



**University of
Nottingham**
UK | CHINA | MALAYSIA

**Department of Mechanical,
Materials and Manufacturing
Engineering**

The economic theory of the firm



What we will talk about today:

The economic theory of the firm

- *What is economics?*
- *What is a good?*
- *Overview of main principles of economics*
- *Supply and demand*
- *Different forms of markets*
- *Introduction to the economic theory of the firm*

οἰκονόμος



Definitions:

- Economics as field produces insight on many things:
 - Behaviour of people, markets and economies
 - Business thinking and ideas
- Here, we focus on “Microeconomics”

“**Microeconomics** is the study and analysis of the ways in which individuals, households and companies make decisions and how they interact in markets.”

οἰκονόμος



**“The one who manages a household” or
simply “manager”**

- Economics is about decision making on an ongoing basis
- Sustaining activity and engaging in productive processes
- Deciding how scarce resources are used

Scarcity

This organising role is crucial because in economics it is assumed that many available resources are scarce

This implies a number of things:

- Available resources, be it to the individual, the household, the firm, or the economy, are limited
- Not all desirable goods and services can be generated
- Not all needs can be satisfied



What is a good?

The term “good” describes a beneficial physical (‘tangible’) object or item



- Categories of goods are articles, commodities, materials, merchandise, products, supply, and wares
- Generated, for example, though:
 - Farming
 - Construction
 - Manufacturing
 - Exploitation of natural resources (e.g. mining or fishing)
- Goods satisfy human wants or needs → more of a good is always better than less (known as the ‘axiom of non-satiety’)
 - Essentially this says something about rationality...

General types of goods:

- Scarce goods (“economic goods”)
 - Limited supply
 - Can not be obtained without payment / sacrifice
 - E.g. manufacturing products
- Free goods
 - Unlimited supply (for practical purposes...)
 - Can be obtained without payment / sacrifice
 - E.g. air, water
- Numeraire goods
 - Goods with the purpose of expressing the value of other goods
 - E.g. money, gold and silver, bitcoin
- Analogous concept: services
 - Intangible yet valuable
 - Value demonstrated by the buyer’s willingness to pay
 - Cannot be manufactured, transported or stored
 - Irreversibly vanish after use (e.g. plane ticket)



Not scarce!

What is efficiency?

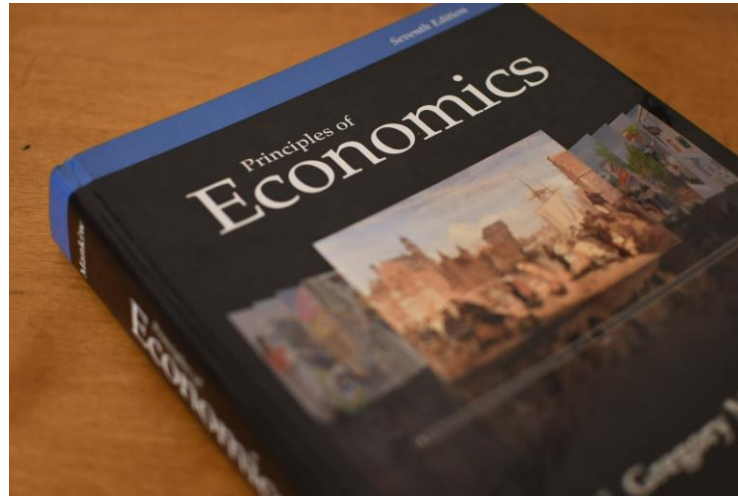
It is the overarching desirable property in economics, meaning an individual, a firm or society gets the most out of the available resources or goods.

- It reflects the ability to avoid wasting raw materials, energy, effort, money and time or creating undesirable effects such as pollution
- Economists distinguish between two types of efficiency:

Allocative efficiency	<ul style="list-style-type: none">▪ State in which every product that can be produced or sold is supplied to a customer who is willing and able to pay for it
Productive efficiency	<ul style="list-style-type: none">▪ Condition under which goods or services are generated at the lowest possible average cost



Textbook approach: Ten important economic principles



Principle 1: Trade-offs are unavoidable

- Scarcity means that making sensible decisions requires sacrificing, or trading off, of one goal against another
- A good everyday example of such a trade-off is how individuals spend their time
- On a societal level: trade-off arises between efficiency and equity
 - A large number of government policies aim to address this trade off
 - Also a technological question...



Principle 2: The cost of opportunity

The existence of scarcity and trade-offs implies that people are forced to compare the value of one available option against another

- All individuals make such calculations on an ongoing basis

Gives rise to the concept of “**Opportunity Cost**”:

- measures the value of the next best option given up, or forgone, by choosing a particular option
- Forgoing a valuable option means that a high opportunity cost is incurred - and vice versa

Principle 3: Marginal benefit and marginal cost



- To find out what is happening or to identify the best decision requires “thinking at the margin”
- Investigating the effects of small incremental changes
- E.g. comparing marginal benefits, the benefits of one extra unit of action or product, against the marginal costs
 - This is very useful when trying to find out what is “rational” as we will see later in this lecture...

Principle 4: Incentives are important

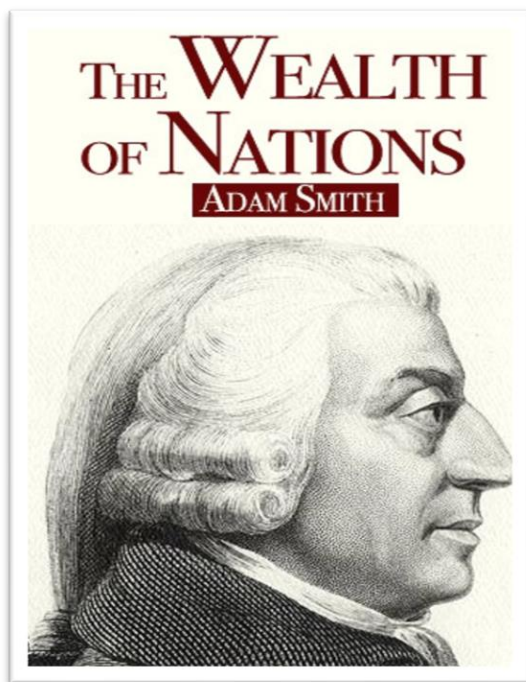
An incentive is something that drives or motivates an individual to perform an action or choose an option

- The magnitude of an incentive is defined by the difference between the perceived costs and benefits
- Where the benefits far outweigh the costs, incentives are assumed to large, and vice versa
- Incentives cannot be negative – but there are “disincentives”



Principle 5: Exchanging things is beneficial

Despite competition occurring between individuals and firms, it is generally accepted that exchanging goods in the form of trade makes every member of a society better off



- Common topic in this is how trade increases wealth
- But also think about the division of labour...

Principle 6: Activity should be organised through markets



Major theme in economics → a market is a structure that allows buyers and sellers to interact to exchange goods, services, information or other assets.

- Can be viewed as a process by which prices for goods and services and quantities are determined
- An exchange within a market is referred to as a “transaction”
- Normally producing a state of efficiency → Economists think that activity should generally be organised through markets
- Examples: auctions, stock markets, wholesale markets, shopping centres, informal discussions, black markets, etc.

Principle 7: Government action is sometimes needed



Markets, economic activity and society as a whole can benefit from government intervention

- Immediate reason: Enforcing property rights
- Governmental action is sometimes needed to support the economy because of market failure
 - Example for market failure: ability of a monopolist to charge prices above competitive levels
 - Further example: Pollution or other damaging effects on society as a whole

Principle 8: Overall wealth depends on the ability to produce

Material wellbeing is seen as a prerequisite for leading a good life. Countries with a high Gross Domestic Product (GDP) will on average offer better nutrition, superior healthcare and longer life expectancy

- Main determinant of GDP is the productivity of labour, a measure of the quantity of goods and services generated
 - There are other types of productivity...
- This point is sometimes challenged as outdated...



Principle 9: If the government issues too much money prices will increase



If the central bank (Bank of England in the UK) prints more money or issues more debt by reducing the interest rate, the prices in the economy will tend to increase

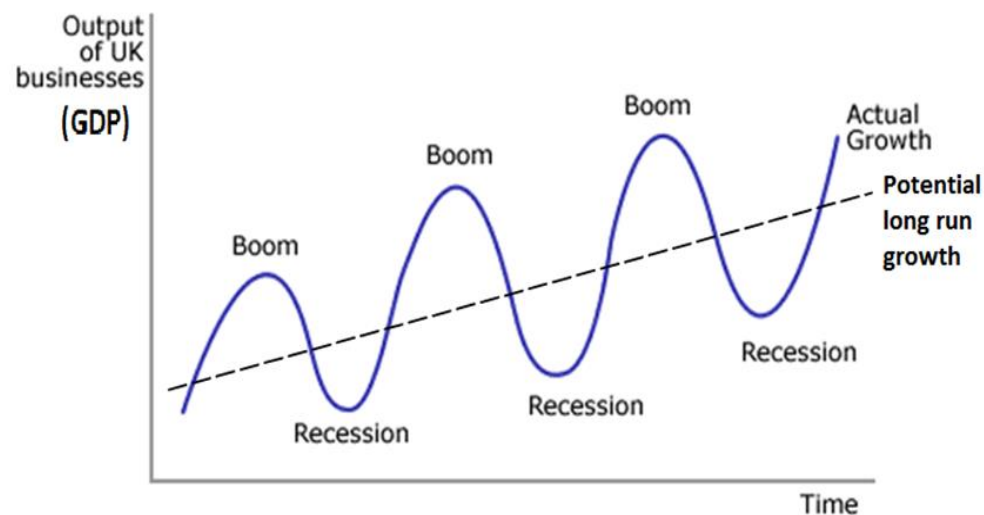
- The decrease in the relative value of money is called **inflation**, which is a major theme in macroeconomics
- Inflation is measured in % per year
- A level of inflation of 2-3% is considered desirable



Principle 10: In the short run there is a trade-off between output and inflation

When governments expand the supply of money, and thereby cause inflation, there will be a positive effect on businesses in the economy

- This will increase the level of economic activity and decreasing the level of unemployment
- Works by encouraging firms to invest and consumers to borrow and spend
- This effect is normally only temporary but can last for a number of years
- Leads to the “business cycle”



The elements of a market

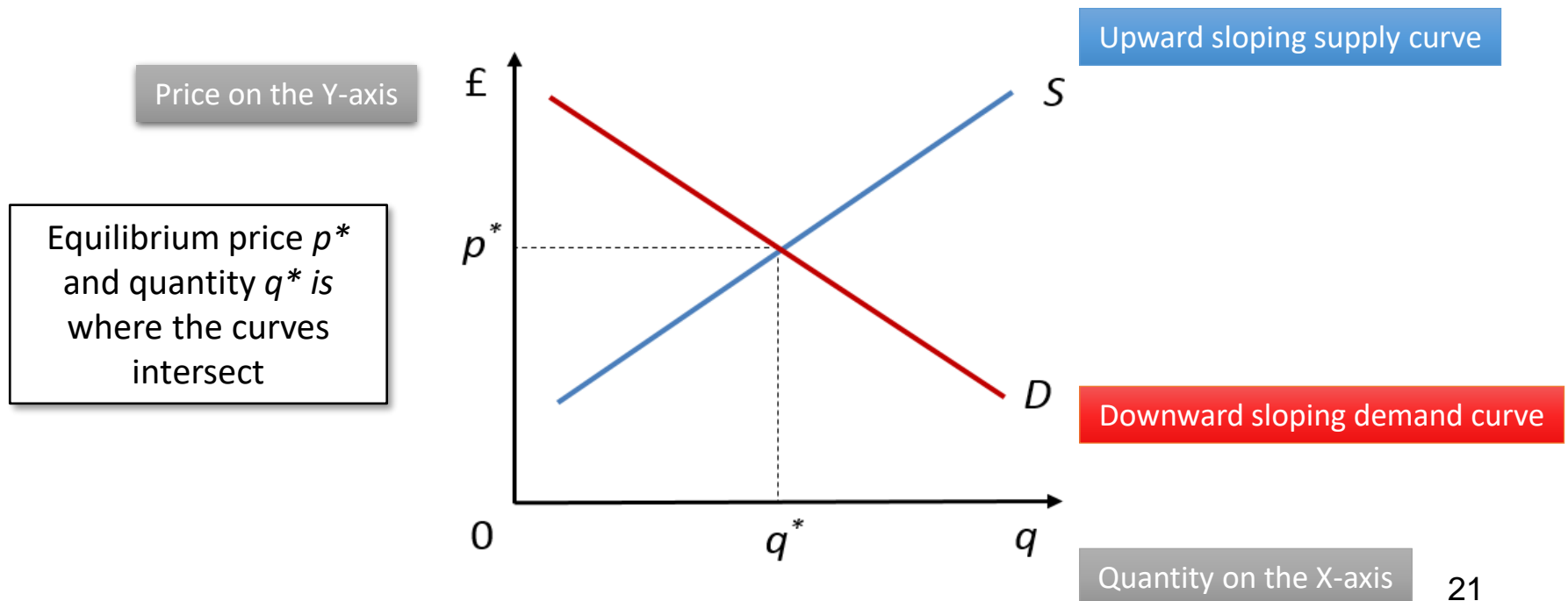
The standard way of looking at a market is through the two main elements that make it up, supply and demand:

Supply	Demand
<ul style="list-style-type: none">▪ Supply reflects the quantity of a good sellers are willing and able to sell at a particular price▪ If the price for a product increases, sellers will supply a greater quantity of the good	<ul style="list-style-type: none">▪ Demand reflects the quantity of a good buyers are willing and able to buy at a particular price▪ They will want to buy more if the price of the product decreases. This is known as the “law of demand”

The market as a model of supply and demand

While both demand and supply are referred to as curves, they are normally represented as linear relationships in basic analyses

- This type of analysis ignores the effect of time. This is why such models are called 'comparative statics'



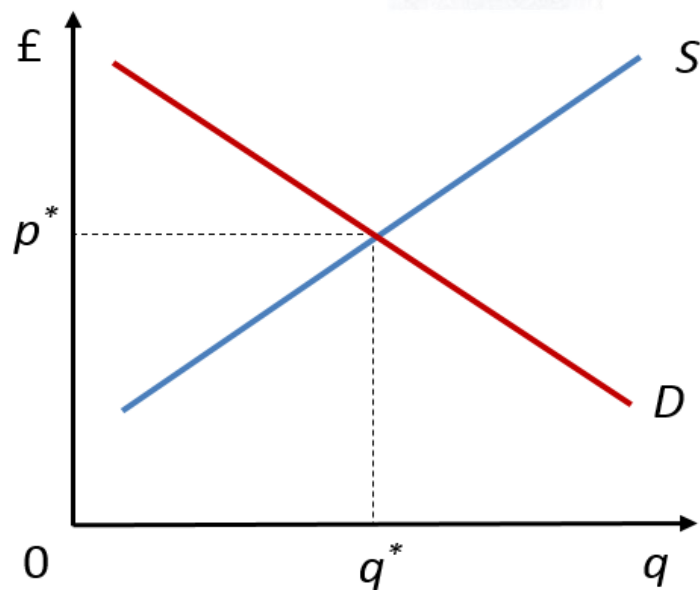
“The invisible hand” of the market

If the market operates in an undisturbed way, a peculiar situation occurs:

- The buyers act in a purely self-interested way
- The sellers act in a purely self-interested way

Yet, at the same time, the market coordinates what the buyers and sellers do so that:

Every product that can be produced or sold at p^* is supplied to a customer who is willing and able to pay for it!



But: aren't the axes switched?

Normally price p is seen as the determinant of quantity q , not the other way around. But normally the dependent variable is on the Y-axis:

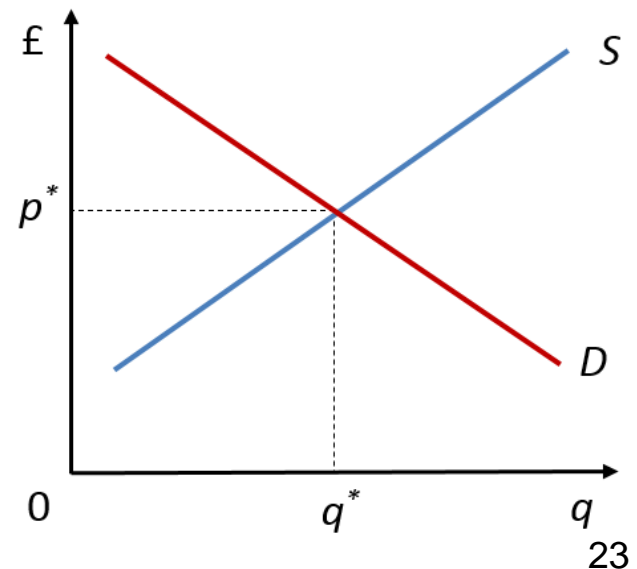
- Yes, this observation is correct. The usual graphs are actually showing inverse demand and inverse supply
- This means the linear demand function is:

$$q(p) = mp + t$$

- And the linear supply function is:

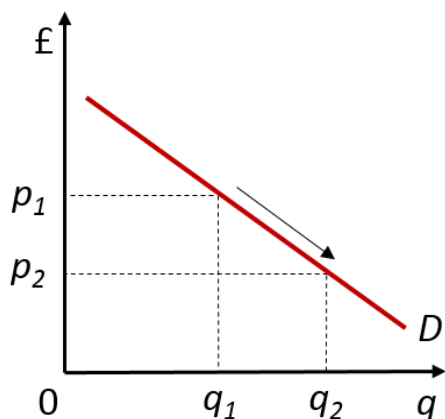
$$q(p) = ap + b$$

- Where the constants m and b are <0 and a and t are >0



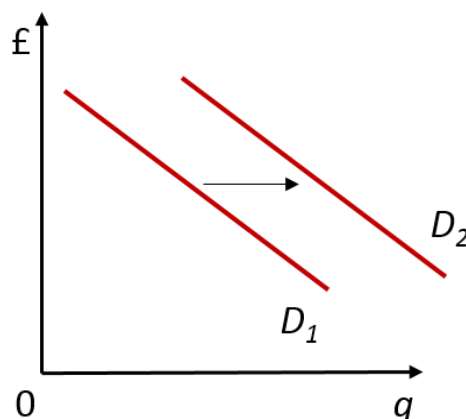
A closer look at the demand curve

Our static model is able to reflect three basic changes to demand structure:



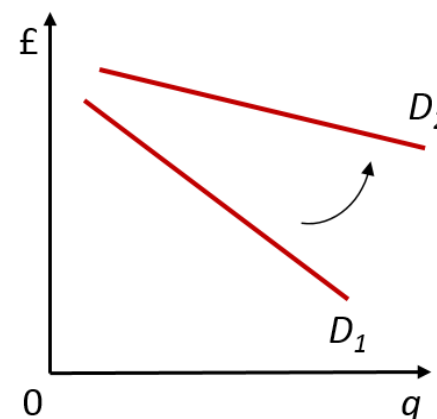
Movement along the curve

- Simply, either change in price or quantity



Shift of the curve

- Change in the buyers' income
- Prices for related goods change
- Change in preference, tastes, fashion, etc.
- Change in the size of the population



Pivot of the curve

- Change in “price elasticity of demand” → e.g. caused by change in level of necessity, consumer habits, branding, etc.

Own-price elasticity of demand

The slope of the non-inverse demand function is related to the concept of own-price elasticity of demand (*PED*)

- Also known as “price elasticity of demand”
- Defined as the percentage change of q over the percentage change of p :

$$PED = \frac{\Delta q/q}{\Delta p/p}$$

- *PED* measures the responsiveness of a change in q resulting from a change in p
- It is important to note that *PED* is not constant along linear demand curves and it measures a percentage change from one state to another (q_0, p_0 to q_1, p_1)

How to estimate and interpret *PED*

Estimating *PED* is straightforward if q_0 , p_0 , q_1 and p_1 are given:

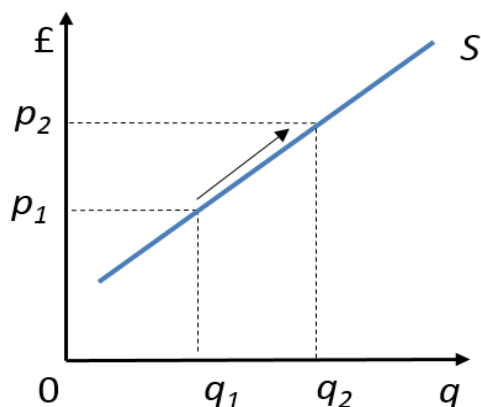
- The formula is simply:

$$PED = \frac{(q_1 - q_0)/q_0}{(p_1 - p_0)/p_0}$$

- We will interpret *PED* in terms of whether a good is a basic necessity or a luxury:
 - If the price of a basic product increases this has a smaller effect on quantity than with a luxury product
 - For example, a generic type of bread will exhibit a far smaller *PED* than a luxury artisanal bread
 - If $|PED| < 1$, economists speak of a price-inelastic good and if it is high $|PED| > 1$ they refer to the good as being price elastic
 - Note that $PED \leq 0$

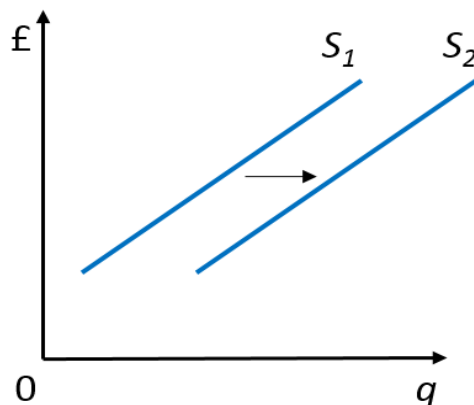
A closer look at the supply curve

Analogous, to demand, our static model is able to reflect three basic changes to supply structure:



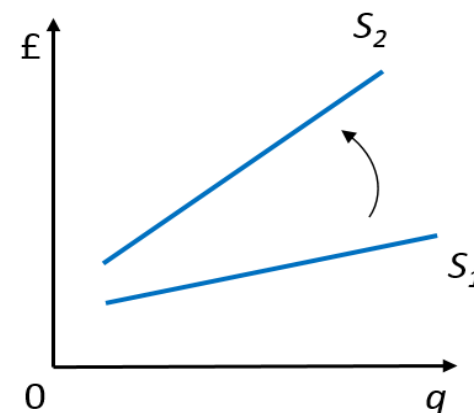
Movement along the curve

- Either changes in price or quantity



Shift of the curve

- Improvement in the available technology (inward/upward shift)
- Changes in input prices
- ...



Pivot of the curve

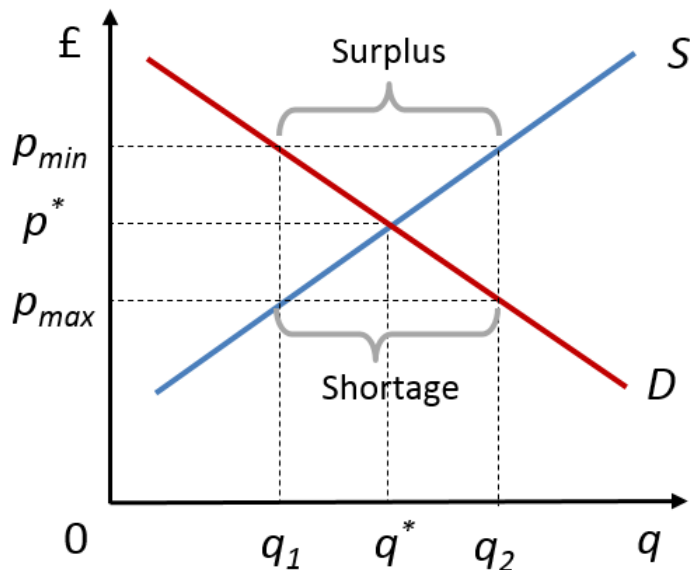
- Change in “price elasticity of supply” (*PES*) → change in:
 - number of producers
 - spare capacity
 - ease of switching products
 - ease of storage
 - length of production period
 - time period of training
 - how costs react to change in q

- See if you can figure out how to estimate *PES*...

Interfering with the market price

It is possible to analyse some effects of artificially setting a price, rather than letting the market determine it:

- E.g. the sellers may collude to charge a minimum price that lies above the equilibrium price → **results in a surplus**
- Alternatively, the government may set a price limit to favour certain parts of the electorate → **results in a shortage**



A simple numerical example



Imagine a hypothetical market for electric bicycles with a given linear demand function $d(p)$ and a given supply function $s(p)$. Calculate equilibrium price p^* and equilibrium quantity q^* :

Demand function	$d(p) = -5p + 10,000$
Supply function	$s(p) = 6p - 1,000$

- At the equilibrium price p^* demand matches supply $d(p^*) = s(p^*)$, so:

$$\begin{aligned} -5p^* + 10,000 &= 6p^* - 1,000 \\ p^* &= 1,000 \end{aligned}$$

- At $p^* = 1,000$ the equilibrium quantity q^* can be determined:

$$d(p^*) = q^* = -5(1,000) + 10,000 = 5,000$$

Additional information: basic types of market

It is possible to distinguish between markets on the basis of the number of buyers and sellers present in a market

- This has significant implications for the competitiveness of the market

Market type	Description
Monopoly	<ul style="list-style-type: none">▪ Only one seller of a product and multiple buyers▪ Output is likely to be too small, prices too high▪ Examples: power generation, pharmaceuticals, social media
Oligopoly	<ul style="list-style-type: none">▪ Small group of sellers and multiple buyers▪ Price and quantity depends on strategy, anything can happen▪ Examples: automotive industry
Monopolistic competition	<ul style="list-style-type: none">▪ Many sellers and many buyers▪ Slightly different versions of products → quantity will be too small▪ Examples: branded consumer goods and fashion
Perfect competition	<ul style="list-style-type: none">▪ Many sellers and many buyers, indistinguishable products▪ Prices will be competitive, quantity will be efficient▪ Examples: agricultural products or commodities

Theory of the firm...

**... bringing together the market and
decisions in firms**

The Theory of the Firm

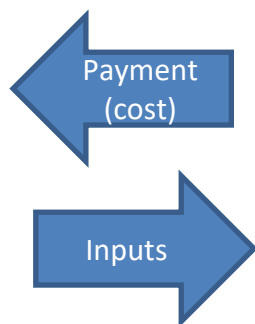
The Theory of the Firm is a group of theories which explain and predict how firms and companies behave under market conditions.

- The goal of this is to show how firms will behave when they resolve technical (i.e. engineering) considerations and market forces
 - Setting prices and quantities
- All of this happens under the assumption of rationality (i.e. profit maximisation)

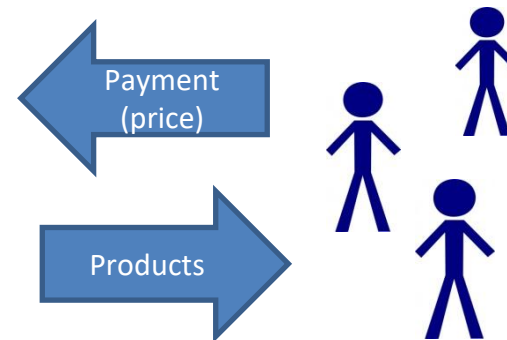
What a firm does

It buys inputs...

Inputs include the *three primary factors of production*: land, labour, and capital goods. Inputs also include raw materials. The firm incurs costs for buying these inputs. The sum of these costs is the total cost (TC)



... and makes and sells products



Products or services (“outputs”) are sold at a price to buyers, resulting in revenues. The sum of these revenues is the total revenue (TR).

The traditional (“orthodox”) view of the firm is that it is a rational entity, making decisions, buying inputs, making outputs and selling them with the sole objective of maximising profit

- Profit (π) is defined as the difference of total revenue (TR) and total cost (TC):

$$\pi = TR - TC$$

Cost theory

Cost theory is the study of the costs arising to the firm for the production of goods and services

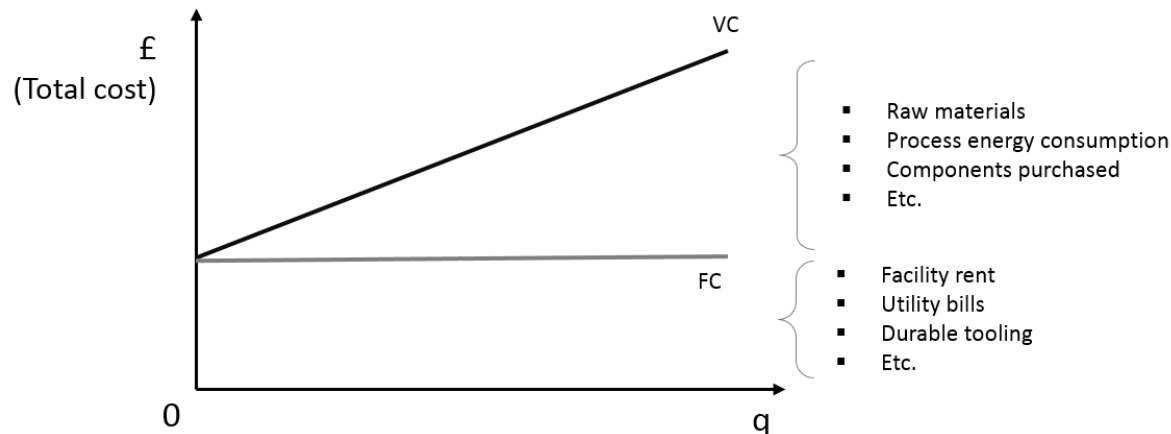
- A fundamental distinction can be made between fixed costs (FC) and variable costs (VC)

Fixed costs (FC)	Variable costs (VC)
<p>FC are costs that are not linked to the total quantity of goods and services produced.</p> <ul style="list-style-type: none">• FC are not fixed indefinitely, they are only fixed over a relevant period of time (the “short run”).• Examples: rent, utility bills, but also tooling if it is durable, etc.	<p>VC are costs that change in proportion to total sum of goods and services produced.</p> <ul style="list-style-type: none">• Examples: raw materials, energy used for production, components purchased, etc.• Direct labour used in the productive process

Fixed costs and variable costs

Variable costs and fixed costs do not always align with other concepts of cost, such as Cost of Goods Sold (COGS)

- The mapping between the categories of input/process/operating costs and fixed/variable costs depends on the situation analysed
- The total cost TC associated with a quantity q' can be decomposed into the total fixed costs (FC) and the total variable costs (VC):



Average cost and marginal cost

Average cost (AC), also called unit cost, is the basic form of cost associated with each unit of output and a quantity of q units. AC is the total cost TC associated divided by the quantity produced:

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

- In the engineering context, design approaches such as Design for Manufacture and Assembly (DFMA) have been formulated to minimise AC

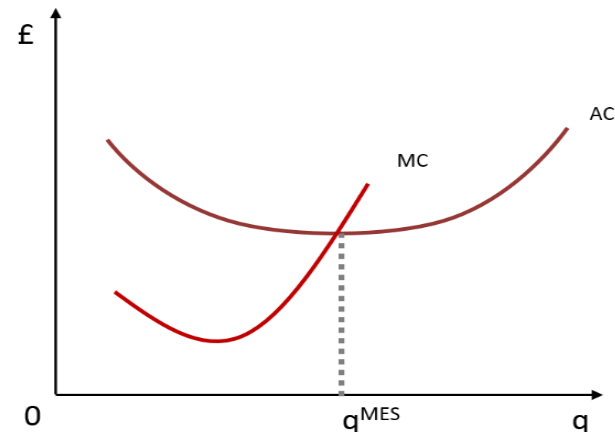
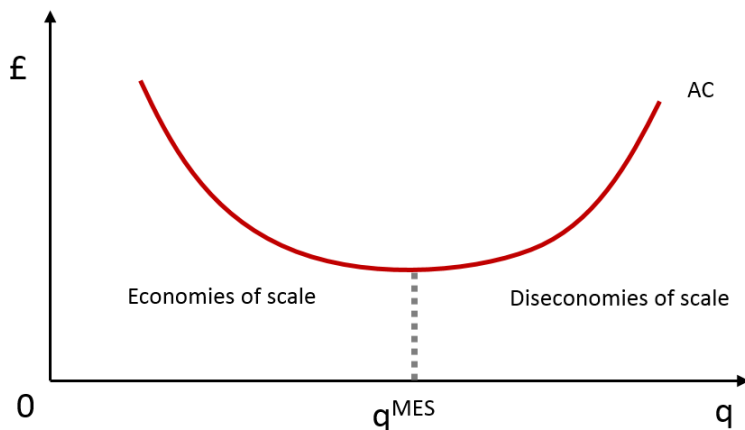
Marginal cost (MC) a different form of cost associated with each unit of output. As a process-related cost, it describes the cost of the additional unit of output “at the margin”

- It is the derivative of the total cost function $TC(q)$
- Example: a car manufacturer has produced 500 cars. The MC of the 500th car is the extra cost incurred to make it after making 499 cars

Drawing cost curves

Drawing AC and MC functions as curves is a very helpful tool. Usually, they are understood to be 'U' shaped curves, at least in the long run. The reason for this is a mix of technical and organisational factors

- “Economies of scale” which reduce AC at low levels of output
- “Diseconomies of scale” increasing AC at high levels of output
- The point of minimum efficient scale q^{MES} , at which the firm is incurring the minimum AC, defines how production should be set up to minimise cost. Note that the AC and MC curves intersect at this point

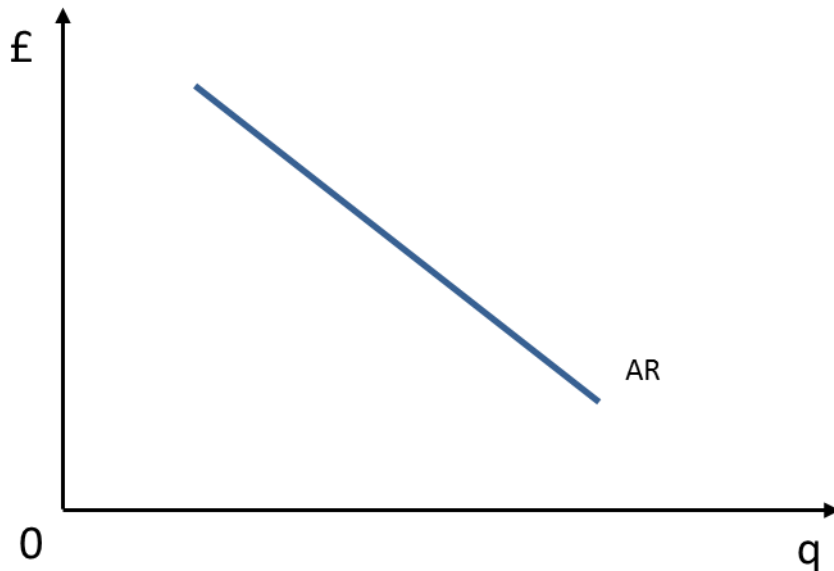


Revenue theory

Unlike costs, which are shaped by technical questions in the theory of the firm, revenue seen as determined by buyer behaviour and the market

- Average revenue is defined as the total revenue TR divided by the quantity q produced:

$$AR = \frac{TR}{q}$$

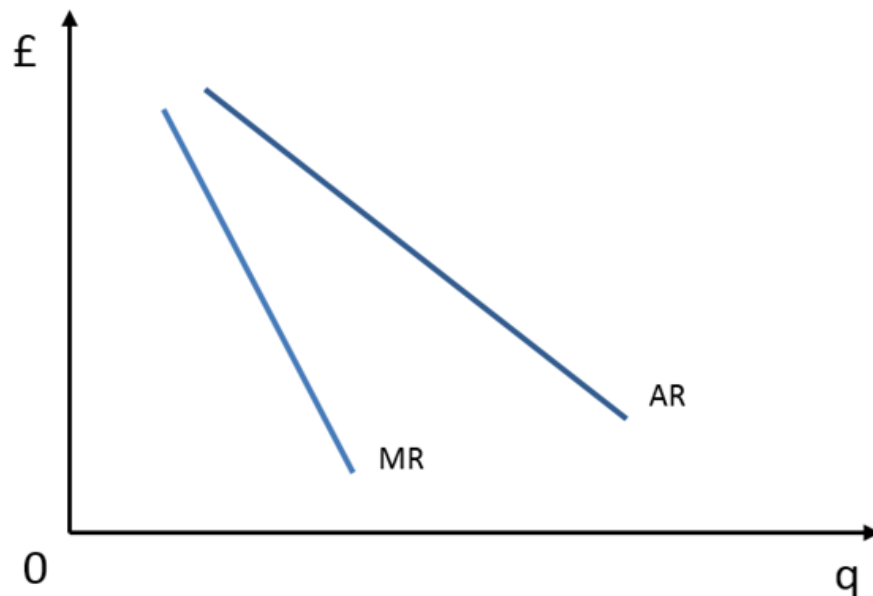


- Normally, the AR function enters as a downward sloping line, indicating that at output quantity q increases, the willingness to pay for each unit decreases.
- The AR curve equates to the demand curve faced by the firm, but **NOT** demand in the market
- Exceptions: monopoly and perfect competition

Marginal revenue

Marginal revenue (MR) is the additional (“extra”) revenue obtained by increasing the output quantity q by one unit

- Example: A car manufacturer has produced 500 cars. The MR associated with the 500th car is the extra income generated after selling 499 cars



- The MR function is expressed graphically as downward sloping curve
- It is the derivative of $TR(q)$

Determination of quantity, price and profit

With this basic framework, it is possible to use comparative statics to show how a rational, profit maximising firm will determine quantity q to maximise its profits (π)

- Note that in the traditional theory of the firm, it is assumed that the producer will always maximise profit.
- This is done by applying what is known as the ‘first order criterion of profit maximisation’, setting q such that:

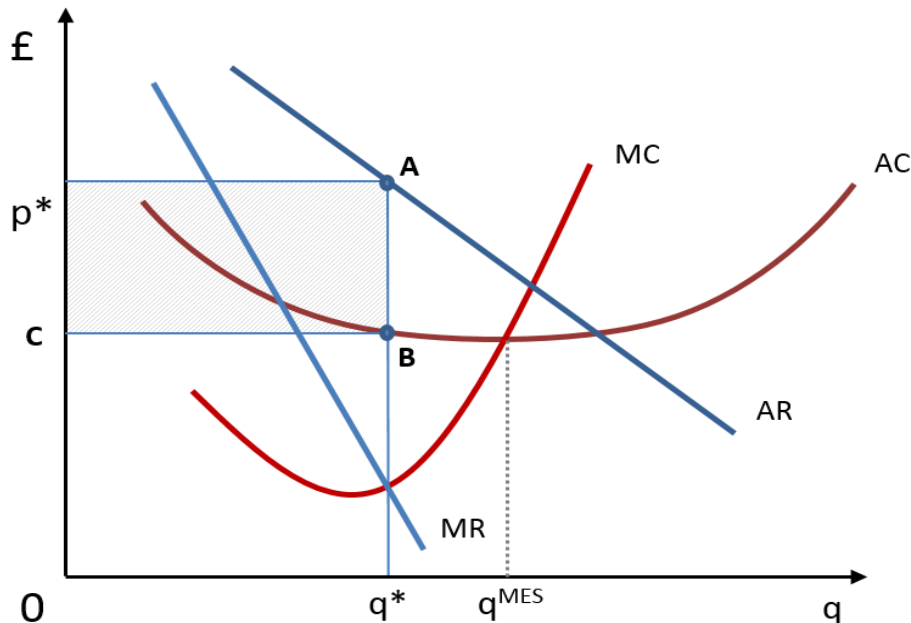
$$MR = MC$$

- Note that due to the non-linearity in the MC function we will solve this graphically

Profit maximisation in the theory of the firm

In the following graphical solution, we combine the AC , MC , AR and MR curves:

- The profit maximising level of output q^* is defined by the intersection between the MC and MR functions.
- Profit will be maximised by making q^* products, incurring a TC of q^*c and receiving total revenues (TR) of q^*p^*



- The profit received by the firm corresponds to the shaded area $ABcp^*$
- The firm will make a loss if $TC > TR$

Key messages of the theory of the firm

- Price and cost are two distinct concepts but can be resolved in a single framework
- The framework incorporates both technical aspects in cost functions and market characteristics in revenue functions
- Just as in a market, the price set by a rational firm is the outcome of some profit maximising behaviour

MAIN POINT: RATIONAL FIRMS WILL NOT SET PRICES ARBITRARILY (E.G. “MARK-UP PRICING”)



Lecture summary in three points

- Know now what a good is and understand the idea of efficiency
- Know now what a market is and how it works, including market equilibrium
- Understand how the theory of the firm brings together market characteristics and technical characteristics to determine profit maximising levels of output



University of
Nottingham

UK | CHINA | MALAYSIA

Thank you!