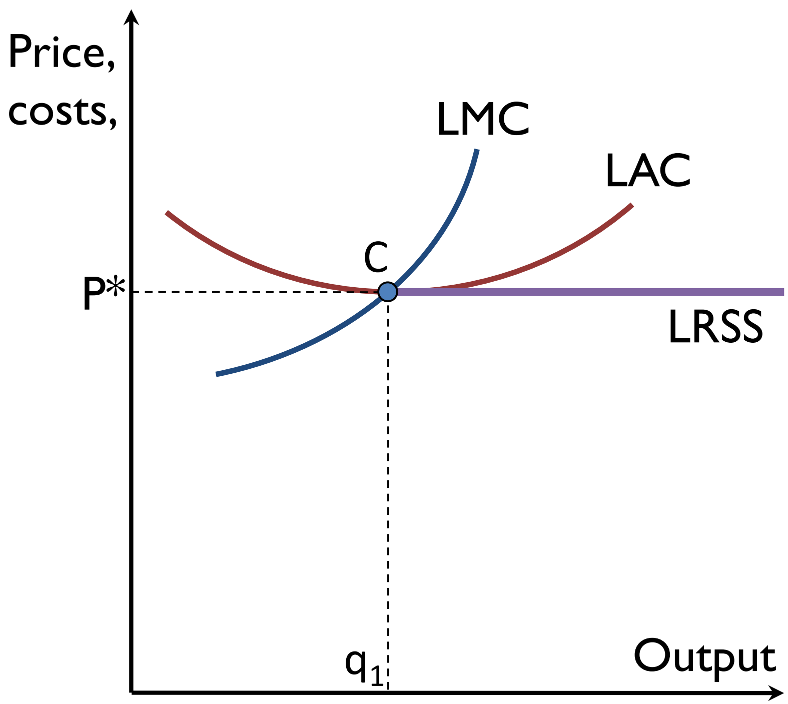


$Profit_B = (P^* - LAC_B)q_B = 0$

- The **marginal firm** in an industry just breaks even.
- All firms with higher costs than firm **B** cannot compete in the industry at a long-run price *P**.
- If a potential entrant has an *LAC* curve whose lowest point is only slightly above *P**, it is the **marginal firm waiting to enter the industry**.
- If anything makes *P** rise a little, this marginal firm can enter.

A horizontal long-run industry supply curve

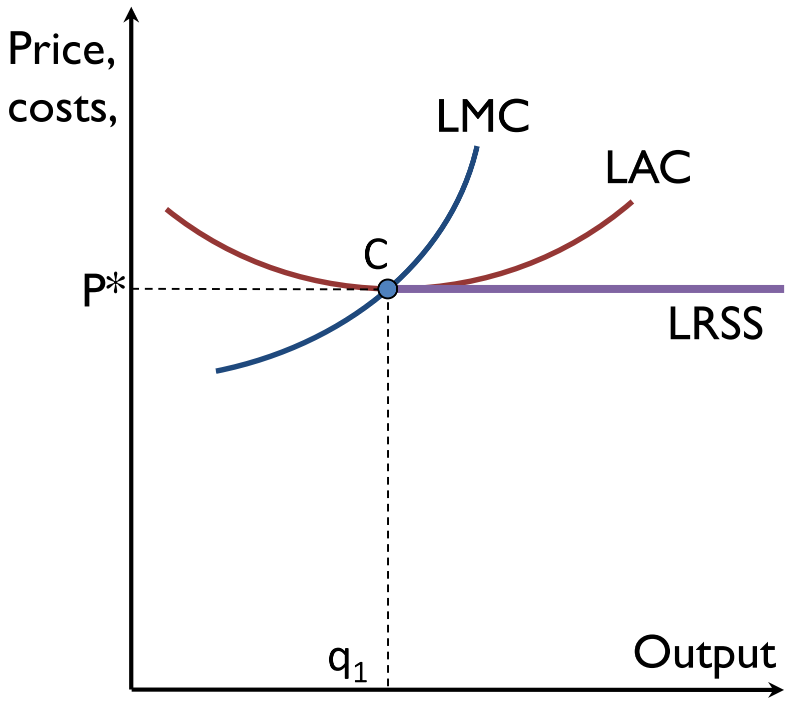
Figure 4



- Each firm has a rising LMC curve, and thus a rising long-run supply curve. The industry supply curve is a bit flatter. Higher prices not merely induce existing firms to produce more, but also induce new firms to enter.
- In the extreme case, the industry long-run supply curve is horizontal if all existing firms and potential entrants have identical cost curves.
- Below P^* no firm wants to supply. It takes a price P^* to induce each individual firm to make q_1.

The horizontal long-run industry supply curve

Figure 4

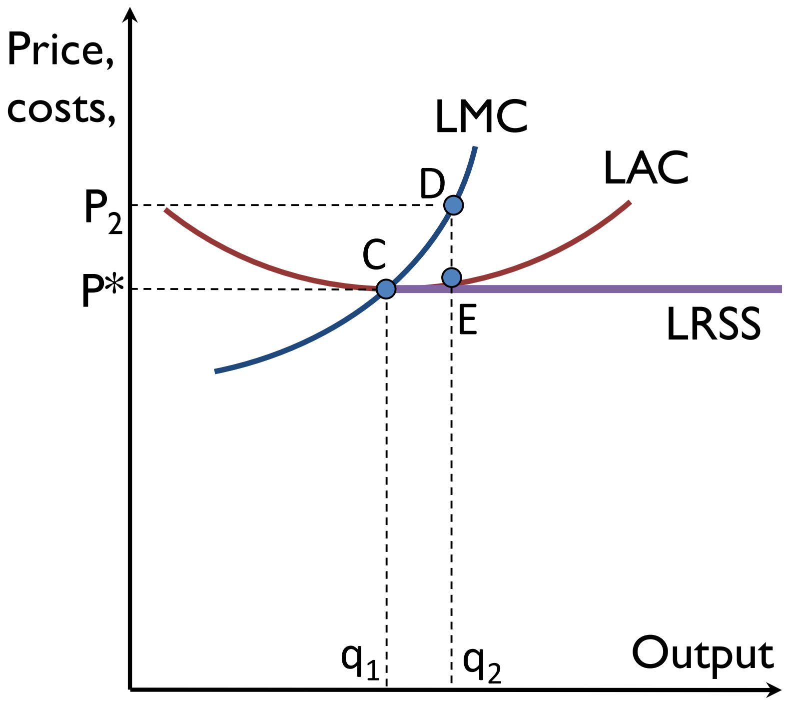


- When all existing firms and potential entrants have identical costs, industry output can be expanded without offering a price higher than *P**. The long-run industry supply curve is the horizontal line *LRSS* at *P**

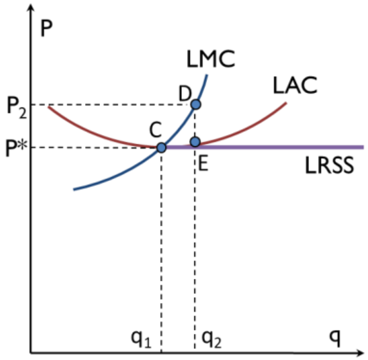
- Industry output can be indefinitely expanded at this price by increasing the number of firms that each produce q_1.

Why is the *LRSS* horizontal?

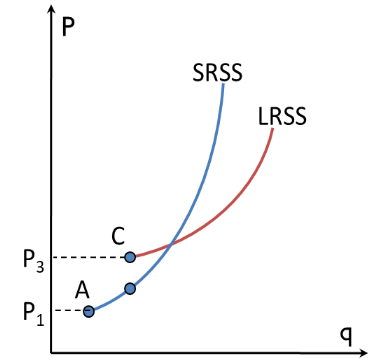
Figure 4



- At a price P_2 above $P*$, each firm makes q_2 and earns supernormal profits. Point ***D*** is above point ***E***.
- Since potential entrants face the same cost curves, new firms flood into the industry, thus pushing the price back to $P*$. The industry supply curve is horizontal at the long run at $P*$.
- It is not necessary to "bribe" existing firms to move up their individual supply curves. Industry output is expanded by the entry of new firms alone.
- Figure 4 shows the long-run industry supply curve *LRSS*, horizontal at the price $P*$.



Rising long-run industry supply curves



- There are two reasons why a rising long-run industry supply curve is much more likely than a horizontal long-run supply curve for a competitive industry.
- First, it is unlikely that every firm and potential firm in the industry has identical cost curves.

- Second, even if all firms face the same cost curves, we draw a cost curve for given technology and given input prices.
- Although each small firm affects neither output prices nor input prices, collective expansion of output by all firms may bid up input prices.
- It then needs a higher output price to induce industry output to rise. In general, the long-run industry supply curve slopes up.


Thank you

Perfect competition and pure monopoly

Part III: Pure monopoly

MICRO- AND MACROECONOMICS

Pure monopoly

Part 3

A perfectly competitive firm and a monopolist

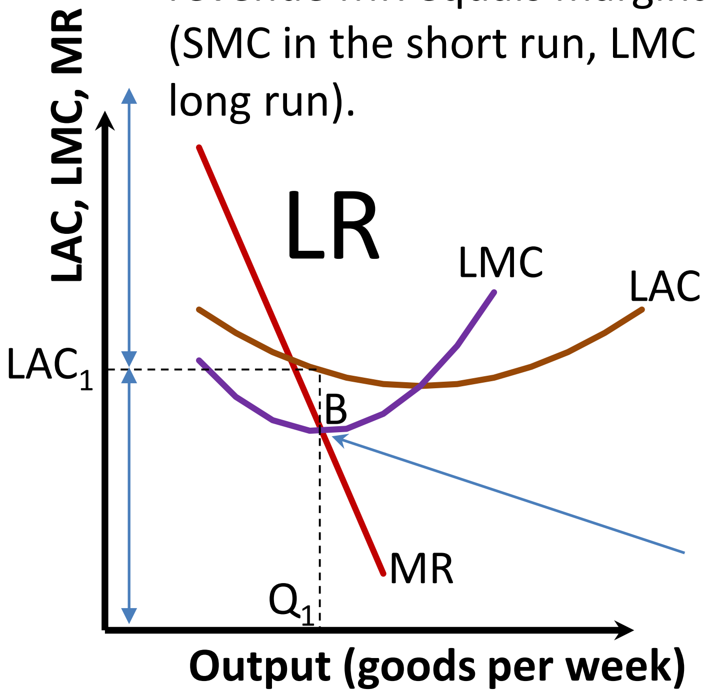
- A **perfectly competitive firm** is too small to worry about any effect of its output decision on industry supply and hence price. It can sell as much as it wants at the market price.
- A **monopolist** is the sole supplier and potential supplier of the industry's product. A real monopolist need not worry about entry even in the long run.

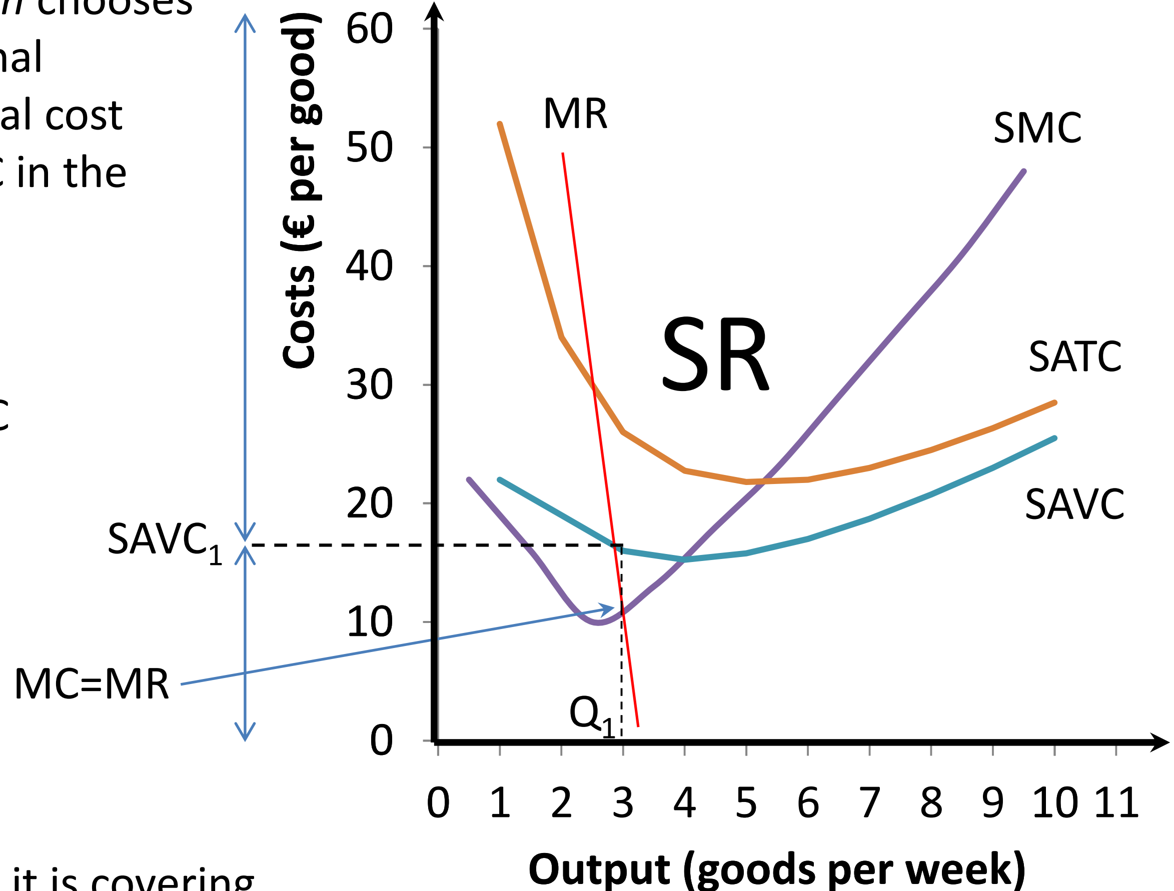
A monopolist and the industry

- The firm and the industry coincide. The sole national supplier may not be a monopolist if the good or service is internationally traded.
- *Royal Mail* (formerly *Consignia*) is the sole supplier of UK stamps and a monopolist in them. *Airbus* is the only large plane-maker in Europe, but is not a monopolist since it faces cut-throat international competition from *Boeing*. Sole suppliers may also face invisible competition from potential entrants. If so, they are not monopolists.

Marginal condition	Average condition	
	Short run	Long run
Produce output Where MR = MC	If P < SAVC shut down temporarily	If P < LAC exit industry

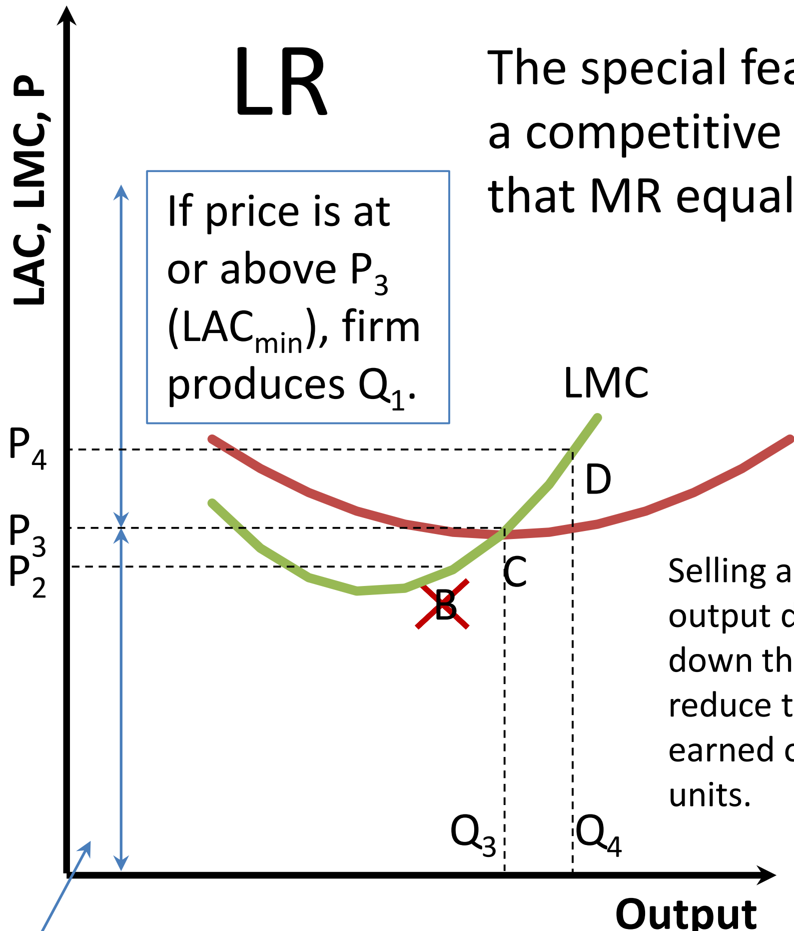
To maximize profits *any firm* chooses the output at which marginal revenue MR equals marginal cost (SMC in the short run, LMC in the long run).





It then checks whether it is covering average costs (SAVC in the short run and LAC in the long run).

Marginal condition	Average condition	
	Short run	Long run
Produce output Where P = MC	If P < SAVC shut down temporarily	If P < LAC exit industry

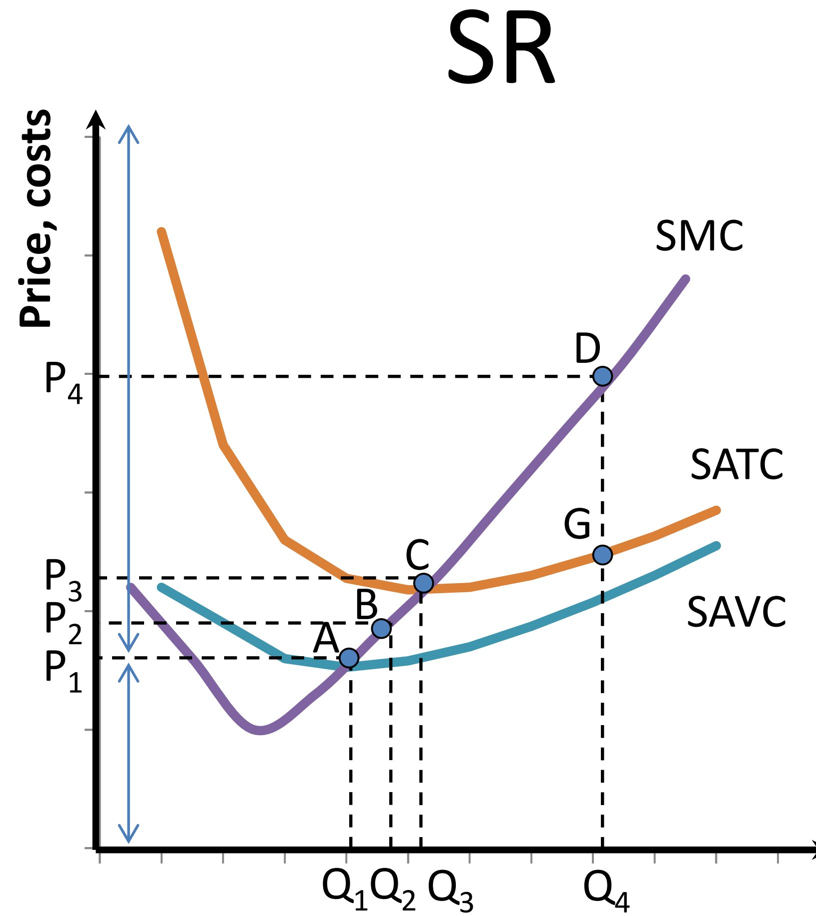


If price is less than P_3 (LAC_{min}), firm goes out of business

The special feature of a competitive firm is that MR equals price.

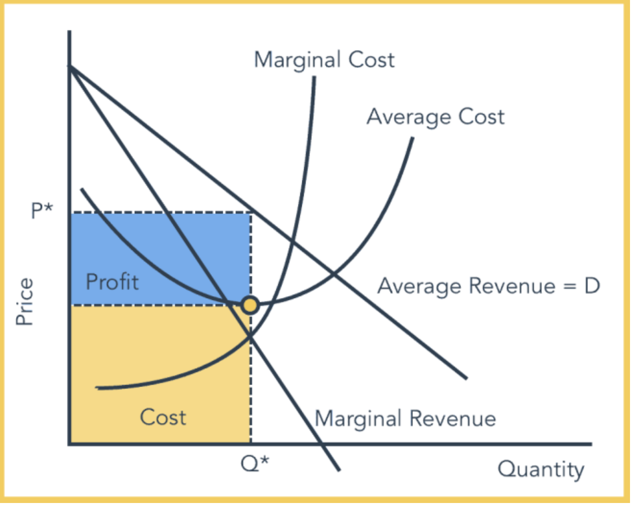
Selling an extra unit of output does not bid down the price and reduce the revenue earned on previous units.

The price at which the extra unit is sold is the change in total revenue.

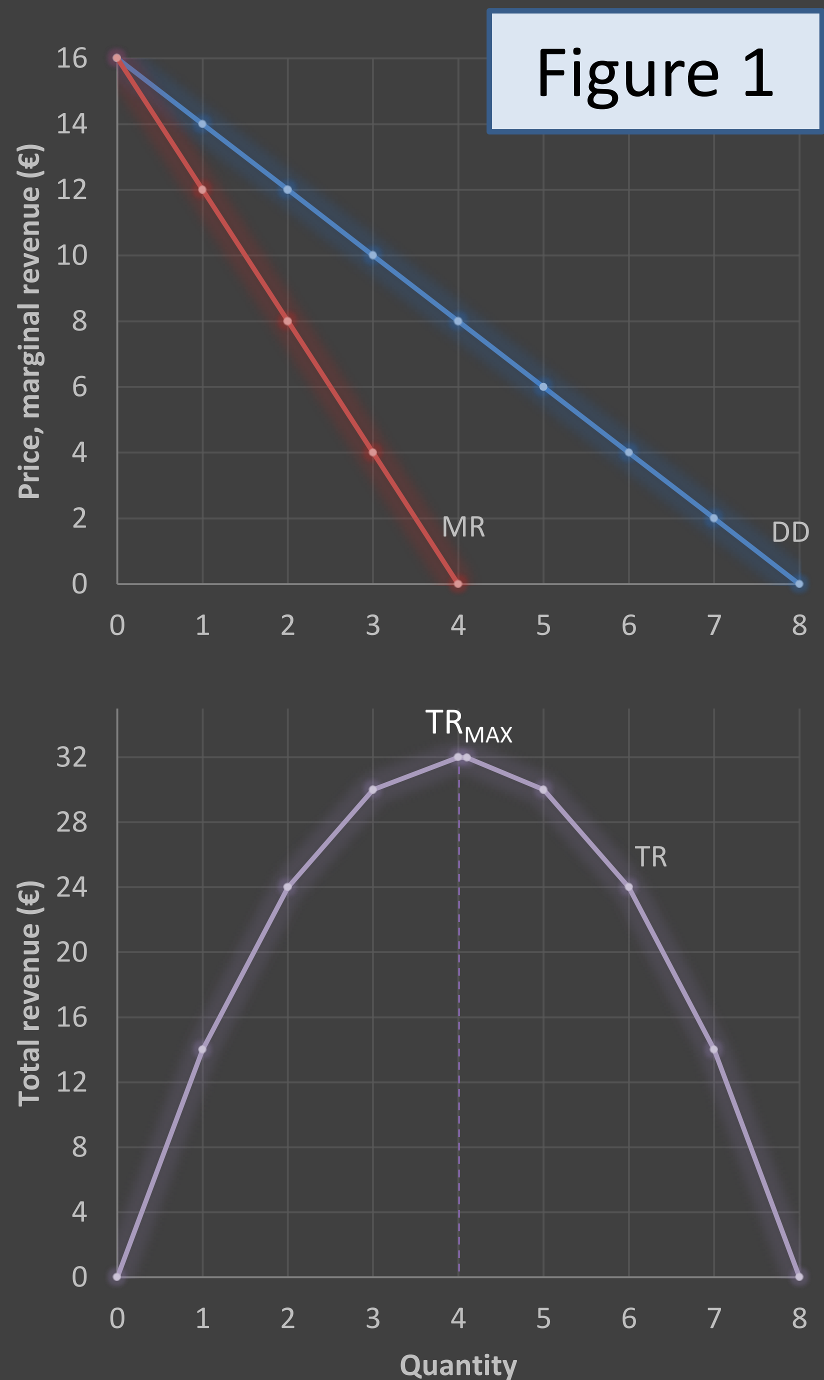


The monopolist's demand curve

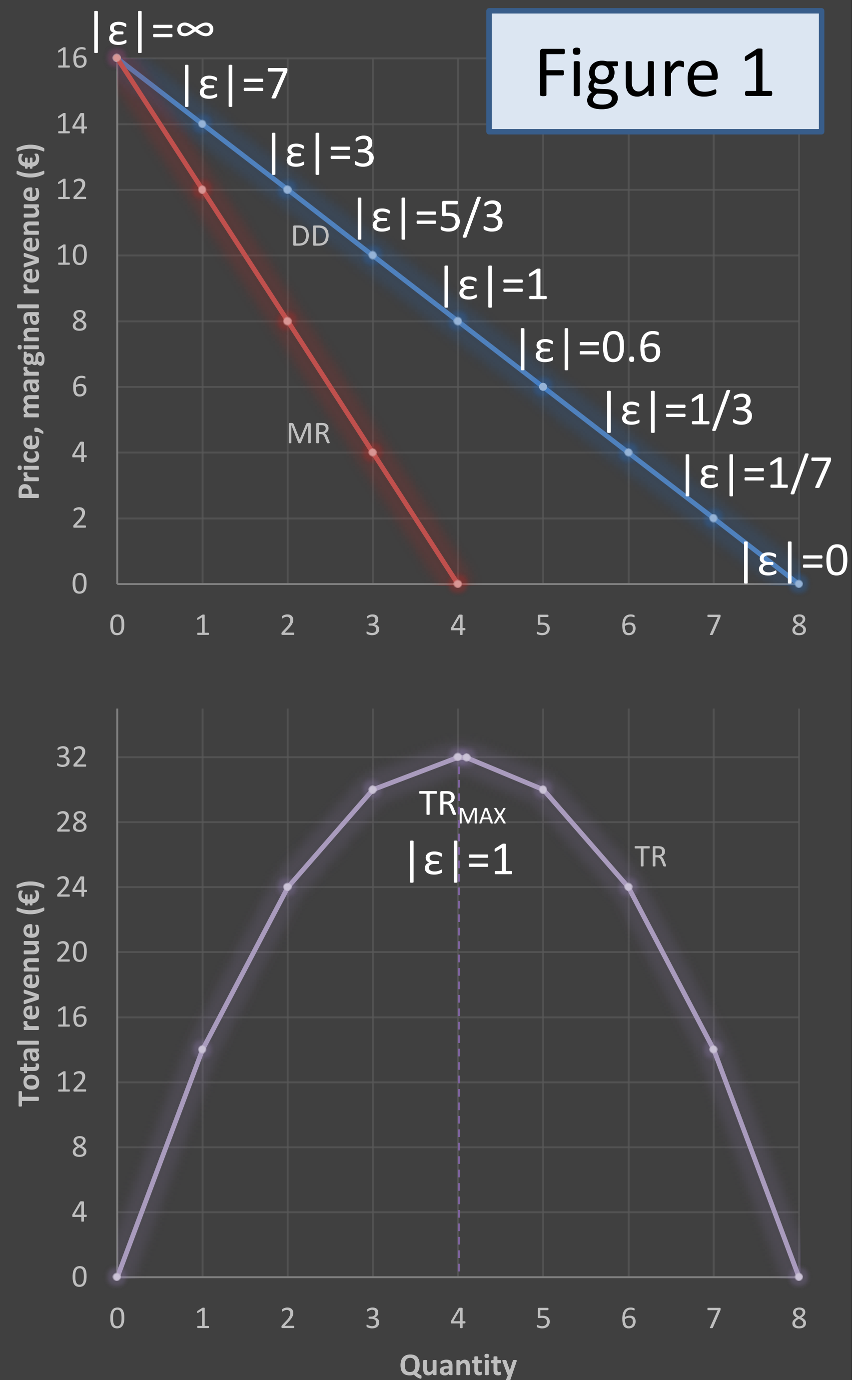
- In contrast, the monopolist's demand curve is the **industry demand curve**, which slopes down.
- Hence, MR is **less** than the price at which the extra output is sold.
- The monopolist knows that **extra output reduces revenue** from existing units. To sell more, the price on all units must be cut.



Demand, total revenue and marginal revenue

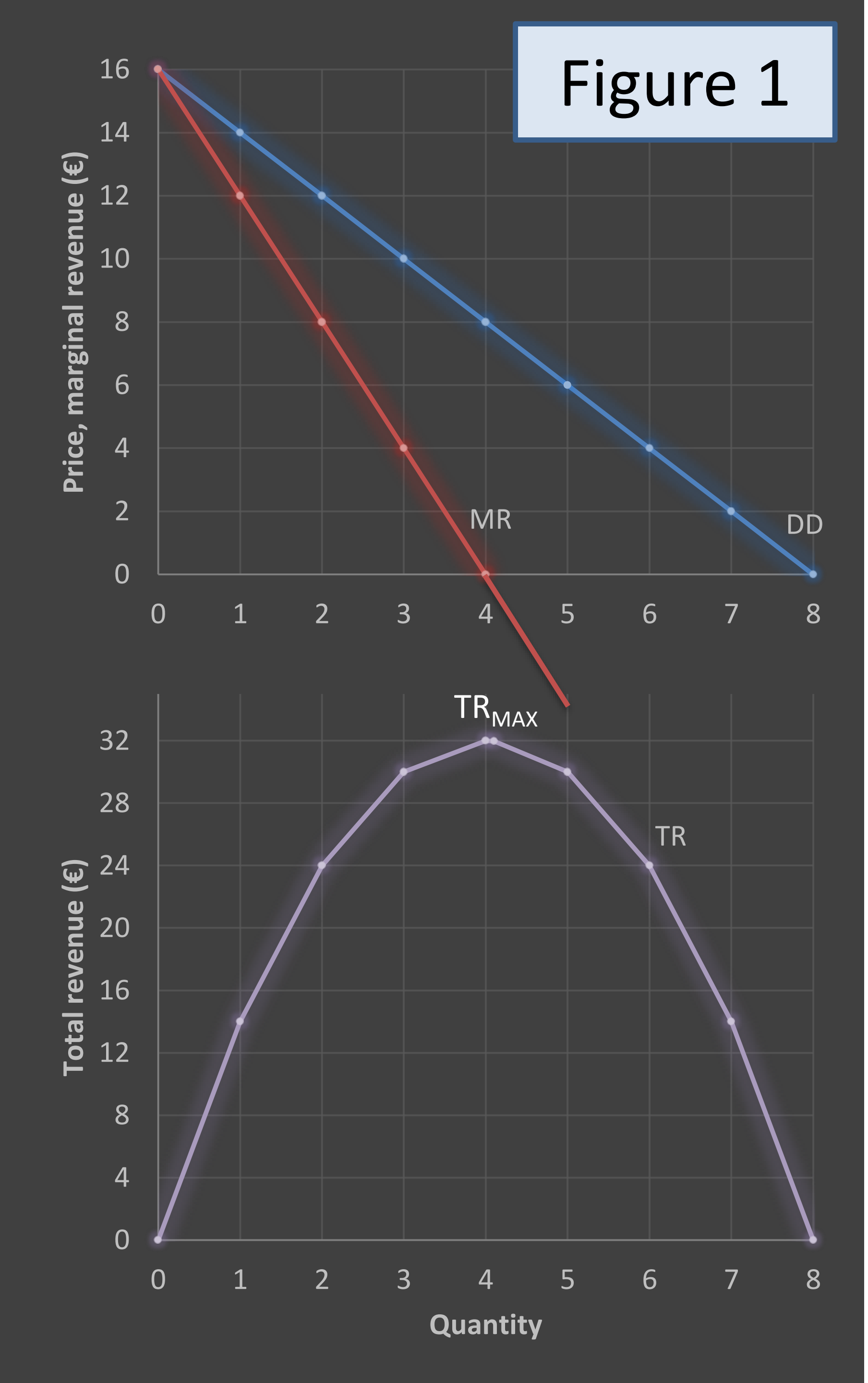


- Total revenue (TR) equals price times quantity. From the demand curve *DD* we can plot the *TR* curve at each quantity. Maximum *TR* occurs at €32, when 4 units are sold for €8 each.
- Marginal revenue (MR) shows how *TR* changes when quantity is increased a small amount. *MR* lies below the demand curve DD.
- From the price of the extra unit we must subtract the loss in revenue from existing units as the price is bid down.



Price, MR and TR

- The more inelastic the demand curve, the more an extra unit of output bids down the price, reducing revenue from existing units.
- At any output, MR is further below the demand curve the more inelastic is demand.
- Also, the larger the existing output, the larger the revenue loss from existing units when the price is reduced to sell another unit.
- For a given demand curve, MR falls increasingly below price the higher the output from which we begin.



Revenue and cost

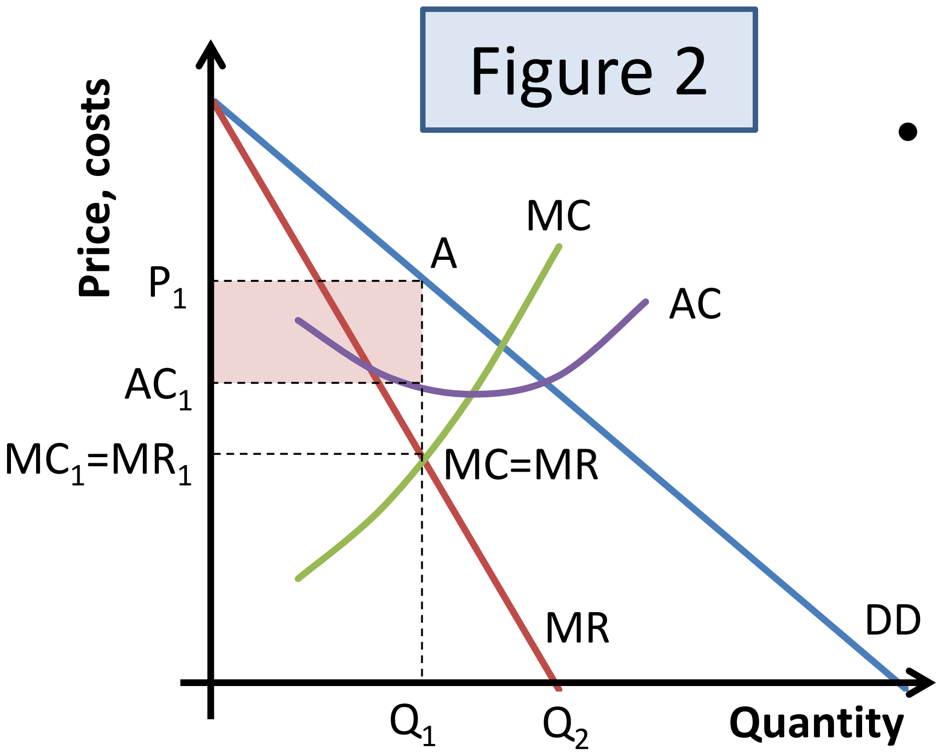
- Beyond a certain output (4 in figure 1), the revenue loss on existing output exceeds the revenue gain from the extra unit itself. Marginal revenue is negative. Further expansion reduces total revenue.
- On the cost side, with only one product, the cost curves of a single firm carry over directly. The monopolist has the usual cost curves, average and marginal, short-run and long-run.
- For simplicity, we discuss only the long-run curves in detail.

Profit-maximizing output

- Setting MR equal to MC leads to the profit-maximizing level of positive output. Then the monopolist must check, whether, at this output, the price (average revenue) covers average variable costs in the short run and average total costs in the long run. If not, the monopolist should shut down in the short run and leave the industry in the long run.

				Average condition			
	Marginal condition			**Short-run**		**Long-run**	
	MR>MC	MR=MC	MR<MC	P>SAVC	P<SAVC	P>LAC	P<LAC
Output decision	Raise	Optimal	Lower	Produce	Shut down	Stay	Exit

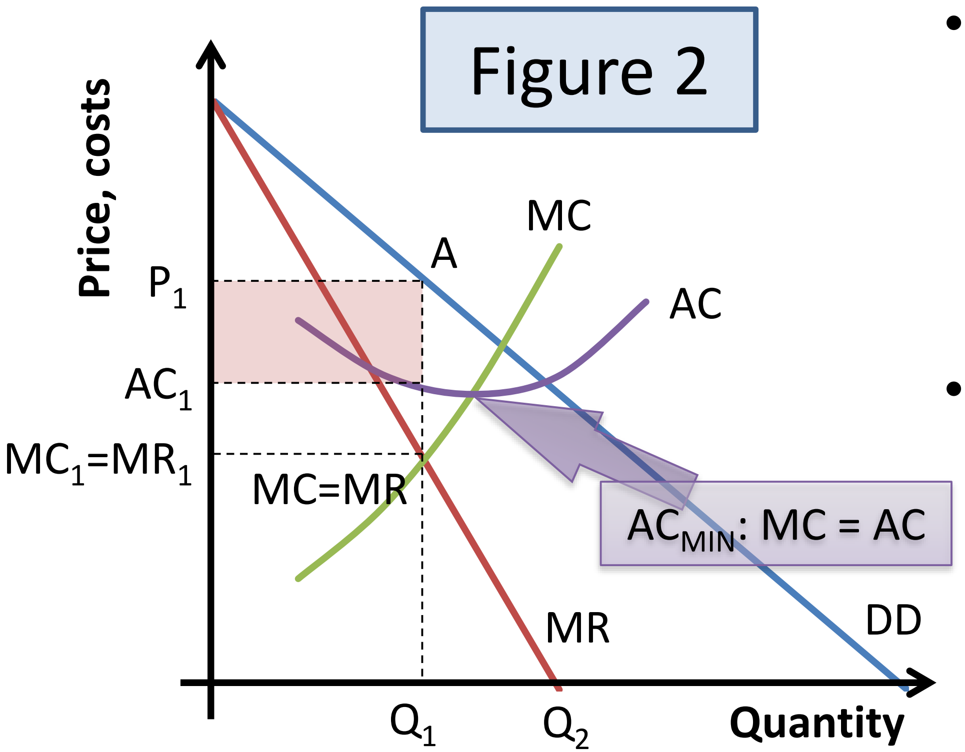
The monopoly equilibrium



- Applying the usual marginal condition, a profit-maximizing monopolist produces output level Q_1 at which marginal cost MC equals marginal revenue MR.

- Then it must check that price covers average cost. In this figure, Q_1 can be sold at price P_1 in excess of average costs AC_1. Monopoly profits are the shaded areas $(P_1 - AC_1) \times Q_1$.

The monopolist's profits



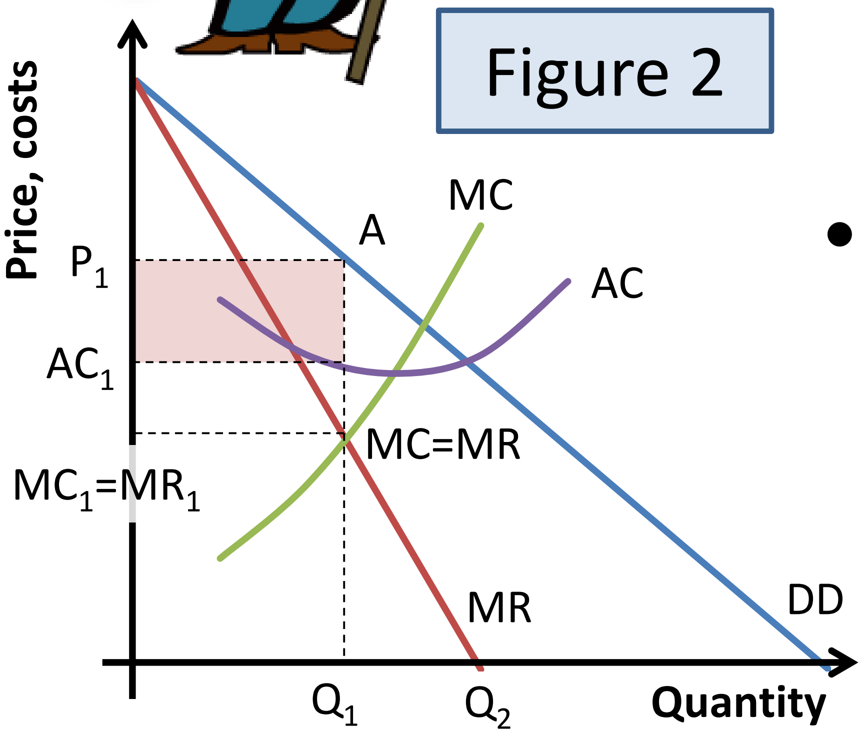
$$\pi(Q) = TR(Q) - TC(Q) =$$
$$= (P(Q) - AC(Q)) \times Q$$

- Figure 2 shows the average cost curve AC with its usual U-shape. The marginal cost curve MC goes through the lowest point on the AC curve.
- Marginal revenue MR lies below the down-sloping demand curve DD. Setting MR = MC, the monopolist chooses the output Q_1. To find the price for which Q_1 is sold we look at the demand curve DD.
- The monopolist sells output Q_1 at a price P_1. Profit per unit is $(P_1 - AC_1)$, and total profit is the shaded area $(P_1 - AC_1)\times Q_1$.

Supernormal (monopoly) profits

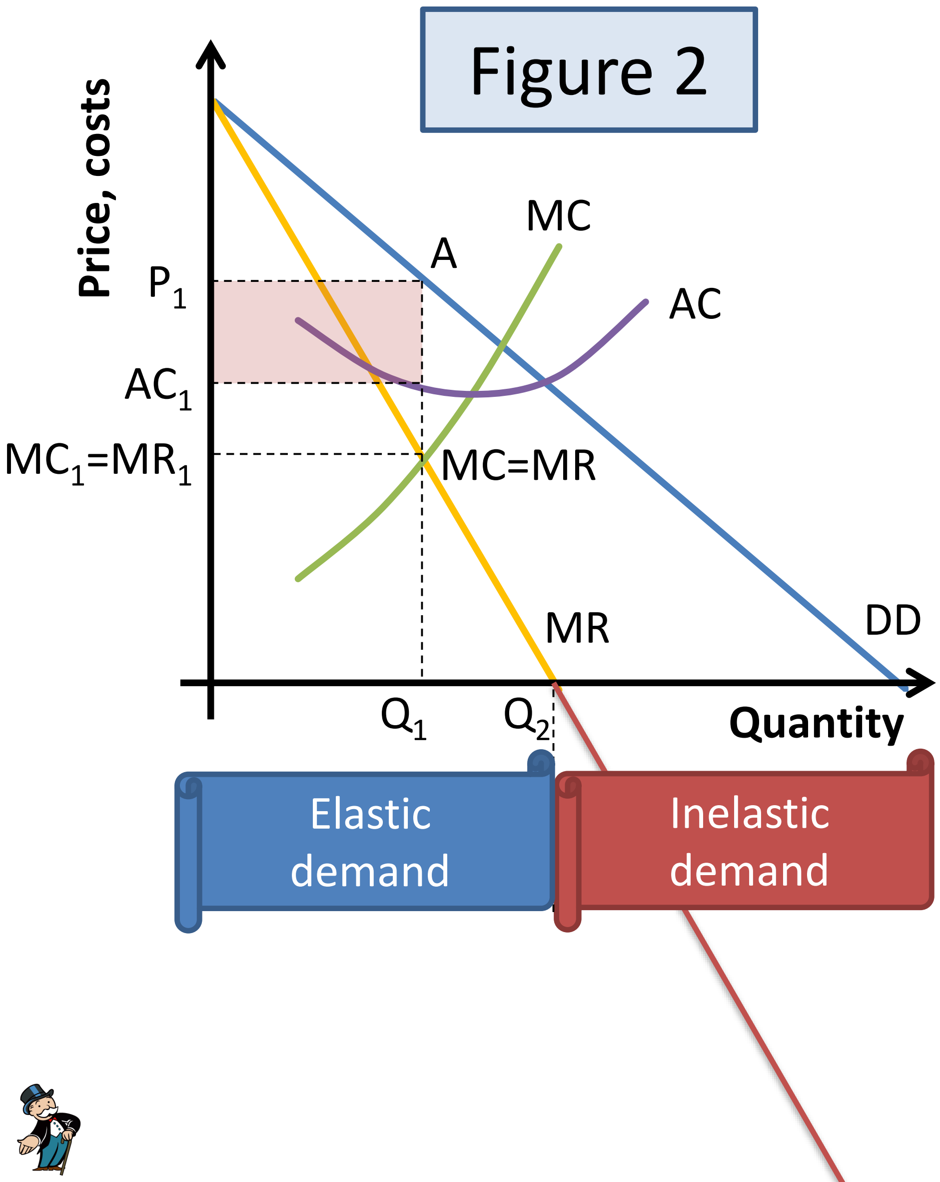
- Even in the long run, the monopolist makes *supernormal* profits, sometimes called *monopoly* profits.
- Unlike the competitive industry, supernormal profits of a monopolist are not eliminated by entry of more firms and a fall in the price.
- A monopoly has no fear of possible entry. By ruling out entry, we remove the mechanism by which supernormal profits disappear in the long run.

Price-setting



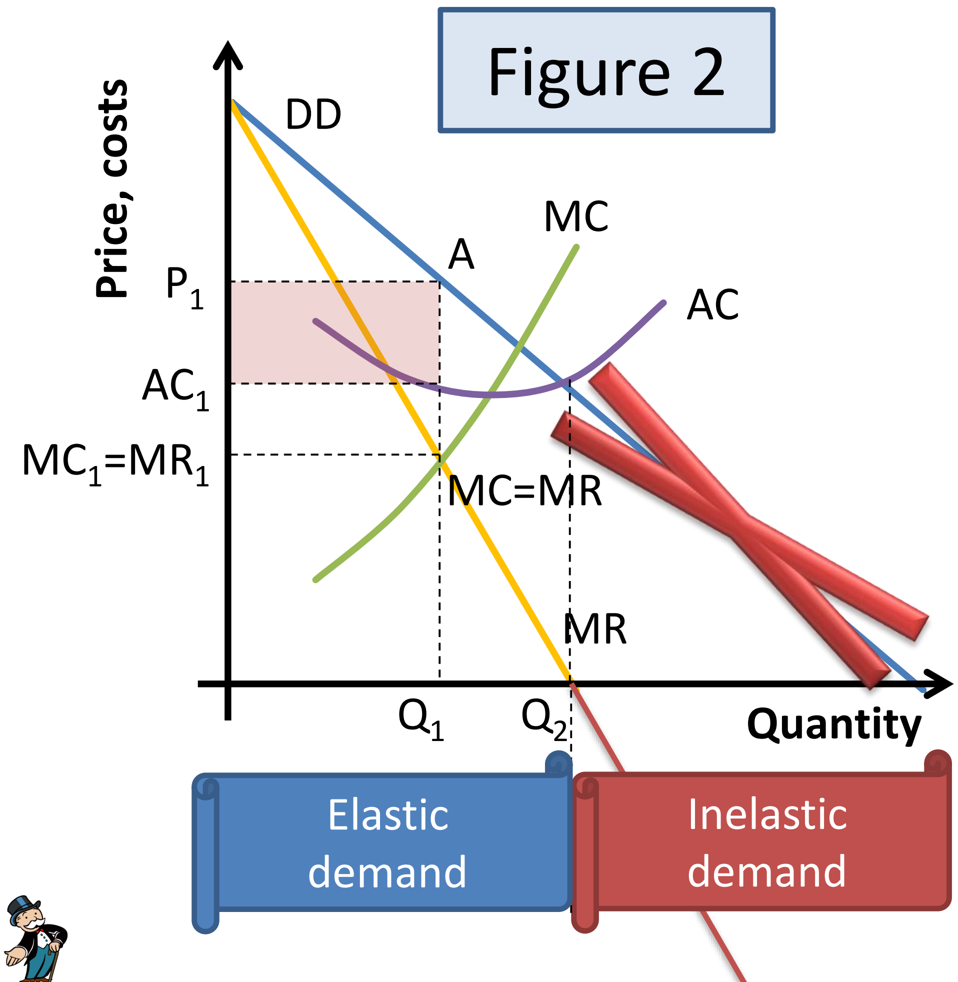
- Whereas a competitive firm is a *price-taker*, a monopolist sets prices and is a *price-setter*.
- Having decided to produce Q_1, in figure 2, the monopolist quotes a price P_1 knowing that customers will then demand the output Q_1.

Elasticity and marginal revenue



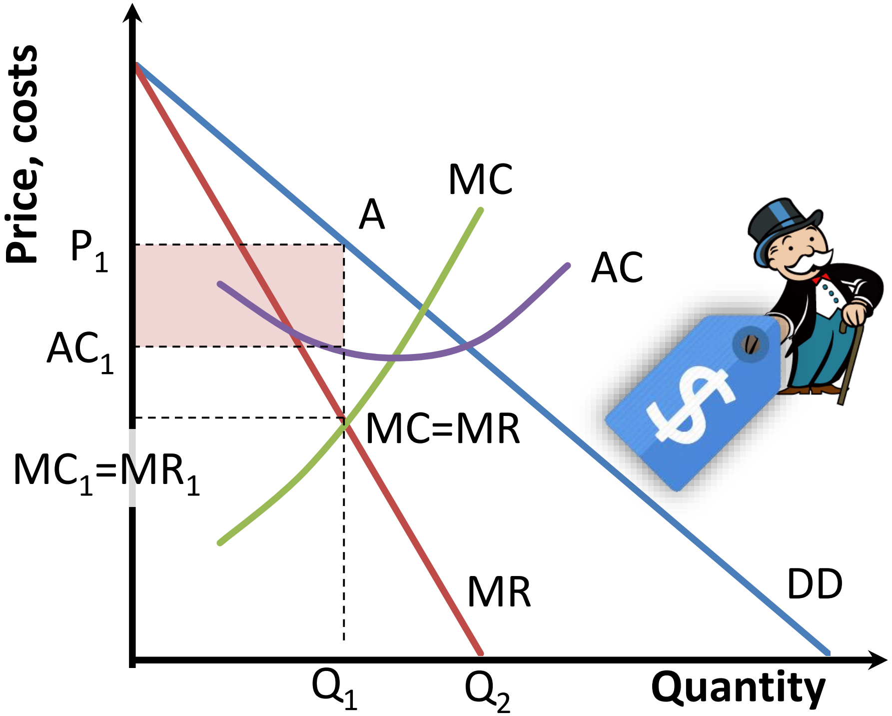
- When the elasticity of demand is between 0 and −1, demand is inelastic and a rise in output reduces total revenue. Marginal revenue is negative. In percentage terms, the fall in the price exceeds the rise in quantity.
- All outputs to the right of Q_2 in figure 2 have negative MR. The demand curve is inelastic at quantities above Q_2.
- At quantities below Q_2 the demand curve is elastic. Higher output leads to higher revenue. Marginal revenue is positive.

A monopolist never produces on the inelastic part of the demand curve

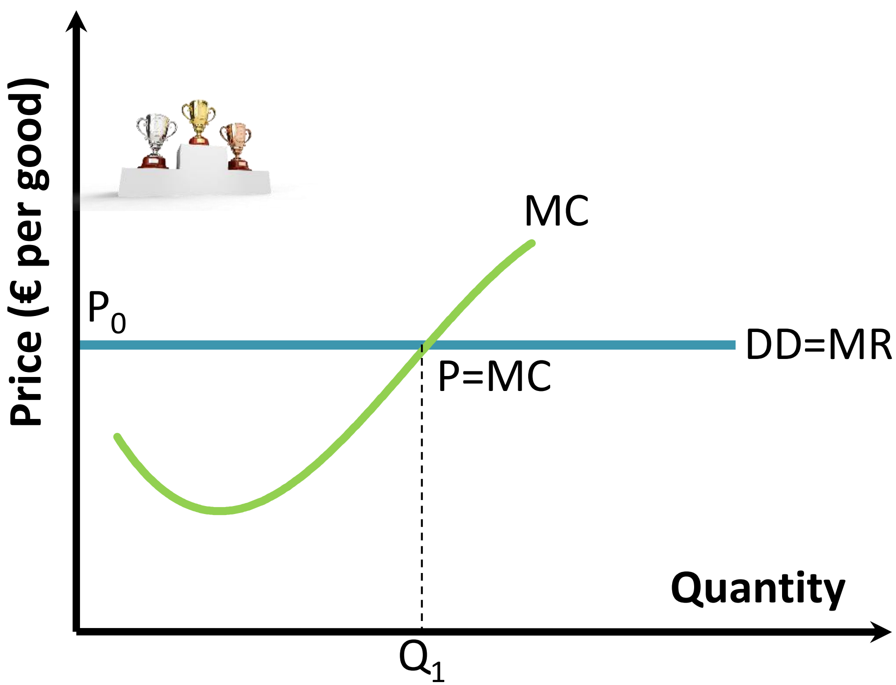


- The monopolist sets MC = MR.
- Since MC must be positive, so must MR.
- The chosen output must lie to the left of Q_2.
- **A monopolist never produces on the inelastic part of the demand curve**.

Prices and marginal costs



- At any output, price exceeds the monopolist's marginal revenue since the demand curve slopes down.
- Hence, in setting MR = MC the monopolist sets a price that exceeds marginal cost.
- In contrast, a competitive firm always equates price and marginal cost, since its price is also its marginal revenue.



$$LI = \frac{P - MC}{P} = \frac{1}{\varepsilon_d}$$

Monopoly power

- The excess of price over marginal cost is a measure of **monopoly power**.
- A competitive firm cannot raise the price above marginal cost and has no monopoly power.
- The more inelastic the demand curve of the monopolist, the more marginal revenue is below price, the greater is the excess of price over marginal cost, and the more monopoly power it has.

Comparative statics for a monopolist

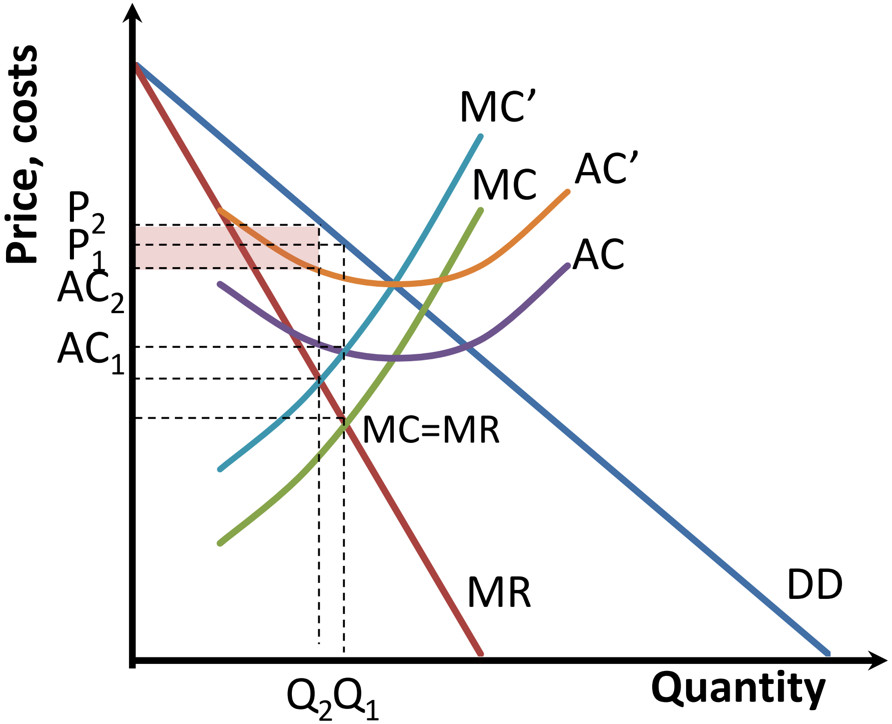


Figure 2 (variant)

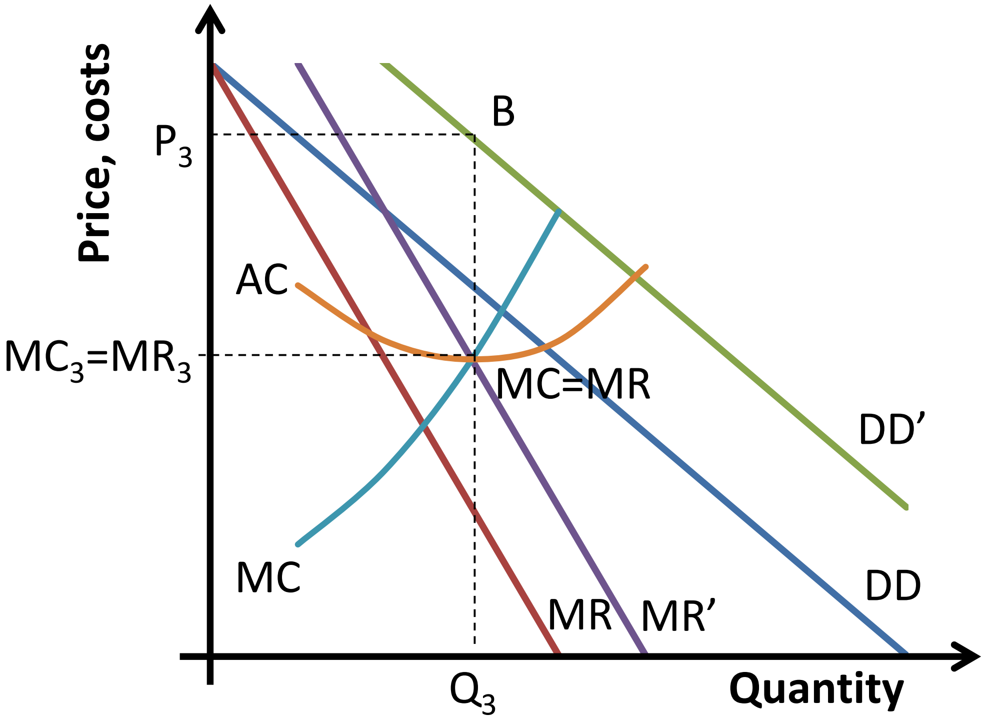
$$MC \uparrow \rightarrow Q \downarrow \rightarrow P \uparrow$$

- Figure 2 may also be used to analyse changes in costs or demand. Suppose a rise in costs shifts the *MC* and *AC* curves upwards.
- The higher *MC* curve must cross the *MR* curve at a lower output. If the monopolist can sell this output at a price that covers average costs, the effect of the cost increase must be to reduce output. Since the demand curve slopes down, lower output means a higher equilibrium price.

Effects of a change in demand

- Similarly, for the original cost curves in figure 2, suppose there is an outward shift in demand and marginal revenue curves.
- *MR* must now cross *MC* at a higher output.
- Thus a rise in demand leads the monopolist to increase output.

Figure 3

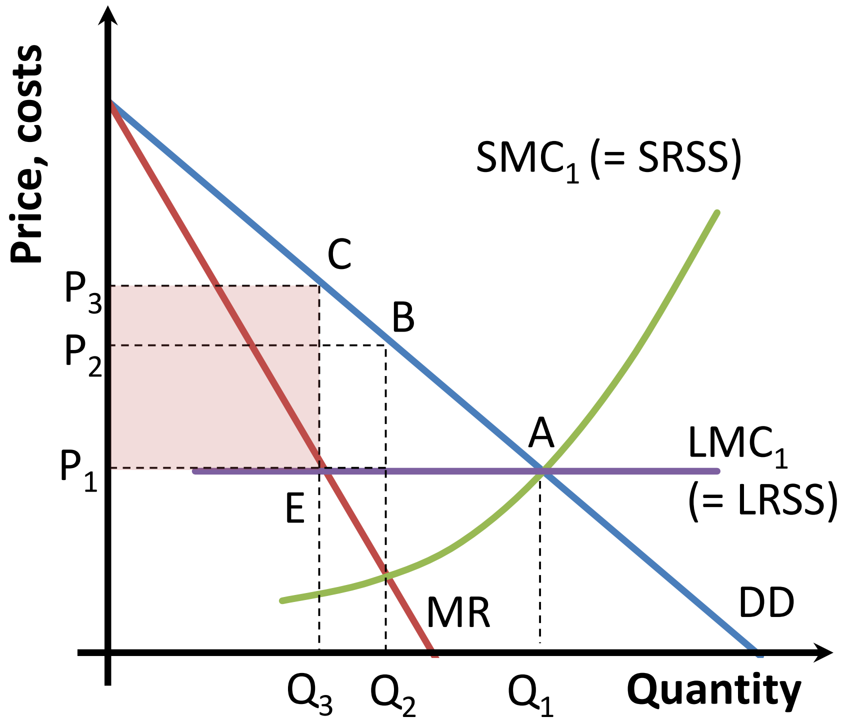


Comparing a perfectly competitive industry with a monopoly

- We now compare a perfectly competitive industry with a monopoly.
- For this comparison to be of interest the two industries must face the same demand and cost conditions. How would the same industry change if it were organized first as a competitive industry then as a monopoly?
- Can the same industry be both competitive and a monopoly? Only in some special cases.

A monopoly produces a lower output at a higher price

Figure 4



Long-run equilibrium in a competitive industry occurs at ***A***. Total output is Q_1 and the price P_1. A monopolist sets MR equal to SMC_1, restricting output to Q_2 and increasing the price to P_2.

In the long run, the monopolist sets MR equal to LMC_1, reducing output to Q_3 and increasing the price again to P_3. There are no entrants to compete away supernormal profits P_3CEP_1 by increasing the industry output.

Comparing a competitive industry and a multi-plant monopolist

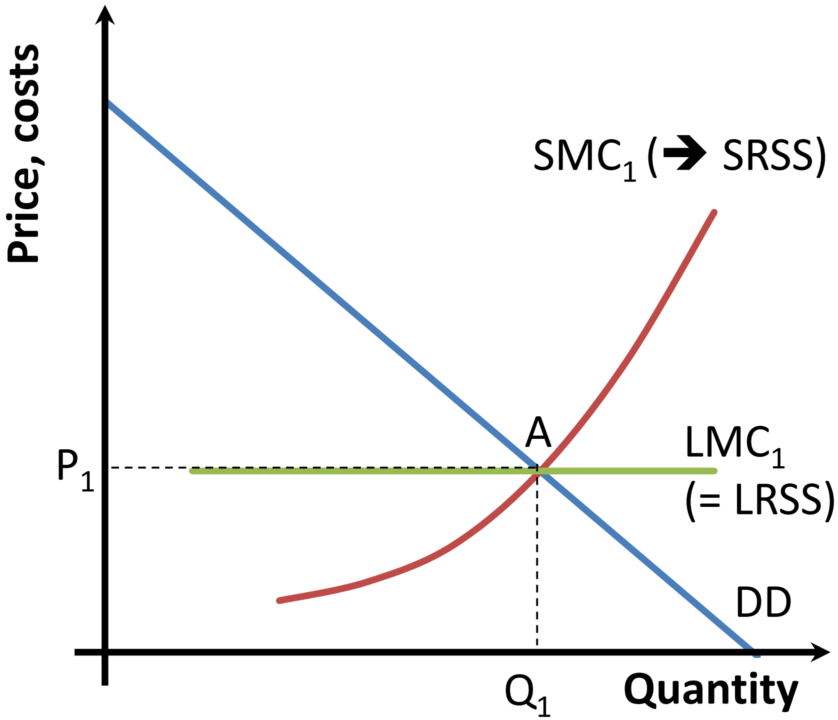
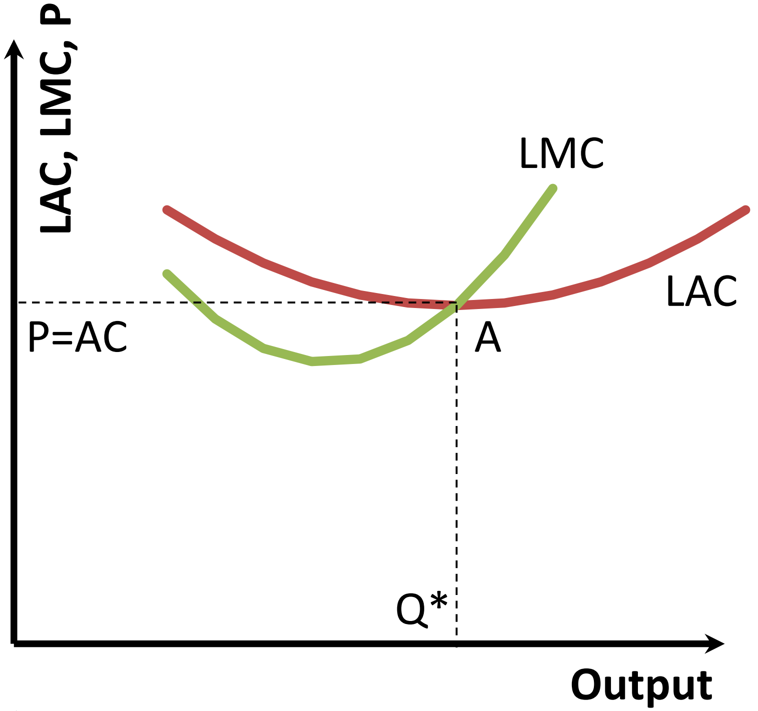
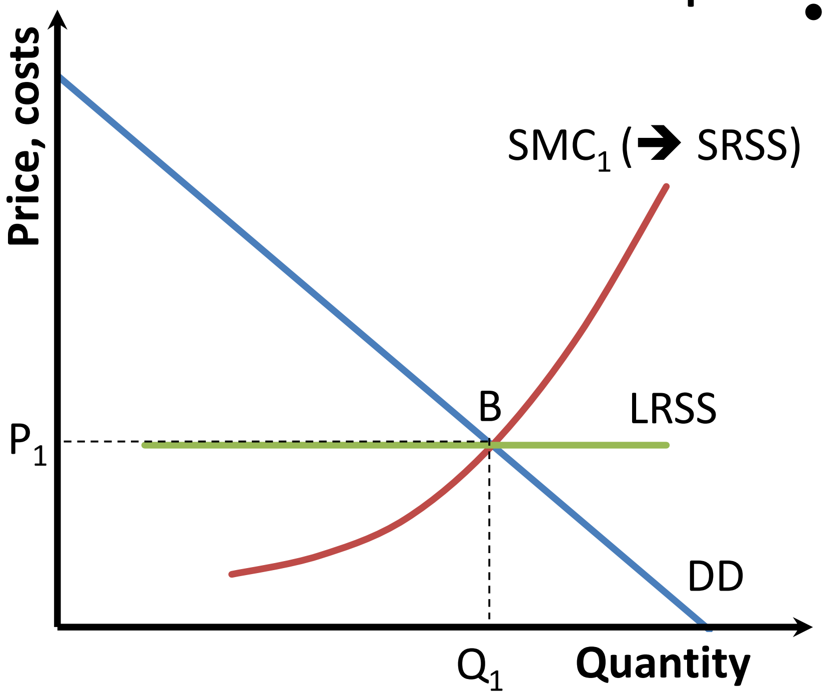


Figure 4

- Consider a competitive industry in which all firms and potential entrants have the same cost curves. The horizontal *LRSS* curve for this competitive industry is shown in figure 4.
- Facing the demand curve *DD*, the industry is in long-run equilibrium at ***A*** at a price P_1 and total output Q_1. The industry *LRSS* curve is horizontal at P_1, the lowest point on the *LAC* curve of each firm.
- Any other price leads eventually to infinite entry or exit from the industry. *LRSS* is the industry's long-run marginal cost curve LMC_1 of expanding output by enticing new firms into the industry.

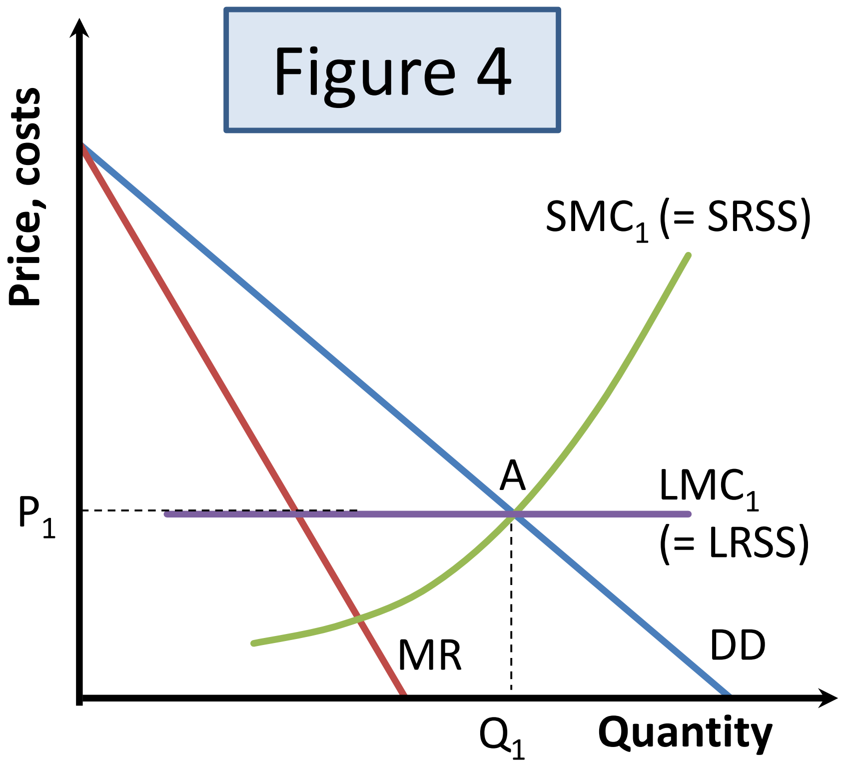
Benchmark: a competitive industry





- In the long run each firm produces at the lowest point on its *LAC* curve, breaking even. Marginal cost curves pass through the point of minimum average costs. Hence, each firm is also on its *SMC* and *LMC* curves.
- Horizontally adding the SMC curves of each firm we get *SRSS*, the short-run industry supply curve. This is the industry's short-run marginal cost curve SMC_1 of expanding output from existing firms with temporarily fixed factors. Since *SRSS* crosses the demand curve at P_1, the industry is both in short-run and long-run equilibrium.

A monopolist takes over…



$$Q \uparrow \rightarrow P \downarrow$$

- Beginning from this position, the competitive industry becomes a monopoly. The monopolist takes over each plant (firm) but makes central pricing and output decisions.
- Overnight, the monopolist still has the same number of factories (ex-firms) as in the competitive industry. Since the firm and the industry now coincide, SMC_1 remains the short-run marginal cost curve for the monopolist taking all plants together.
- However, the monopolist knows that higher total output bids down the price.

The monopolist raises prices and reduces quantity

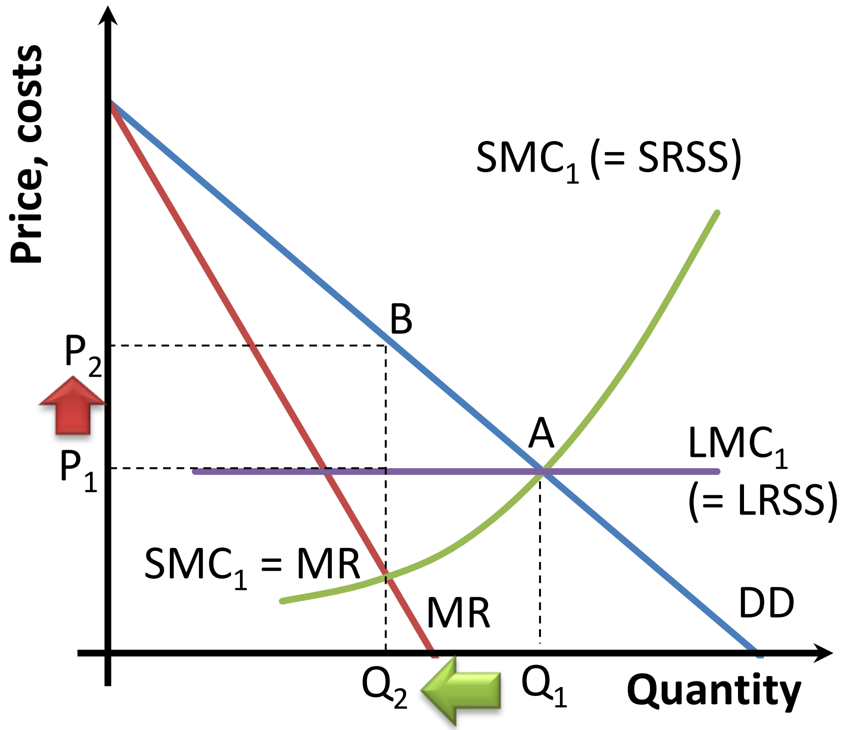


Figure 4

- In the short run the monopolist equates *SMC_1* and *MR*, reaching equilibrium at ***B***.
- Output is Q_2 and the price P_2.
- Relative to competitive equilibrium at ***A***, *the monopolist raises prices and reduces quantity*.

The monopolist's behaviour in the long run

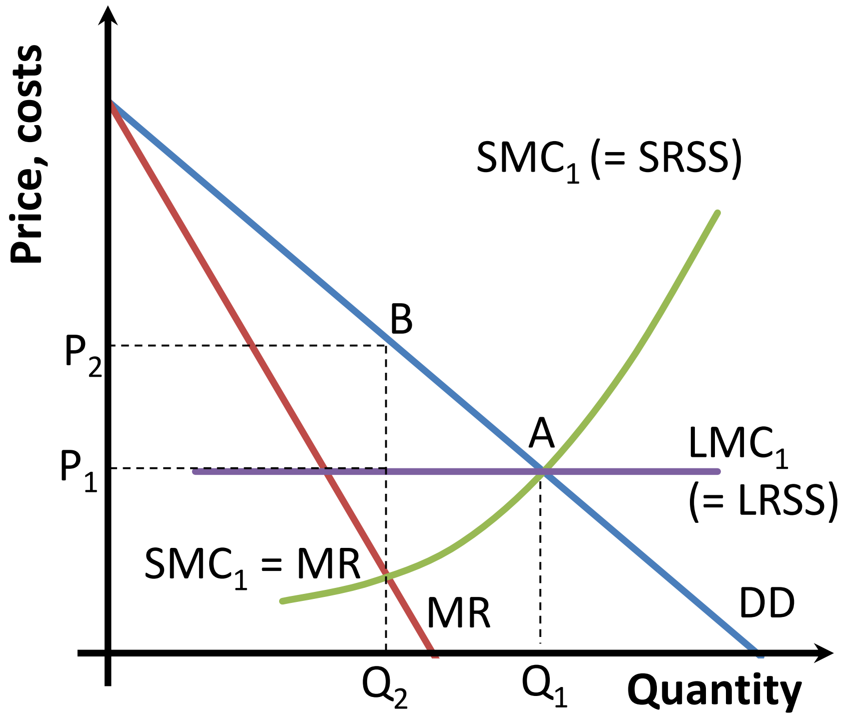
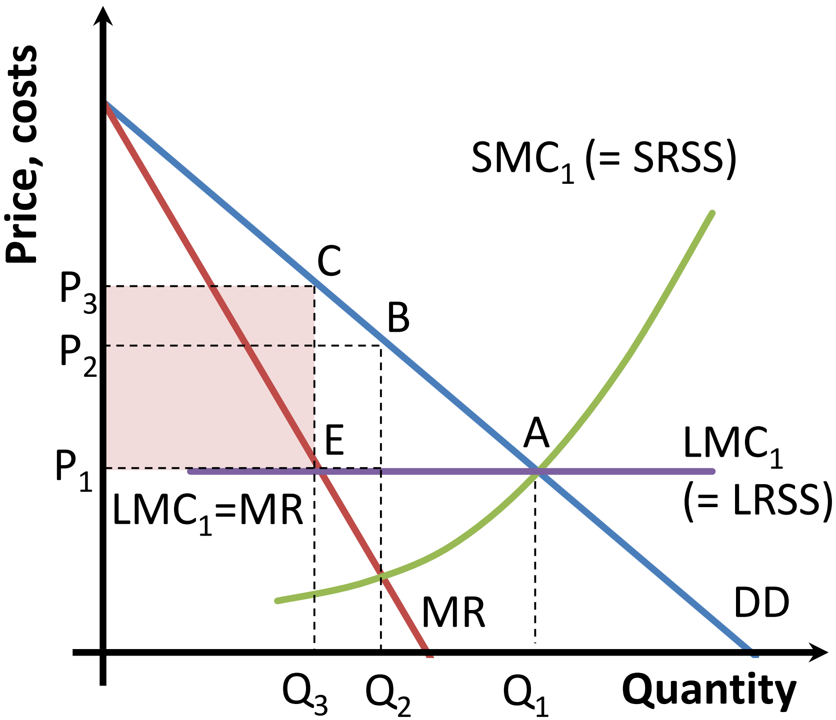
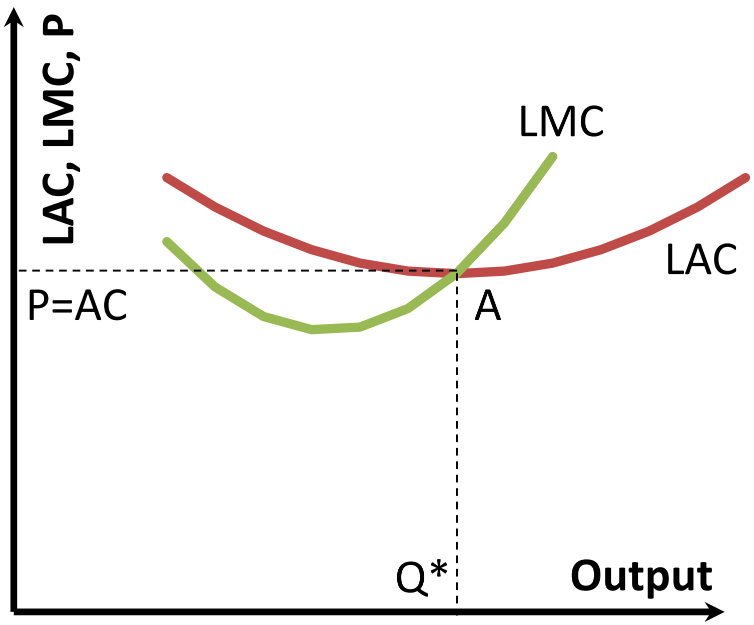


Figure 4

- In the long run, the monopolist can set up new factories ('enter') or close down existing factories ('exit').
- Whether making short-run profits or losses at ***B*** (we need to draw the *SATC* to see which), a monopolist will now 'exit' or retire some factories from the industry in the long run.

A further price rise



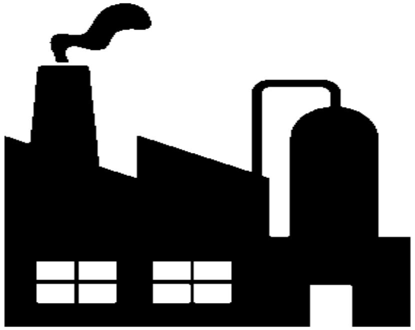


- The monopolist cuts back output to force up the price. In the long run it makes sense to operate each factory at the lowest point on its *LAC* curve. To reduce total output some factories are closed.
- In the long run, the monopolist sets $LMC_1 = MR$ and reaches equilibrium at ***C***. Price has risen yet further to P_3 and output has fallen to Q_3.
- Long-run profits are given by the area P_3CEP_1 since P_1 remains long-run average cost when all plants are at the lowest point of their *LAC* curve.

Absence of entry

- Because *MR* is less than price, a monopolist produces less than a competitive industry and charges a higher price.
- However, in this example, they would have to rely on a legal prohibition on entry by competitors that allows the monopolist to succeed in the long run.
- Otherwise, with identical cost curves, other firms would set up in competition, expand industry output, and compete away these supernormal profits. Absence of entry is intrinsic to the model of monopoly.

A single-plant monopolist



- Instead of a multi-plant monopolist taking over many previously competitive firms, consider a monopolist meeting the entire industry demand from a single plant.

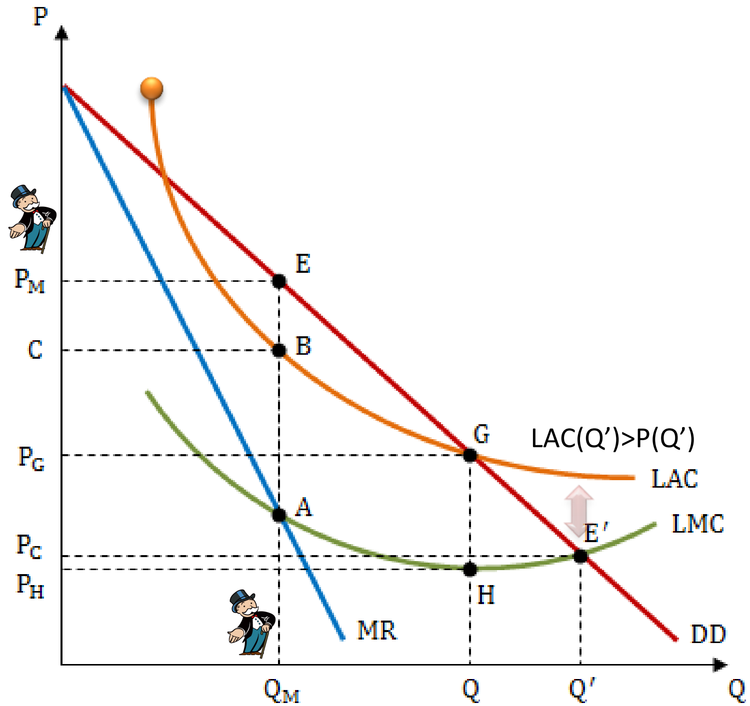
- This is most plausible when scale economies are big. There are huge costs in setting up a national telephone network. Yet the cost of connecting a marginal subscriber is low once the network has been set up.

Natural monopolies

- Monopolies enjoying huge economies of scale – falling LAC curves over the entire range of output – are **natural monopolies**.
- Large-scale economies may explain why there is a sole supplier without fear of entry by others.
- Smaller entrants would be at a prohibitive cost disadvantage.

Figure 5

A natural monopoly with economies of scale



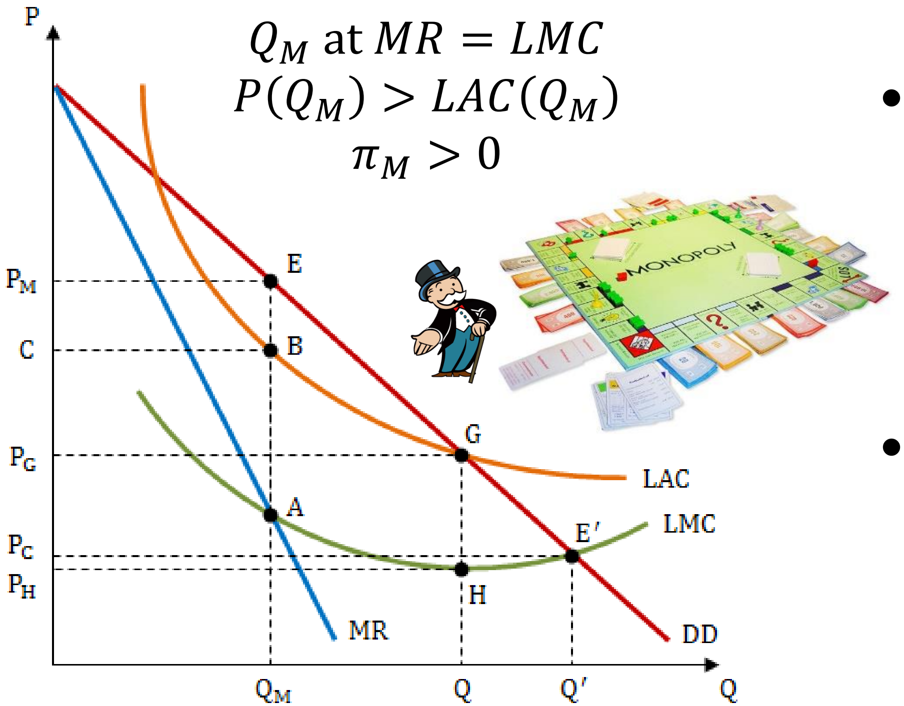
The LAC curve is falling throughout the relevant range of output levels.

Economies of scale are large relative to the market size. The monopoly produces Q_M at price P_M and makes profits.

If it tried to behave like a price taking competitive firm, it would produce at E' where price equals LMC and make losses.

By recognizing the effect of output on price the single firm monopoly can do much better. This industry cannot support a lot of small firms. Each would have very high average costs at low output. This cannot be a competitive industry.

Example of a natural monopoly



- Figure 5 illustrates a natural monopoly. In the long run it faces average and marginal cost curves *LAC* and *LMC*.
- Given the position of the demand curve (*DD*), *LAC* is declining over the entire range of outputs that might be sold.
- The monopoly produces at *LMC* equal to *MR*, selling output Q_M for a price P_M. At this output, price exceeds *LAC*. The monopoly makes supernormal profits and is happy to remain in business.

- It makes no sense to compare this equilibrium with how the industry would behave if it were competitive. With such economies of scale there is only one firm in the industry.
- LAC is the cost curve for each possible firm. If a lot of small firms each produced a small fraction of total output, their average costs would be huge. By expanding, a single firm could undercut them and wipe them out.
- This industry must have a sole supplier. This natural monopoly will maximize profits only by recognizing that its marginal revenue is not its price.

A discriminating monopolist

- A **discriminating monopolist** charges different prices to different customers.
- To equate the marginal revenue from different groups, groups with an inelastic demand must pay a higher price.
- Successful price discrimination requires that customers cannot trade the product among themselves.

Monopoly and technical change

- Monopolies may have more internal resources available for research and may have a higher incentive for cost-saving research because the profits from technical advances will not be eroded by entry.
- Although small firms do not undertake much expensive research, it appears that the **patent laws** provide adequate incentives for medium- and larger-sized firms. There is no evidence that an industry has to be a monopoly to undertake cost-saving research.


Thank you

Exercises for Topics 7-9

Micro- and macroeconomics

Extra Exercises: Costs and Supply

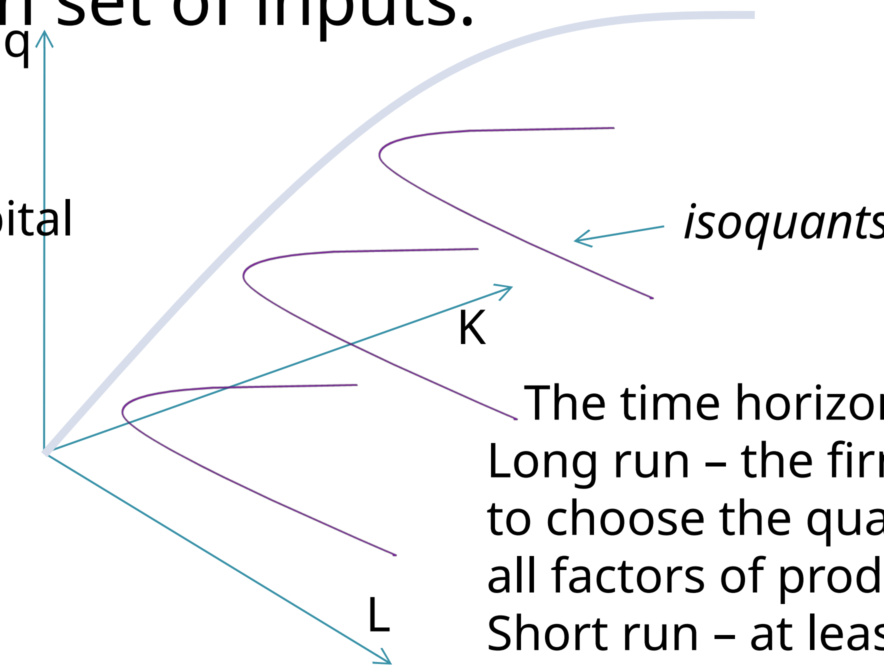
Micro- and Macroeconomics
(BMEGT30A001, BMEGT30A410)

Reminder

The production function

- The production function ($Q = f(x_1, x_2, \ldots)$) shows how many goods or services a firm can produce utilizing its resources (factors of production) – the maximum output possible from a given set of inputs.

In our examples
K – Capital [← das Kapital (German)]
L – Labour
q – Quantity of output



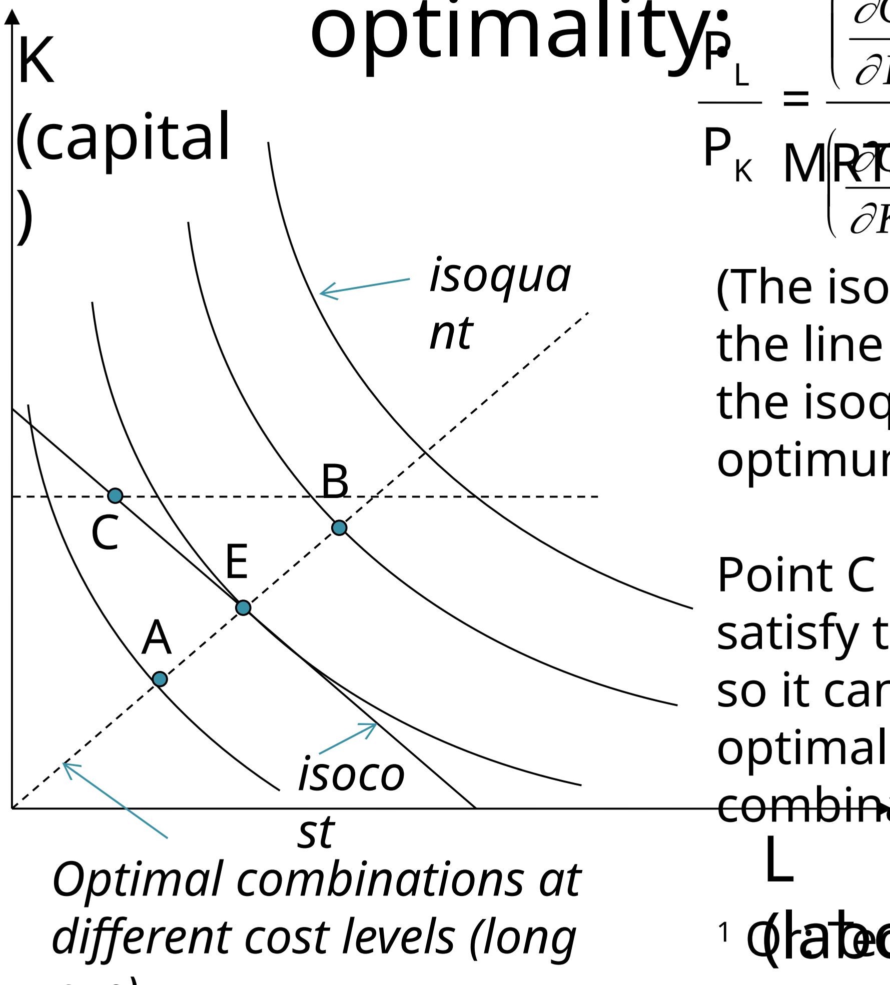
The time horizon:
Long run – the firm is free to choose the quantity of all factors of production
Short run – at least one of these factors is fixed

The optimal combination of inputs

A necessary condition for optimality:

$$\frac{P_L}{P_K} = \frac{\left(\frac{\partial Q}{\partial L}\right)}{\left(\frac{\partial Q}{\partial K}\right)} = |\text{MRTS}^{\dagger}|$$

In the long run



Fixed capital in the short run

Optimal combinations at different cost levels (long run)

(The isocost line is the line tangent to the isoquant at the optimum point)

Point C does not satisfy this condition so it cannot be the optimal (long-run) combination.

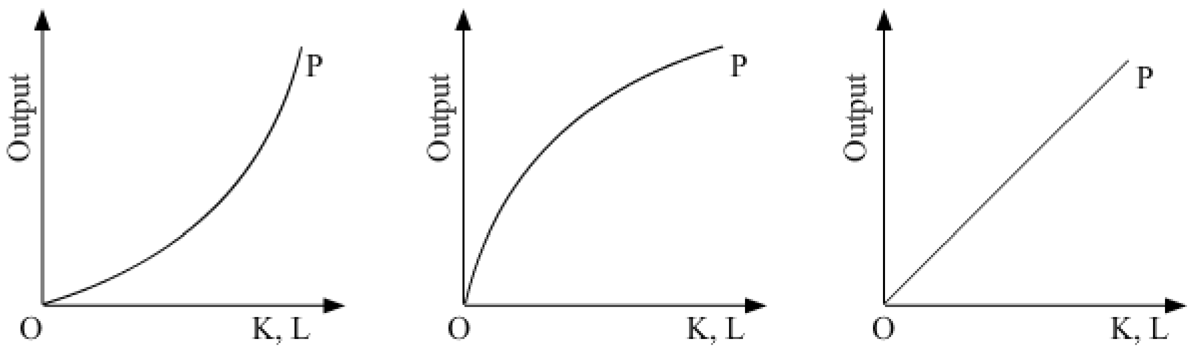
†MRTS: the Marginal Rate of Technical Substitution

The optimum point is at „E"

[1] Or: Technical Rate of Substitution (TRS)

Returns to scale

Reminder



(a) Increasing Returns to Scale

(b) Decreasing Returns to Scale

(c) Constant Returns to Scale

Increasing returns to scale mean that one (big) company can produce more efficiently than more than one (smaller) firms utilizing the same factors of production → emergence of natural monopolies

Formally, „returns to scale", refers to changes in output (quantity, q) resulting from a proportional change (λ) in all inputs:

a) If output increases by more than that proportional change, there are increasing returns to scale (economies of scale):
   e.g. $Q = KL \quad Q(\lambda K, \lambda L) = (\lambda K)(\lambda L) = \lambda^2 Q(K, L)$

b) If output increases by less than that proportional change, there are decreasing returns to scale:
   e.g. $Q = \sqrt[3]{KL} \quad Q(\lambda K, \lambda L) = \sqrt[3]{(\lambda K)(\lambda L)} = \lambda^{2/3} Q(K, L)$

c) If output increases by that same proportional change, there are constant returns to scale:
   e.g. $Q = \sqrt{KL} \quad Q(\lambda K, \lambda L) = \sqrt{(\lambda K)(\lambda L)} = \lambda Q(K, L)$

A few useful formulae

$$Q = Q(K, L)$$

Production function

$$TC = FC + VC = p_K \cdot K + p_L \cdot L \qquad K = -\frac{p_L}{p_K} \cdot L + \frac{TC}{p_K}$$

Isocost eq.

$$AP_L = \frac{Q}{L}; \quad MP_L = \frac{\partial Q}{\partial L}$$

$$AP_K = \frac{Q}{K}; \quad MP_K = \frac{\partial Q}{\partial K}$$

Average and marginal products

$$MRTS = \frac{dK}{dL} = -\frac{MP_L}{MP_K} = \left[-\frac{p_L}{p_K}\right]$$

Optimum input combination

$$AC = \frac{TC}{Q}; \quad AVC = \frac{VC}{Q}; \quad AFC = \frac{FC}{Q}; \quad MC = \frac{dTC}{dQ} = \frac{dVC}{dQ}$$

Cost functions

$$TR = P \cdot Q; \quad AR = \frac{TR(Q)}{Q}; \quad MR = \frac{dTR(Q)}{dQ}$$

Revenue functions

Exercise 1

Our production function:

$q = F(K, L) = \sqrt{K_0 L}$, where $K_0 = 16$.

The input prices are $p_K = 10$ & $p_L = 40$.

a) Determine the short-run total cost function!

b) Determine the marginal product of labour and capital!

c) Determine the long-run total cost function!

Exercise 1a

Our production function:

$q = F(K, L) = \sqrt{K_0 L}$, where $K_0 = 16$.

The input prices are $p_K = 10$ & $p_L = 40$.

Which depends on the desired output volume

a) Determine the short-run total cost function!

General form of the total cost function:

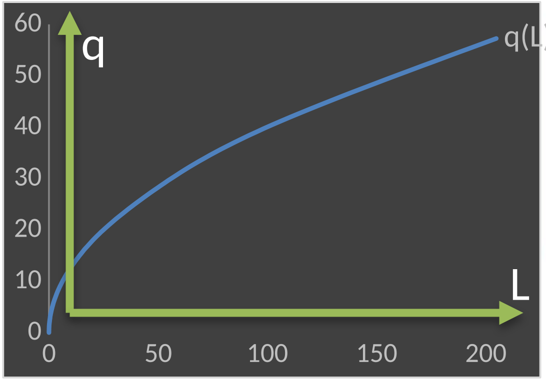
$$TC = p_K K + p_L L$$

With our initial values: SFC

$$TC = 10 \times 16 + 40L = 160 + 40L$$

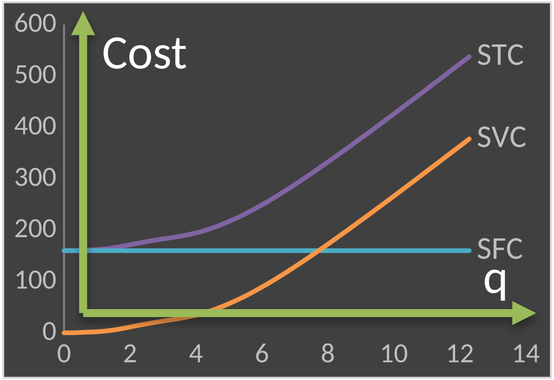
The short-run variable costs are driven by the number of workers.

Exercise 1a$^{\text{cont.}}$



Our production function in the short run:

$$q_S = F(K_0, L) = \sqrt{K_0 L} = \sqrt{16L} = 4\sqrt{L}$$



We should express *L* as a function of *q*:

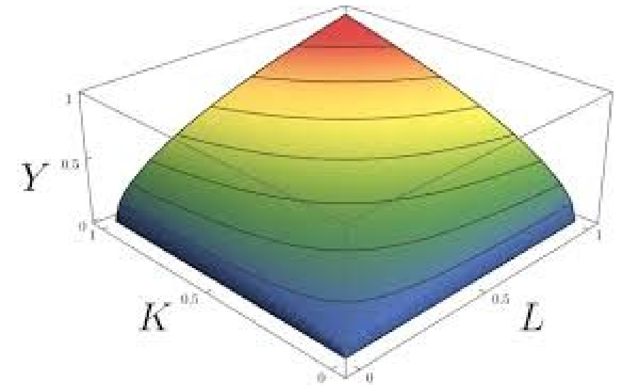
$$\sqrt{L} = q_S/4$$

$$L = q^2/16$$

Substitute this *L*(*q*) function into the total cost function:

$$TC = 160 + 40L = 160 + \frac{40q^2}{16} = 2.5q^2 + 160$$

Exercise 1b



Our production function:

$q = F(K, L) = \sqrt{KL}$

The input prices are $p_K = 10$ & $p_L = 40$.

b) Determine the marginal product of labour and capital!

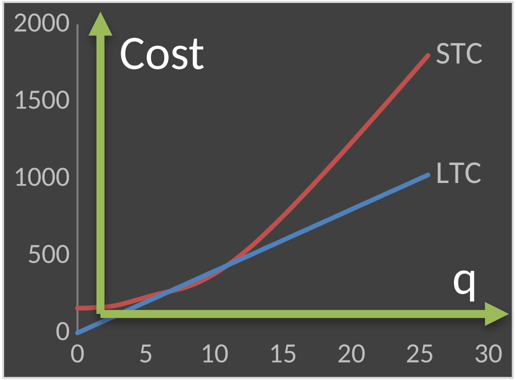
The marginal products are:

$$F_L = MP_L = \frac{\partial q}{\partial L} = \frac{\sqrt{K}}{2\sqrt{L}} \qquad F_K = MP_K = \frac{\partial q}{\partial K} = \frac{\sqrt{L}}{2\sqrt{K}}$$

$q = F(K,L) = \sqrt{KL} \quad p_K = 10, p_L = 40$

$MP_L = \frac{\sqrt{K}}{2\sqrt{L}} \quad MP_K = \frac{\sqrt{L}}{2\sqrt{K}}$

Exercise 1c



c) Determine the long-run total cost function!

$$|MRTS| = \frac{MP_L}{MP_K} = \frac{K}{L} = \frac{p_L}{p_K} = \frac{40}{10} = 4 \Rightarrow K = 4L$$

Substitute this *K*(*L*) function into the production function:

$$q = F(K,L) = \sqrt{4L \times L} = 2L$$

The required number of workers (as a function of *q*): $L = q/2$

The required number of machines (*K*(*q*)): $K = 4L = 2q$

Finally, we can express the total cost as a function of *q*:

$$TC(q) = p_K K + p_L L = 10 \times 2q + 40 \times \frac{q}{2} = 20q + 20q = 40q$$

Exercise 2

Our production function (Sato's production function) is

$$q = \mathrm{F(K, L)} = \frac{K^2L^2}{K^3+L^3}$$

Does this function exhibit increasing, decreasing or constant returns to scale?

$$\mathrm{F(\lambda K, \lambda L)} = \frac{\lambda^2 K^2 \lambda^2 L^2}{\lambda^3 K^3 + \lambda^3 L^3} = \frac{\lambda^4}{\lambda^3} \frac{K^2 L^2}{K^3 + L^3} = \lambda q$$

Constant returns to scale.

Exercise 3

Our production function is:

$q = F(K, L) = \sqrt{KL}$.

The input prices are $p_K = 10$ & $p_L = 250$.

Determine the minimum (long-run) cost of producing $\hat{q} = 1000$ units of the output!

Exercise 3 (solution)

Our production function is: $q = F(K, L) = \sqrt{KL}$. The input prices are $p_K = 10$ & $p_L = 250$. Determine the minimum (long-run) cost of producing $\hat{q} = 1000$ units of the output!

$$F_L = MP_L = \frac{\partial q}{\partial L} = \frac{\sqrt{K}}{2\sqrt{L}}$$

$$F_K = MP_K = \frac{\partial q}{\partial K} = \frac{\sqrt{L}}{2\sqrt{K}}$$

$$|MRTS| = \frac{MP_L}{MP_K} = \frac{K}{L} = \frac{p_L}{p_K} = \frac{250}{10} = 25$$

Exercise 3 (solution, cont.)

$$|MRTS| = \frac{MP_L}{MP_K} = \frac{K}{L} = \frac{p_L}{p_K} = \frac{250}{10} = 25 \Rightarrow K = 25L$$

Substitute this ratio into the production function:

$$q = F(K,L) = \sqrt{25L \times L} = 5L$$

The required number of workers (as a function of q): $L = q/5$

The required number of machines ($K(q)$): $K = 25L = 5q$

Use these values to determine the total cost function $TC(q)$:

$$TC(q) = p_K K + p_L L = 10 \times 5q + 250 \times \frac{q}{5} = 100q$$

The cost of producing 1000 units of the output:

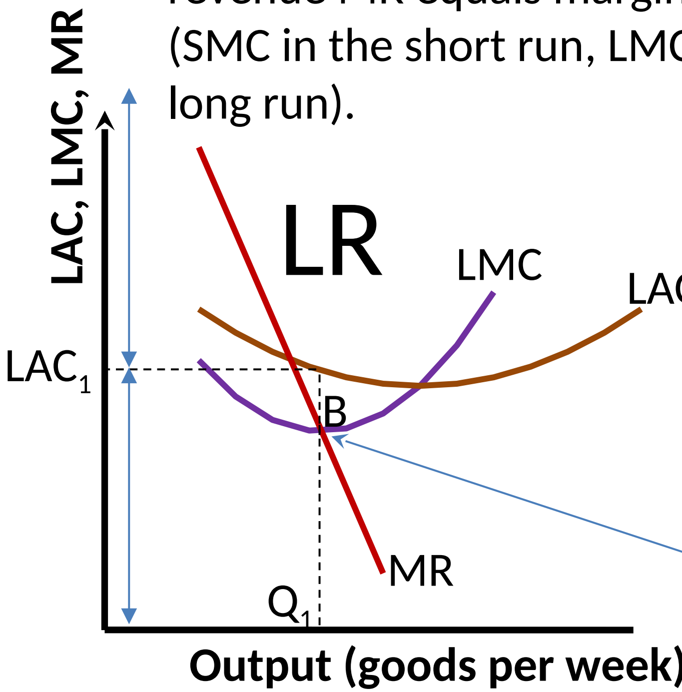
$$\mathrm{TC}(\hat{q} = 1000) = 100{,}000$$

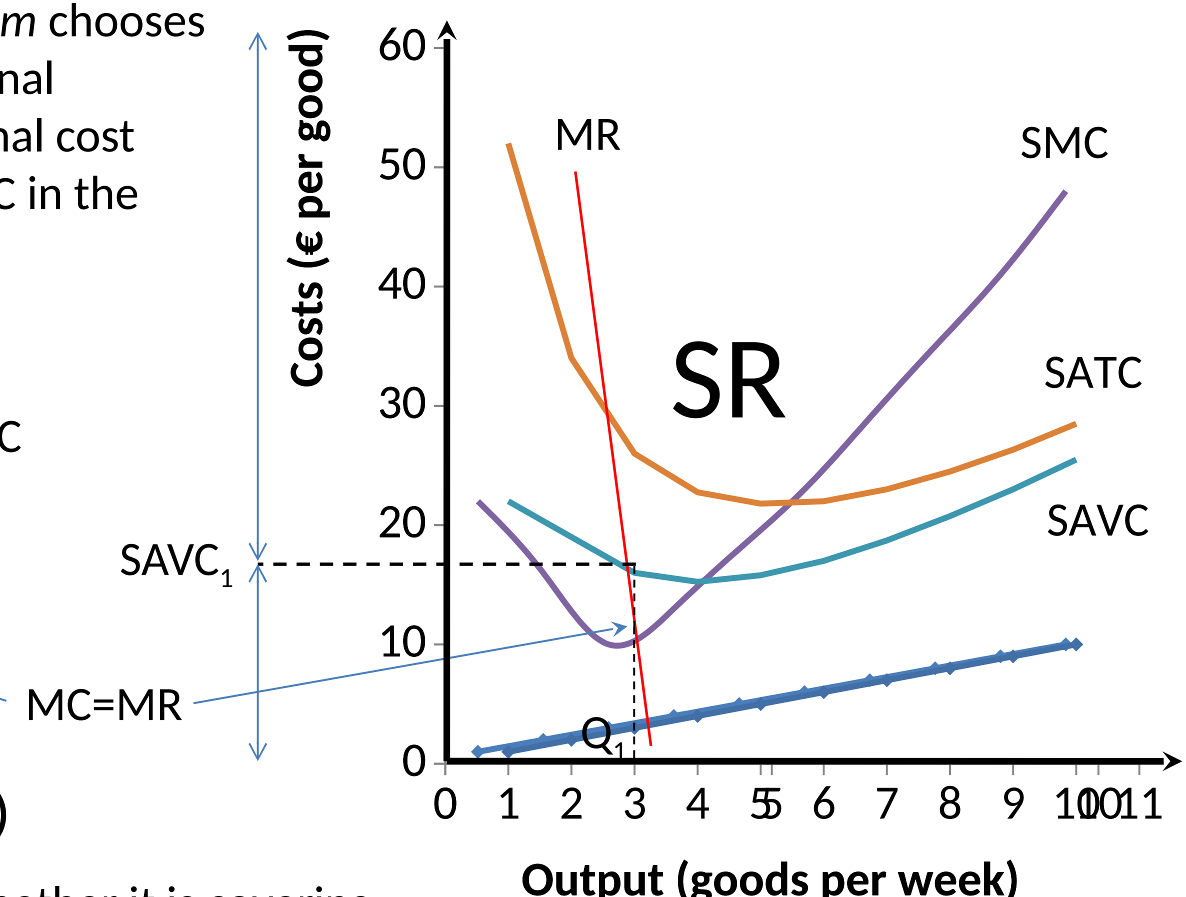
Extra Exercises: Perfect Competition, Monopoly

Micro- and Macroeconomics
(BMEGT30A001, BMEGT30A410)

Marginal condition	Average condition	
	Short run	Long run
Produce output Where MR = MC	If P < SAVC shut down temporarily	If P < LAC exit industry

To maximize profits *any firm* chooses the output at which marginal revenue MR equals marginal cost (SMC in the short run, LMC in the long run).





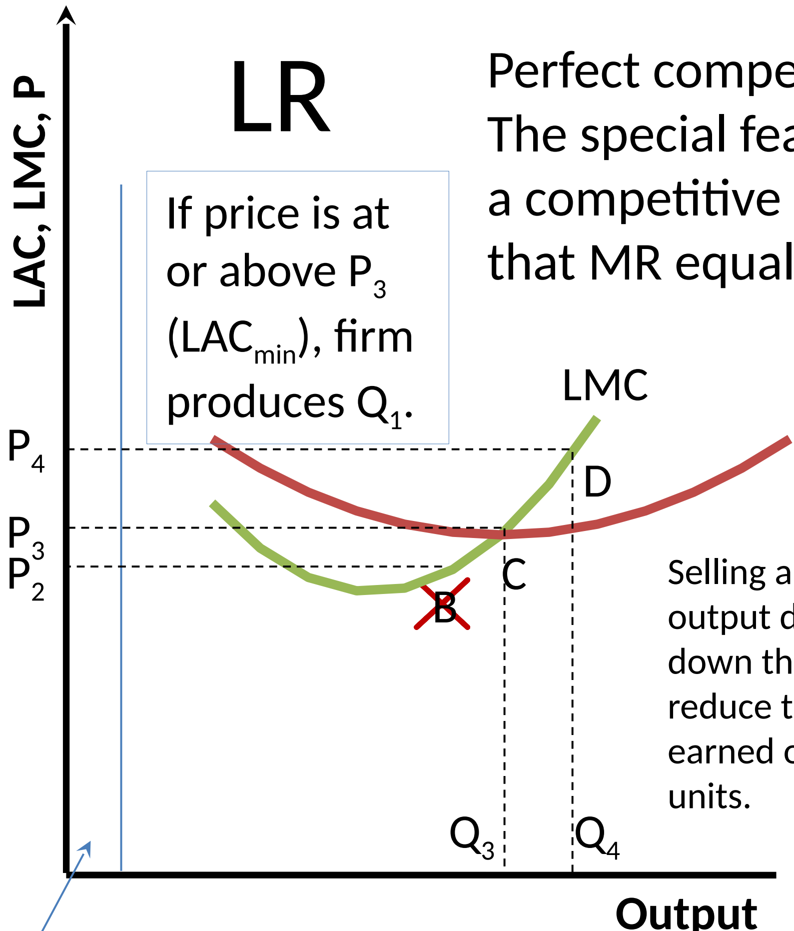
It then checks whether it is covering average costs (SAVC in the short run and LAC in the long run).

Reminder

Marginal condition	Average condition	
	Short run	Long run
Produce output Where P = MC	If P < SAVC shut down temporarily	If P < LAC exit industry

Perfect competition: The special feature of a competitive firm is that MR equals price.

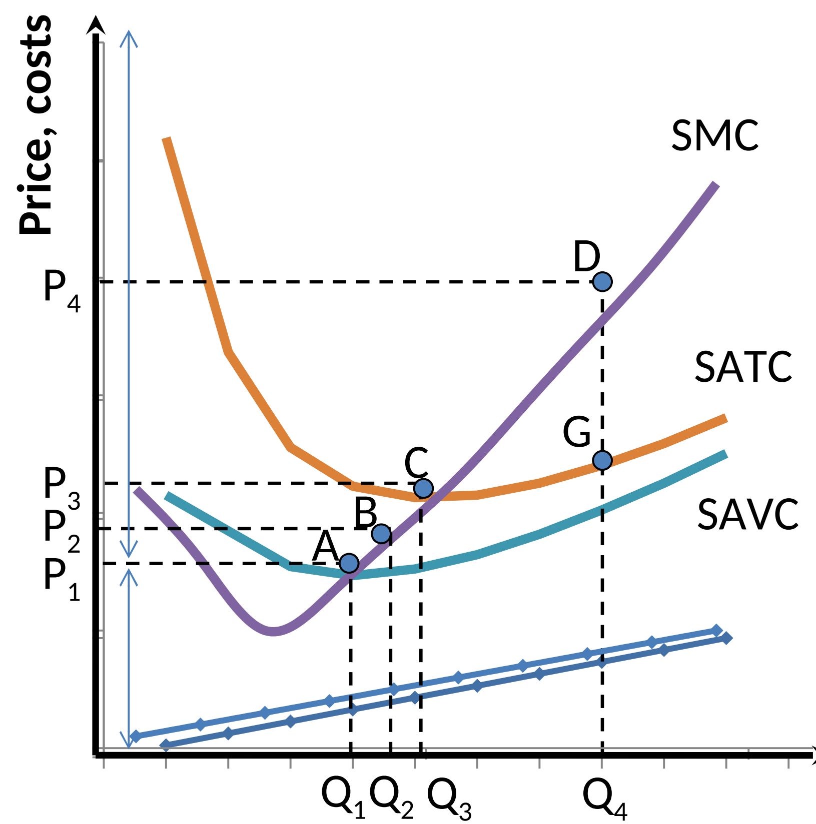
If price is at or above P_3 (LAC_{min}), firm produces Q_1.



Selling an extra unit of output does not bid down the price and reduce the revenue earned on previous units.

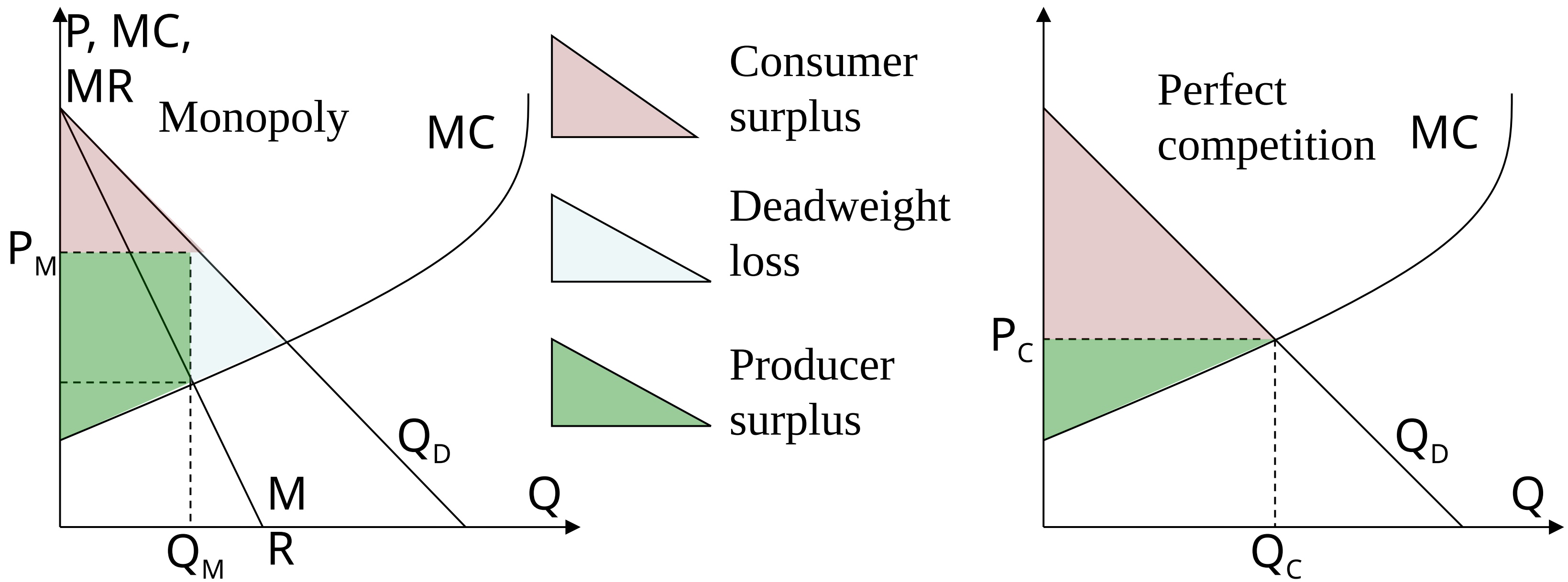
If price is less than P_3 (LAC_{min}), firm goes out of business

Reminder



The price at which the extra unit is sold is the change in total revenue.

Comparison of monopoly and perfect competition, deadweight loss



- The deadweight loss is the economic benefit forgone by the society as the result of the lower quantity of output supplied by the firm with market power.
- In theory, both the consumers and the firm could increase their surplus if the firm could sell (Q_C-Q_M) units of the output at price (P_C) *after* selling Q_M goods at the monopoly price (P_M). If the monopolist could charge individualized prices, the deadweight loss could be reduced (or in an extreme case, eliminated).

  → Discriminating monopolist, price discrimination

Exercise 1: Perfect Competition

In a perfectly competitive industry, the demand function is given by the equation: $Q(P) = 20850 - P$.

The total cost function of a typical firm in the industry is given by the equation: $\mathrm{TC}(q) = 10q^2 + 50q + 25000$.

All firms are *equal* (identical products and cost functions).

The current market price is 1350.

How many firms are in the industry in the *short run* and in the *long run*?

Exercise 1: Short run

$$Q(P) = 20850 - P$$

$$\text{TC}(q) = 10q^2 + 50q + 25000$$

Current price: 1350.

- $MC = 20q + 50 = P = 1350$
- $q = 65$
- $Q = 20850 - 1350 = 19500$
- $n = Q/q = 19500/65 = 300$

Market demand:
$Q^*(P=1350)$

Firms' optimum:
q^*: $MC = P$
(When $P \geq SAVC_{min}$)

Number of firms:
$n = Q/q$

Exercise 1: Long run

$$Q(P) = 20850 - P$$

$$\mathrm{TC}(q) = 10q^2 + 50q + 25000$$

- AC = 10q + 50 + 25000/q = MC = 20q + 50
- q = 50
- MC = 20·50 + 50 = 1050
- Q = 20850 – 1050 = 19800
- n = 19800/50 = 396

Long-run equilibrium:
q*: P = MC = AC

Exercise 2: Monopoly and PC

- The demand function facing a monopolist: $Q = 500 - 0.5P$.
- The total cost function of the monopolist: $TC = 1.5Q^2 + 160Q + 20000$.

a. Determine the optimal (profit-maximizing) quantity of output and price for the monopolist!
b. If the same industry was perfectly competitive (identical demand and cost conditions), what would be the market price and industry output?
c. Determine the deadweight loss associated with monopoly pricing in this industry!

Exercise 2: a. Monopoly

- $MC = 3Q + 160$
- $MR = 1000 - 4Q$
- $MR = MC$
- $3Q + 160 = 1000 - 4Q$
- $Q = 120$
- $P = 760$

The demand function facing a monopolist (= market demand): $Q = 500 - 0.5P$.

Inverse demand function: $P = 1000 - 2Q$.

Total revenue function: $TR = P \cdot Q = 1000Q - 2Q^2$.

The total cost function of the monopolist: $TC = 1.5Q^2 + 160Q + 20000$.

Exercise 2: b. Competition

Perfect competition: $P = MC$ (at the industry level):

- $P = 3Q + 160$

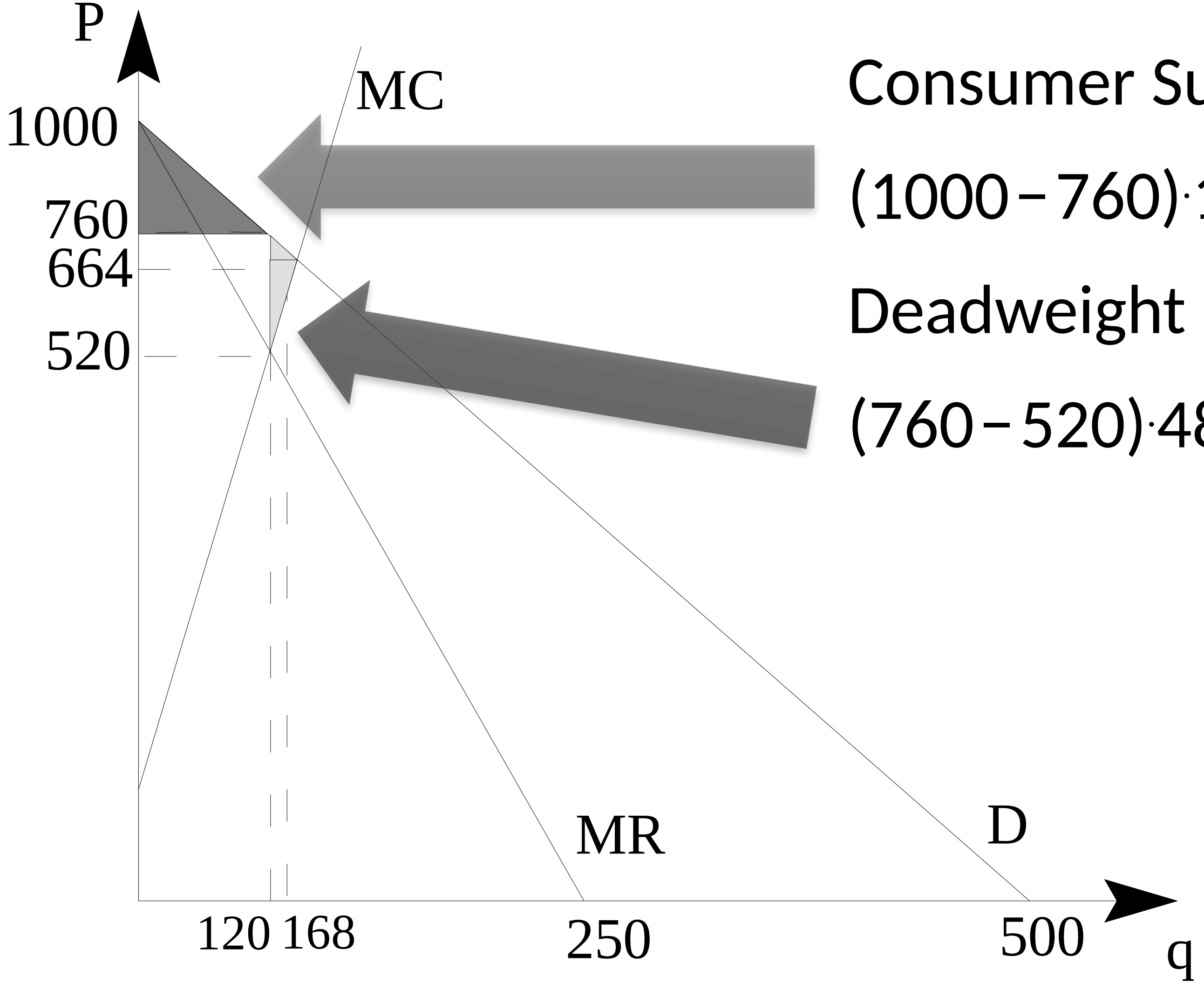
Market equilibrium (supply equals demand):

- $3Q + 160 = 1000 - 2Q$
- $Q = 168$
- $P = 664$

The market demand function: $Q = 500 - 0.5P \sim P = 1000 - 2Q$

The total cost function characterizing the industry: $TC = 1.5Q^2 + 160Q + 20000$.

c. Consumer Surplus and Deadweight Loss



Consumer Surplus:

$(1000 - 760) \cdot 120/2 = 14400$

Deadweight Loss:

$(760 - 520) \cdot 48/2 = 5760$

Bonus Content:
Exotic Production Functions

Micro- and Macroeconomics
(BMEGT30A001, BMEGT30A410)

Exercise 1

Our production function (CES production function; CES: Constant elasticity of substitution) is

$$F(K,L) = B[\alpha K^{-\rho} + (1-\alpha)L^{-\rho}]^{-\frac{1}{\rho}}.$$

Does this function exhibit increasing, decreasing or constant returns to scale?

Exercise 1 (solution)

$$F(\lambda K, \lambda L) = B[\alpha(\lambda K)^{-\rho} + (1-\alpha)(\lambda L)^{-\rho}]^{-\frac{1}{\rho}} =$$

$$= [\lambda^{-\rho}]^{-\frac{1}{\rho}} B[\alpha K^{-\rho} + (1-\alpha) L^{-\rho}]^{-\frac{1}{\rho}} = \lambda q$$

Constant returns to scale.

Exercise 2

Our production function is $q = Ae^{0.5K^2+L^2}$, where K is the number of machines, while L is the number of workers, *e* is Euler's number and A is an unknown constant.

Determine the optimal capital intensity *K*(*L*) if p_L and p_K are the input prices!

Exercise 2 (solution)

Our production function is $q = Ae^{0.5K^2+L^2}$, where K is the number of machines, while L is the number of workers, *e* is Euler's number and A is an unknown constant.

Determine the optimal capital intensity $K(L)$ if p_L and p_K are the input prices!

$$F_L = MP_L = \frac{\partial q}{\partial L} = Ae^{0.5K^2+L^2}2L$$

$$F_K = MP_K = \frac{\partial q}{\partial K} = Ae^{0.5K^2+L^2}K$$

$$|MRTS| = \frac{MP_L}{MP_K} = \frac{2L \times Ae^{0.5K^2+L^2}}{K \times Ae^{0.5K^2+L^2}} = \frac{2L}{K} = \frac{p_L}{p_K}$$

$$L = \frac{Kp_L}{2p_K}$$

$$K = \frac{2Lp_K}{p_L}$$

Exercise 3

Our production function is: $q = F(K,L) = \ln(K^{\alpha}L^{1-\alpha})$.
Determine the total cost function if input prices are p_L & p_K!

$$q = \alpha \ln K + (1-\alpha)\ln L$$

$$F_L = MP_L = \frac{\partial q}{\partial L} = \frac{1-\alpha}{L}$$

$$F_K = MP_K = \frac{\partial q}{\partial K} = \frac{\alpha}{K}$$

$$|MRTS| = \frac{MP_L}{MP_K} = \frac{1-\alpha}{\alpha}\frac{K}{L} = \frac{p_L}{p_K}$$

$$L = \frac{1-\alpha}{\alpha}\frac{p_K}{p_L}K$$

$$q = \ln\left(K^{\alpha}\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}K\right)^{1-\alpha}\right) =$$

$$= \ln\left(K\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{1-\alpha}\right)$$

Exercise 3 (cont.)

$$K = L\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{-1}$$

$$q = \ln\left(L\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{-\alpha}\right)$$

$$L = e^q\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{\alpha}$$

$$K = e^q\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{\alpha-1}$$

$$L = \frac{1-\alpha}{\alpha}\frac{p_K}{p_L}K$$

$$q = \ln\left(K^{\alpha}\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}K\right)^{1-\alpha}\right) =$$

$$= \ln\left(K\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{1-\alpha}\right)$$

Exercise 3 (solution)

$$K = e^{q}\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{\alpha-1} \qquad L = e^{q}\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{\alpha}$$

Our production function is: $q = F(K, L) = \ln(K^{\alpha}L^{1-\alpha})$.

Determine the total cost function if input prices are p_L & p_K!

$$TC(q) = p_K K + p_L L =$$

$$= p_K e^{q}\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{\alpha-1} + p_L e^{q}\left(\frac{1-\alpha}{\alpha}\frac{p_K}{p_L}\right)^{\alpha}$$

Answers for Test H (Introducing supply decisions, Cost and supply, Perfect competition and pure monopoly)

A/1	A/2	A/3	A/4	A/5	A/6	A/7	A/8	A/9	A/10	A/11	A/12	A/13	A/14	A/15
C	**A**	**B**	**E**	**D**	**B**	**E**	**A**	**B**	**C**	**E**	**B**	**A**	**D**	**D**

B/1	B/2	B/3	B/4	B/5	B/6	B/7	B/8	B/9	B/10
T	**F**	**T**	**T**	**F**	**F**	**T**	**F**	**T**	**F**

Answers for Test I (Economics and the economy; Demand, supply and the market; Elasticities of demand and supply, Consumer choice and demand decisions)

A/1	A/2	A/3	A/4	A/5	A/6	A/7	A/8	A/9	A/10	A/11	A/12	A/13	A/14	A/15
D	**E***	**D**	**C**	**E**	**E**	**D**	**D**	**B**	**E**	**C**	**E**	**C**	**D**	**A**

***0 fish (They don't need to sacrifice anything to increase production by 9 units)**

B/1	B/2	B/3	B/4	B/5	B/6	B/7	B/8	B/9	B/10
F	**T**	**T**	**F**	**T**	**T**	**F***	**F**	**F**	**T**

***Private markets also play a role – China is a mixed economy.**

Started on	Friday, 6 June 2025, 11:00 AM
State	Finished
Completed on	Friday, 6 June 2025, 11:23 AM
Time taken	23 mins 47 secs
Grade	**60** out of 60 (**100**%)

Question **1**

Correct

Mark 2 out of 2

The short-run supply decision is determined by finding the level of output at which short-run marginal cost is equal to marginal revenue, provided that the average condition (P ≥ SAVC) is also satisfied.

Select one:

- a. FALSE
- b. TRUE ✔

The correct answer is: TRUE

Question **2**

Correct

Mark 3 out of 3

The most shareholders can lose if their company goes bust is...

Select one:

- a. their pride (they cannot lose anything).
- b. the money they spent buying shares. ✔
- c. all of their personal possessions.
- d. the money they spent buying shares and some but not all of their personal possessions.
- e. None of the above.

The correct answer is: the money they spent buying shares.

Question **3**

Correct

Mark 2 out of 2

Even an industry with only a handful of players in the market and with a differentiated product can be perfectly competitive.

Select one:

- a. FALSE ✔
- b. TRUE

The correct answer is: FALSE

Question **4**

Correct

Mark 4 out of 4

The demand for butter can be characterized by the inverse demand function $P^D = 522 – 4Q$ and the supply can be characterized by the inverse supply function $P^S = 174 + 4Q$

Please calculate the equilibrium price!

Answer: 348 ✔

This is the right answer!

The correct answer is: 348.00

Question **5**

Correct

Mark 3 out of 3

If the elasticity of supply is 1.2, to increase quantity supplied by 3.6 percent, price must

Select one:

- a. fall by 4 percent
- b. rise by 3.6 percent
- c. fall by 1.2 percent
- d. rise by 3 percent ✔
- e. None of the above.

The correct answer is: rise by 3 percent

Question **6**

Correct

Mark 3 out of 3

The demand curve faced by a perfectly competitive firm ...

Select one:

- a. slopes downward and to the right.
- b. is the same as the industry demand curve.
- c. shows that in order to sell more, the firm must lower product price.
- d. is horizontal at the going market price. ✔
- e. None of the above.

The correct answer is: is horizontal at the going market price.

Question **7**

Correct

Mark 2 out of 2

Opportunity costs are part of the economic costs of a business but not its accounting costs.

Select one:

- a. FALSE
- b. TRUE ✔

The correct answer is: TRUE

Question **8**

Correct

Mark 4 out of 4

Charlie Little owns a firm with total sales revenue of $200,000 and total accounting costs of $100,000. If he worked for a firm as an employee, he could earn $58,000. Meanwhile, the $580,000 he invested to start his own firm could earn an annual interest rate of 20%. Calculate his economic profit (in $)!

Please only include a **number** as your answer (without a dollar sign or a thousand separator).

Answer: -74000 ✔

The correct answer is: -74000.00

Question **9**

Correct

Mark 3 out of 3

If the two transfers have the same monetary value, consumers prefer to receive transfers...

Select one:

- a. in kind rather than in cash.
- b. in cash rather than in kind. ✔
- c. as food stamps rather than money.
- d. a gift of a good or a service rather than banknotes that they would have to spend.
- e. None of the above (the consumer does not care about anything else, but the monetary value).

The correct answer is: in cash rather than in kind.

Question **10**

Correct

Mark 2 out of 2

An increase in consumers' incomes will cause an expansion in the demand for all goods.

Select one:

- a. TRUE
- b. FALSE ✔

The correct answer is: FALSE

Question **11**

Correct

Mark 3 out of 3

The demand curve faced by a sole supplier (a true monopolist)...

Select one:

- a. slopes downward and to the right.
- b. is the same as the industry demand curve.
- c. shows that in order to sell more, the firm must lower product price.
- d. All of the above. ✔
- e. None of the above.

The correct answer is: All of the above.

Question **12**

Correct

Mark 2 out of 2

A utility-maximizing consumer chooses to be at a point at a tangent between his budget line and an indifference curve.

Select one:

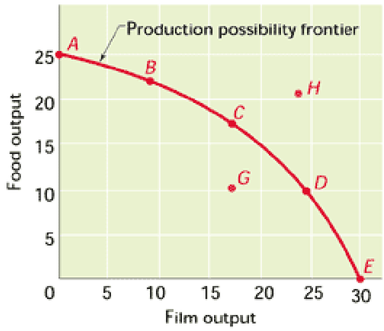
- a. FALSE
- b. TRUE ✔

The correct answer is: TRUE

Question **13**

Correct

Mark 3 out of 3



Points A, B, C, and D show

Select one:

- a. an inefficient allocation of society's scarce resources.
- b. possible combinations of food output and film output that efficiently utilise all resources available to this society. ✔
- c. a constant trade-off between food output and film output.
- d. society prefers food output to film output.
- e. All the above.

The correct answer is: possible combinations of food output and film output that efficiently utilise all resources available to this society.

Question **14**

Correct

Mark 4 out of 4

The demand for yoghurt can be characterized by the inverse demand function $P^D = 64000 - 0.5Q$ and the supply can be characterized by the inverse supply function $P^S = 16000 + 0.5Q$. How much should a perfectly competitive firm produce if its costs can be characterized by the function $STC(q) = 100q^2 + 8000q + 50000$?

Answer: 160 ✔

The correct answer is: 160.00

Question **15**

Correct

Mark 3 out of 3

In general, marginal costs ...

Select one:

- a. are zero for low levels of output but begin to increase as output increases.
- b. start out high for low levels of output, fall as output increases, but then increase as output continues to expand. ✔
- c. fall as output increases (and might become negative).
- d. are constant for all levels of output.
- e. None of the above.

The correct answer is: start out high for low levels of output, fall as output increases, but then increase as output continues to expand.

Question **16**

Correct

Mark 3 out of 3

When a market is in equilibrium, ...

Select one:

- a. no shortages exist.
- b. quantity demanded equals quantity supplied.
- c. a price is established that clears the market.
- d. no surpluses exist.
- e. All of the above. ✔

The correct answer is: All of the above.

Question **17**

Correct

Mark 4 out of 4

The demand for butter can be characterized by the inverse demand function P^D = 248 – Q and the supply can be characterized by the inverse supply function P^S = 62 + Q

A specific tax of 40 (which is collected from the sellers) is introduced by the government. Calculate the post-tax price!

Answer: 175 ✔

This is the right answer!

The correct answer is: 175.00

Question **18**

Correct

Mark 4 out of 4

The demand for a new innovative cancer drug is characterized by the inverse demand function $P^D = 1040 - 2Q$. The total cost for the sole supplier, a pure monopolist, is given by $TC(Q) = 520Q + 2Q^2$.

Please calculate the monopoly price for the product!

Answer: 910 ✔

The correct answer is: 910.00

Question **19**

Correct

Mark 2 out of 2

An economy in which there is no unemployment is producing on the production possibility frontier.

Select one:

- a. TRUE ✔
- b. FALSE

The correct answer is: TRUE

Question **20**

Correct

Mark 4 out of 4

The demand for butter can be characterized by the inverse demand function $P^D = 200 - Q$ and the supply can be characterized by the inverse supply function $P^S = 50 + Q$

Calculate the consumer surplus! (A fraction should be rounded to two decimal places.)

Answer: 2812.50 ✔

This is the right answer!

The correct answer is: 2812.50

◄ Final exam MACRO_TEST 06_06 10:30-10:58

Jump to...

Macroeconomics_material_1st_part ►

Started on	Friday, 28 March 2025, 10:17 AM
State	Finished
Completed on	Friday, 28 March 2025, 10:28 AM
Time taken	11 mins 22 secs
Grade	**8** out of 12 (**67**%)

Question **1**
Incorrect
Mark 0 out of 4

The demand for butter can be characterized by the inverse demand function $P^D = 612 – 3Q$ and the supply can be characterized by the inverse supply function $P^S = 306 + 3Q$

Please calculate the equilibrium price!

Answer: 513 ✗

The correct answer is: 459.00

Question **2**
Correct
Mark 4 out of 4

The demand for butter can be characterized by the inverse demand function $P^D = 480 – Q$ and the supply can be characterized by the inverse supply function $P^S = 80 + Q$

Calculate the producer surplus! (A fraction should be rounded to two decimal places.)

Answer: 20000 ✓

This is the right answer!

The correct answer is: 20000.00

Question **3**
Correct
Mark 4 out of 4

The demand for butter can be characterized by the inverse demand function $P^D = 456 – Q$ and the supply can be characterized by the inverse supply function $P^S = 114 + Q$

A specific tax of 40 (which is collected from the sellers) is introduced by the government. Calculate the post-tax equilibrium quantity (quantity traded)!

Answer: 151 ✓

This is the right answer!

The correct answer is: 151.00

Started on	Friday, 28 March 2025, 10:34 AM
State	Finished
Completed on	Friday, 28 March 2025, 10:52 AM
Time taken	17 mins 58 secs
Grade	**16** out of 18 (**89**%)

Question **1**
Correct
Mark 2 out of 2

An economy in which there is unemployment is not producing on the production possibility frontier.

Select one:

a. TRUE ✔
b. FALSE

The correct answer is: TRUE

Question **2**
Correct
Mark 3 out of 3

At every point on an indifference curve, the

Select one:

a. level of utility is constant. ✔
b. prices of all goods are constant.
c. marginal utility of each good is constant.
d. consumer's income is constant.
e. All of the above.

The correct answer is: level of utility is constant.

Question **3**
Incorrect
Mark 0 out of 2

If you own an ice cream parlour and the demand for ice cream is price inelastic, to increase the parlour's revenue requires a price reduction.

Select one:

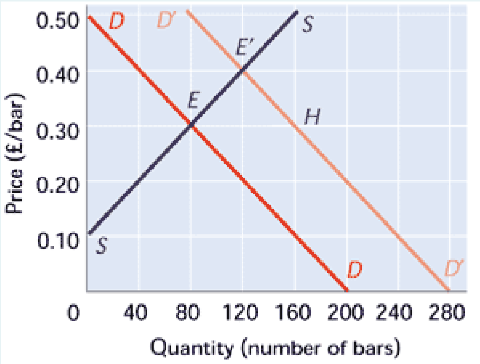
a. TRUE ✖
b. FALSE

The correct answer is: FALSE

Question **4**

Correct

Mark 3 out of 3



In the figure above ...

Select one:

- a. demand has increased.
- b. the new equilibrium price and quantity are £0.40 and 120 respectively
- c. quantity supplied increased.
- d. an increase in consumer incomes might have caused the shift of the demand curve, if this is a normal good.
- e. All of the above. ✔

The correct answer is: All of the above.

Question **5**

Correct

Mark 3 out of 3

The key economic problem is to reconcile the conflict between...

Select one:

- a. people's limited demands with society's virtually unlimited ability to produce goods and services to fulfil these demands.
- b. people's unlimited demands with society's virtually unlimited ability to produce goods and services to fulfil these demands.
- c. people’s virtually unlimited demands with society’s limited ability to produce goods and services to fulfil these demands. ✔
- d. people’s somewhat limited demands with society’s somewhat limited ability to produce goods and services to fulfil these demands.
- e. None of the above.

Your answer is correct.

The correct answer is: people’s virtually unlimited demands with society’s limited ability to produce goods and services to fulfil these demands.

Question **6**

Correct

Mark 2 out of 2

In order to determine how much of a good an individual will buy, it is necessary to have information on income, preferences and prices.

Select one:

- a. TRUE ✔
- b. FALSE

The correct answer is: TRUE

Question **7**

Correct

Mark 3 out of 3

Which one of these would characterize a **luxury good**?

Select one:

- a. Negative income elasticity.
- b. Income elasticity of demand between 0 and -1.
- c. Positive own-price elasticity of demand.
- d. Negative cross-price elasticity of demand.
- e. None of the above. ✔

Your answer is correct.

The correct answer is: None of the above.

Microeconomics for engineers and mathematicians (BMEGT30A001, A410) NAME:…………………………………….

NEPTUN ID:………………………………..

Practice exercises for the topics:

Introducing supply decisions, cost and supply, Perfect competition and pure monopoly (Test H)

A. <u>Multiple choice questions</u>

Instructions: Please fill in the table! Each question in section A is worth 2 points each. Choose the one alternative that <u>best</u> completes the statements or answers the question! (If there is seemingly more than one correct answer – the answer should be d or e.)

A/1	A/2	A/3	A/4	A/5	A/6	A/7	A/8	A/9	A/10	A/11	A/12	A/13	A/14	A/15

1. Which of the following corresponds most closely to the economists' notion of 'normal profit'?
   a.) The level of profits a firm makes by setting MC=MR.
   b.) The level of profits made by a typical firm in the industry.
   c.) The level of profits needed to persuade a firm to stay in its current line of business.
   d.) The rate of profits that ensures a comfortable standard of living for the entrepreneur.
   e.) All of the above.

2. Which of the following statements about the short-run marginal cost curve is/are *not* true?
   a.) Marginal cost is unaffected by changes in factor prices.
   b.) Marginal cost will be rising under conditions of diminishing returns.
   c.) When average cost is falling, marginal cost will be below average cost.
   d.) All of the above are true.
   e.) None of the above is true.

3. Which of the following situations characterize(s) a monopoly?
   a.) Price equals marginal cost.
   b.) Marginal revenue equals marginal cost.
   c.) There are no barriers to entry.
   d.) Average revenue is equal to marginal revenue
   e.) All of the above.

4. Which of the following situations characterize(s) a perfectly competitive market?
   a.) Price equals marginal cost.
   b.) Marginal revenue equals marginal cost.
   c.) There are no barriers to entry.
   d.) Average revenue is equal to marginal revenue
   e.) All of the above.

5. Which of the following conditions is/are necessary before the law of diminishing returns to a factor can be said to operate?
   a.) Other factors are held constant.
   b.) The state of technical knowledge does not change.
   c.) All units of the variable factor are homogeneous.
   d.) All of the above.
   e.) None of the above.

6. Which of the following statements describes the law of diminishing returns? Suppose in each case that labour is a variable factor but capital is fixed. As more labour is used:
   a.) Total output will fall because the extra units of labour will be of poorer quality than those previously employed.
   b.) The relative shortage of capital will eventually cause increases in total product to become progressively smaller.
   c.) After a while fewer units of labour will be needed in order to produce more output.
   d.) The marginal revenue obtained from each additional unit produced will decline.
   e.) None of the above.

7. In the short run …
   a.) a firm produces at a level of output that equates marginal revenue and marginal cost provided that at that level the price exceeds short-run average total cost.
   b.) a firm produces at a level of output that equates marginal revenue and marginal cost provided that at that level the price exceeds short-run average fixed cost.
   c.) a firm shuts down if at the level of output that equates MR and MC it cannot recoup at least the fixed costs.
   d.) a firm will close down if price if less than average revenue.
   e.) None of the above.

8. In the long run …
   a.) a firm never produces at a loss, it would always exit the industry if economic costs exceed total revenue.
   b.) a firm would always produce if they can equate marginal costs and the market price, even if it makes a loss.
   c.) a firm would always produce if they can equate marginal costs and the market revenue, even if it makes a loss.
   d.) a firm will close down if price if less than average revenue.
   e.) None of the above.

9. Suppose that there is an increase in the wage rate of workers in a certain industry. The industry is serviced by a monopolist firm. What happens to the firm’s costs, revenue and output?
   a.) The marginal cost (MC) curve will shift downwards and the profit-maximizing output increases.
   b.) The MC curve will shift upwards and the profit-maximizing output decreases.
   c.) The marginal revenue (MR) curve will shift downwards and the profit-maximizing output decreases.
   d.) The MR curve will shift upwards and the profit-maximizing output increases.
   e.) None of the above.

10. Suppose that there is a fall in market demand. The industry is serviced by a monopolist firm. What happens to the firm's costs, revenue and output?
    a.) The marginal cost (MC) curve will shift downwards and the profit-maximizing output increases.
    b.) The MC curve will shift upwards and the profit-maximizing output decreases.
    c.) The marginal revenue (MR) curve will shift downwards and the profit-maximizing output decreases.
    d.) The MR curve will shift upwards and the profit-maximizing output increases.
    e.) None of the above.

11. Which of the following items would shift the SAFC schedule downwards?
    a.) A rise in wages.
    b.) A rise in demand.
    c.) A rise in the rental rate of machines.
    d.) A rise in fixed costs.
    e.) None of the above.

12. Which of the following items would shift the MR schedule upwards?
    a.) A rise in wages.
    b.) A rise in demand.
    c.) A fall in the rental rate of machines.
    d.) A rise in fixed costs.
    e.) None of the above.

13. Which of the following items would shift the LMC schedule upwards?
    a.) A rise in wages.
    b.) A rise in demand.
    c.) A fall in the rental rate of machines.
    d.) A rise in fixed costs.
    e.) None of the above.

14. That level of profits which just pays the opportunity cost of the owners' money and time is called …
    a.) Supernormal profits.
    b.) Economic profits.
    c.) Accounting profits.
    d.) Normal profit.
    e.) None of the above.

15. Which of the following statements are valid?
    a.) LAC is falling when LMC is less than LAC
    b.) LAC is rising when LMC is greater than LAC
    c.) LAC is at a minimum at the output level at which LAC and LMC cross.
    d.) All of the above are valid.
    e.) None of the above are valid.

B. <u>True or false questions</u>

Instructions: Please decide if the following statements are true ('T') or false ('F'), and fill in the table! Each question in section B is worth 1 point each.

B/1	B/2	B/3	B/4	B/5	B/6	B/7	B/8	B/9	B/10

1. Opportunity cost plus accounting cost equals economic cost.
2. Firms maximize *profits* by selling as much output as they can.
3. When a firm's demand curve slopes down, marginal revenue will fall as output rises.
4. Any firm wanting to maximize profits will minimize cost for any given level of output.
5. A fall in marginal revenue will cause profits to be maximized at a *higher* output level.
6. The long-run supply decision is *determined* by finding the level of output at which long-run marginal cost is equal to marginal revenue.
7. Holding labour constant while increasing capital input will lead to diminishing returns.
8. The short-run supply curve for a perfectly competitive firm is *flatter* than the long-run supply curve
9. Price is equal to marginal revenue for a firm under perfect competition.
10. Total revenue is maximized *when* average revenue is at a maximum.

Microeconomics for engineers and mathematicians (BMEGT30A001, A410)

NAME:…………………………………….

NEPTUN ID:………………………………..

Practice exercises for the topics:

Economics and the economy; Demand, supply and the market; Elasticities of demand and supply, Consumer choice and demand decisions (Test I)

A. <u>Multiple choice questions</u>

Instructions: Please fill in the table! Each question in section A is worth 2 points each. Choose the one alternative that <u>best</u> completes the statements or answers the question! (If there is seemingly more than one correct answer – the answer should be d.)

A/1	A/2	A/3	A/4	A/5	A/6	A/7	A/8	A/9	A/10	A/11	A/12	A/13	A/14	A/15

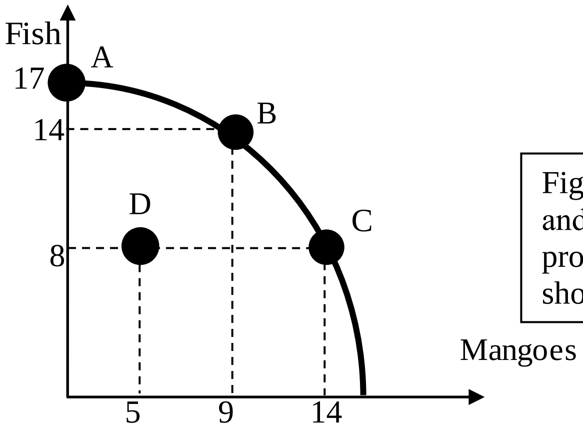
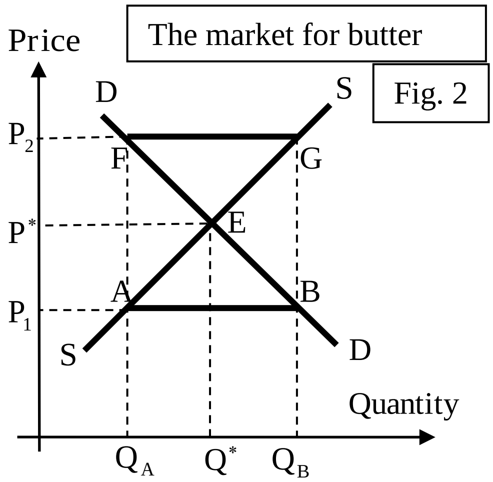


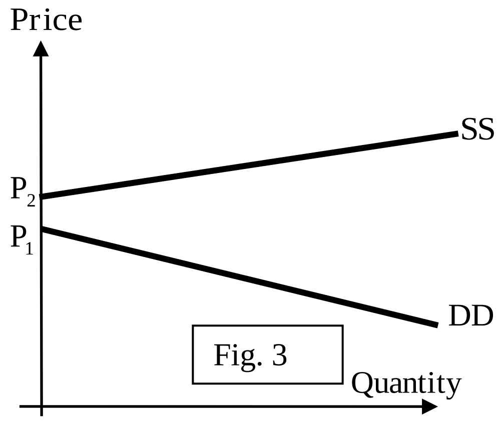
Fig 1. A jungle tribe catches fish and gathers mangoes. The tribe's production possibility frontier is shown in the figure to the left.

1. Suppose the economy is at point A, with 17 fish and 0 mangoes. What is the opportunity cost of gathering the first 9 mangoes?
   a.) 8 fish.
   b.) 14 fish.
   c.) 17 fish.
   d.) 3 fish.
   e.) None of the above.

2. Now suppose the economy is at point D. What is the opportunity cost of gathering 9 more mangoes?
   a.) 5 fish.
   b.) 8 fish.
   c.) 6 fish.
   d.) 14 fish.
   e.) None of the above.

3. Suppose that a new climbing technique is invented, making the harvesting of mangoes easier. After the technological change, which of the following combinations of goods might represent points of inefficient production?
   a.) A, B, C and D.
   b.) A and D.
   c.) A, B and D.
   d.) B, C and D.
   e.) None of the above.





4. Suppose that the government imposes a price *ceiling* (P_1) below P*, the equilibrium price in the market for butter (figure 2).
   a.) At the new market price, the quantity supplied will be Q_B.
   b.) AB shows the excess supply at the new market price.
   c.) The quantity traded will be reduced to Q_A.
   d.) The quantity traded might be maintained at Q* if the government adds its own demand to that of the private sector.
   e.) All of the above.

5. Now suppose that the government imposes a price *floor* (P_1) below P*, the equilibrium price in the market for butter (figure 2). Previously, the market was in equilibrium.
   a.) At the new market price, the quantity supplied will be Q_B.
   b.) AB shows the excess supply at the new market price.
   c.) The quantity traded will be reduced to Q_A.
   d.) The quantity traded can be maintained at Q* only if the government adds its own demand to that of the private sector.
   e.) None of the above.

6. In figure 3, SS and DD represent the supply and the demand curves in the market for refrigerators in Antarctica. Which of the following statements is *not* valid?
   a.) Even the highest price consumers will pay is lower than the minimum price producers require to produce any of this good.
   b.) Price floors are irrelevant in this market.
   c.) Price ceilings are irrelevant in this market.
   d.) Unless the government subsidizes the producers, this good will not be produced.
   e.) None of the above (= All of them are valid).

7. Which of the following statements is *not* valid?
   a.) For both specific and ad valorem taxes, it is the relatively more price insensitive side of the market that bears more of the burden of a tax.
   b.) Ad valorem taxes are measured as a percentage of the commodity's value.
   c.) The total tax revenue for a specific tax can be calculated as $T = t \times Q$, where ***Q*** is the quantity traded and ***t*** is the tax per unit.
   d.) Tax incidence measures 'who really pays the tax'. Since tax changes don't induce changes in equilibrium prices and quantities, these are always the people from whom the government appears to collect the money.
   e.) None of the above

8. The budget share of a good …
   a.) falls if income rises by 1%, and the good is a necessity good.
   b.) is its price times the quantity demanded, divided by total consumer spending.
   c.) falls if income rises by 1%, and the good is an inferior good.
   d.) All of the above.
   e.) None of the above.

9. When a demand curve is linear…
   a.) price rises and cuts of equal size lead to quantity changes that differ in size.
   b.) elasticity typically falls as we move down the demand curve.
   c.) elasticity might never be unit-elastic as we move down the demand curve.
   d.) All of the above.
   e.) None of the above.

10. Which of the following statements should be the definition of an inferior good?
   a.) A good having a supply elasticity between 0 and 1.
   b.) A good with a positive income elasticity of demand.
   c.) A good with a negative price elasticity of demand.
   d.) A good having an income elasticity of demand greater than 1.
   e.) None of the above.

11. Which of the following could result in a price fall in the market for cars?
   a.) A fall in the price of petrol.
   b.) A rise in the price of bicycles (if bikes and cars are considered substitutes).
   c.) A fall in the price of rubber (used to make car tyres).
   d.) A rise in the wages of workers working in car factories.
   e.) None of the above.

12. Which of the following statements is *not* valid? A utility-maximizing consumer chooses to be at a point at a tangent between his budget line and an indifference curve because:
   a.) This is the highest indifference curve that can be attained.
   b.) At any point to the left of the budget line some income would be unused.
   c.) All combinations to the right of their budget line are unreachable, given money income.
   d.) At any other point on the budget line they will gain less utility.
   e.) All of the above are valid.

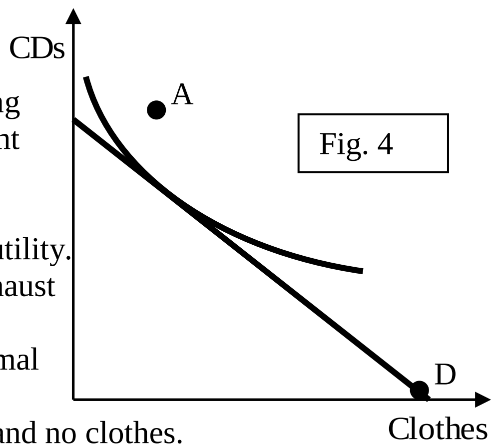


Fig. 4

13. Barbara is choosing how to allocate her spending between CDs and clothes. The figure to the right shows her budget line and indifference curve. Match point A with the appropriate phrase:
   a.) The point at which Barbara maximizes her utility.
   b.) A consumption bundle which would not exhaust Barbara's budget for these goods.
   c.) A consumption bundle preferred to her optimal choice but which Barbara cannot afford.
   d.) The point at which Barbara buys only CDs and no clothes.
   e.) None of the above.

14. Suppose that Barbara's tastes, income and the price of CDs remain constant, but the price of clothes is halved. What would happen to her budget line, point D and her optimal choice?
    a.) Her budget line would rotate around point D.
    b.) Point D would represent a bundle which Barbara cannot afford.
    c.) The budget line would not change but the optimal choice would be different.
    d.) Point D would not exhaust Barbara's budget for these goods.
    e.) None of the above.

15. Which of the following statements is *not* valid?
    a.) A Giffen good is an inferior good where the substitution effect outweighs the income effect, causing the demand curve to slope upwards to the right.
    b.) The income expansion path is a curve showing how the chosen bundle of goods varies with consumer income levels.
    c.) An individual demand curve is a curve showing the amount demanded by a consumer at each price.
    d.) A market demand curve is the sum of the demand curves of all individuals in a market.
    e.) A budget constraint is the set of different consumption bundles that the consumer can afford, given income and prices.

B. True or false questions

Instructions: Please decide if the following statements are true ('T') or false ('F'), and fill in the table! Each question in section B is worth 1 point each.

B/1	B/2	B/3	B/4	B/5	B/6	B/7	B/8	B/9	B/10

1. An economy in which there is full employment is not producing on the production possibility frontier.
2. An expansion of an economy's capacity to produce would be reflected in an 'outwards' movement of the production possibility frontier.
3. An increase in consumers' incomes will cause an expansion in the demand for normal goods.
4. Price cuts will increase total spending on a good if the good is a Giffen good.
5. If two goods are complements, the cross-price elasticity of demand is likely to be negative.
6. Indifference curves never intersect if the consumer has consistent preferences.
7. China is an example of a command economy in which private markets play no part.
8. The imposition of a minimum legal wage will always lead to an increase in employment.
9. The theory of consumer choice demonstrates that consumers prefer to receive transfers in kind rather than transfers in cash.
10. The slope of the budget line depends only upon the relative prices of the goods.