BSc in IB - CBS
Class of '27

Microeconomics

Indholdsfortegnelse

CHAPTER 1 & 2 - INTRODUCTION, SUPPLY AND DEMAND

WHAT IS MICROECONOMICS?

SCARCE is when something is limited.

Microeconomics is concerning **how to allocate scarce resources**. A society faces three main decisions:

- What to produce?
- How to produce?
- How are products distributed?

MARKETS (the interaction of consumers and producers without direct orders from any one individual - supply and demand. Exchange mechanism that allows buyers to trade with sellers) and **governments** (policy makers) makes the decisions.

Microeconomics examines the role of markets: **When** and **why** are markets successful and a failure? And also, government interventions.

Often refers to Adam Smith’s work: Wealth of Nations.

MARKETS

Consumers and producers **interact** in a market, and the **prices link** the decisions about which **goods** and **services** to produce, how to produce them, and who gets them.

How are prices determined?

MARKETS are characterized or defined by:

- time
- place
- good or service

Demand, **supply**, and **prices** will depend on the **definition of a market**.

MODELS

A way to produce information to understand something better; a **simplification**.

Microeconomics uses models to understand **casual relationships**.

- An economic model describes an **economic situation in a simplified way** to focus on the main forces at play.
- Exclude non-important variables but keep all the important: *Everything should be made as simple as possible, but not simpler*.

Useful models have **testable predictions**. A **hypothesis** is a prediction about **cause** and **effect**. A hypothesis can be tested.

MAIN INGREDIENTS IN A MODEL

1. MAXIMIZATION UNDER CONSTRAINTS

- **Example**: It is only possible to choose one thing.
- Choose between chocolate, chips and cake
- **Preferences** play a role in the choice, but preferences are individual, so the choice will not be the same between person A and person B. **Preferences** are revealed from **choices**.

- Hierarchy: cake, chocolate, chips
- *Constraint* (**choice**): ***cake*** *or chocolate*, ***chocolate*** *or chips*, *chips or* ***cake***, *chocolate or chips or* ***cake***.
- **Utility-function** for the hierarchy: $u(\text{cake}) > u(\text{chocolate}) > u(\text{chips})$. It weighs the value, and the choice is chosen on behalf of the **highest utility value**.
- If someone chooses **cake**, when given the choice of *cake, chocolate and chips*, the idea is, that they then will choose **cake** when faced with ***cake*** *or chocolate* and ***cake*** *or chips*.

- People's behavior is following a maximizing utility function.

2. EQUILIBRIUM (BALANCE)

- Used in the **game theory**
- **Example:** two countries are considering emission reductions. Their preferences are the same: (risk of catastrophic climate change and emission reduction?) $u(\text{low risk and no}) > u(\text{no change and yes}) > u(\text{high risk and no}) > u(\text{low risk and yes})$.

- **Outcomes depend** on the choices of both countries:
  i. If both reduce emissions → no catastrophic climate change
  ii. If only one reduces emissions → low risk of catastrophic climate change
  iii. If neither reduces emissions → high risk of catastrophic climate change
- Quantifying the preferences (monetary value of climate change - monetary value of emission reduction):
  i. $u(\text{low risk and no}) = -800 - 0 = \mathbf{-800}$
  ii. $u(\text{no change and yes}) = 0 - 1000 = \mathbf{-1000}$
  iii. $u(\text{high risk and no}) = -1700 - 0 = \mathbf{-1700}$
  iv. $u(\text{low risk and yes}) = -800 - 1000 = \mathbf{-1800}$

- **Scenarios:**

	Reduction	No Reduction
Reduction	-1000, -1000	-1800, -800
No Reduction	-800, -1800	-1700, -1700

If both reduces, they lose 1000 billion euros each, and if neither reduces, they lose 1700 billion euros each.

If the US chooses a reduction, it is more optimal for China to make no reduction (-1000 versus -800). If US chooses no reduction, China is still better off with no reduction (-1800 versus -1700).

The equilibrium: No matter what the other country does, it is better to make no reductions.

But if they both made reductions, it would be cheaper for them both.

POSITIVE AND NORMATIVE STATEMENTS

POSITIVE STATEMENT is a **testable hypothesis**.

Example: The equilibrium outcome of the emission reduction scenario will involve a high risk of catastrophic climate change.

NORMATIVE STATEMENTS specifies what **should** be.

Example: The outcome of the emission reduction scenario should avoid catastrophic climate change.

SUPPLY-AND-DEMAND MODEL

You need to determine three things when using the supply-and-demand model:

- buyer's behavior,
- seller's behavior,
- and how they interact

COMPETITIVE MARKETS are those with many buyers and sellers, such as most agriculture markets, labor markets, and stock and commodity markets.

PRICE says something about value of a good or service.

DIAMOND-WATER PUZZLE: how can it be that water typically has a low price, even though we need it to live, but diamonds have a high price, but we can easily live without that.

Before using a supply-and-demand analysis, you must have a **DEFINITION OF MARKETS** (location, product, time) and **KEY ASSUMPTION** that drive buyers and sellers to act as price takers (firms are selling **homogeneous** products, many buyers and sellers that **do not think of affecting** the world market price).

DEMAND

- The quantity of a good or service that consumers demand depends on price and other factors (**DETERMINANTS**), such as consumers' incomes and the price of related goods.
- Consumers' **tastes** determine what they buy
- **Information** (or misinformation) affects consumers' decisions
- The **prices of other goods** also affect consumer's purchase; there could be a **substitute**
- The price of a **complement**: if you usually buy two things together, but one of the things are expensive, you might not buy the first thing
- **Income** plays a major role
- **Government rules and regulations** also affect purchase decisions
- **Other factors** may also affect the demand for specific goods.

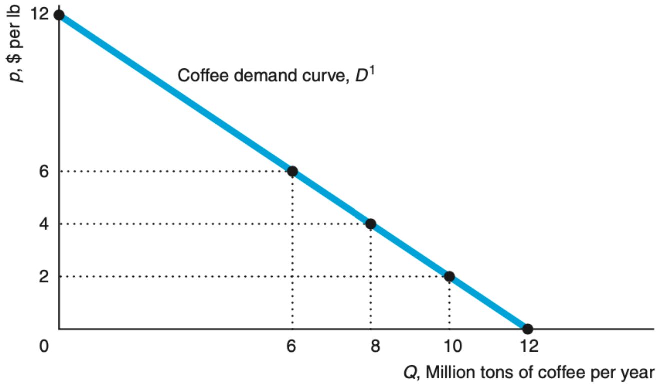
QUANTITY DEMANDED: the amount of a good that consumers are willing to buy at a given price, holding constant the other factors that influence purchases. The quantity demanded of a good or service can exceed the quantity actually sold.

DEMAND CURVE: the quantity demanded at each possible price, holding the other factors that influence purchases.

- The vertical axis of the graph measures the price, p, per unit of the good.
- The horizontal axis measures the quantity, Q, of the good in a physical measure per period.

Figure 2.1 A Demand Curve

The estimated global demand curve, D^1, for coffee shows the relationship between the annual quantity demanded and the price per lb. The downward slope of the demand curve shows that, holding other factors that influence demand constant, consumers demand a smaller quantity of this good when its price is high and a larger quantity when the price is low. A change in price causes a *movement along the demand curve*. For example, an increase in the price of coffee causes consumers to demand a smaller quantity of coffee.



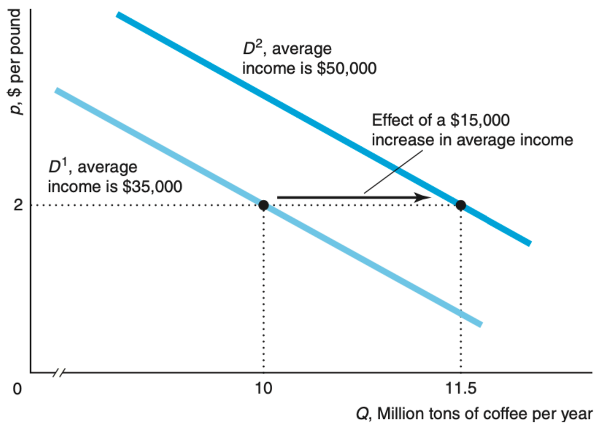
LAW OF DEMAND: consumers demand more of a good the lower its price, holding constant other factors that influence the amount they consume. According to the Law of Demand, demand curves slope downward.

MOVEMENT ALONG THE DEMAND CURVE: a change in price.

SHIFT OF THE DEMAND CURVE: when other factors (than price) have an impact, then the demand curve will move up or down.

Figure 2.2 A Shift of the Demand Curve

The global coffee demand curve shifts rightward from D^1 to D^2 as average annual household income in high-income countries rises by $15,000, from $35,000 to $50,000. At the higher income, a larger quantity of coffee is demanded at any given price.



The Demand Function

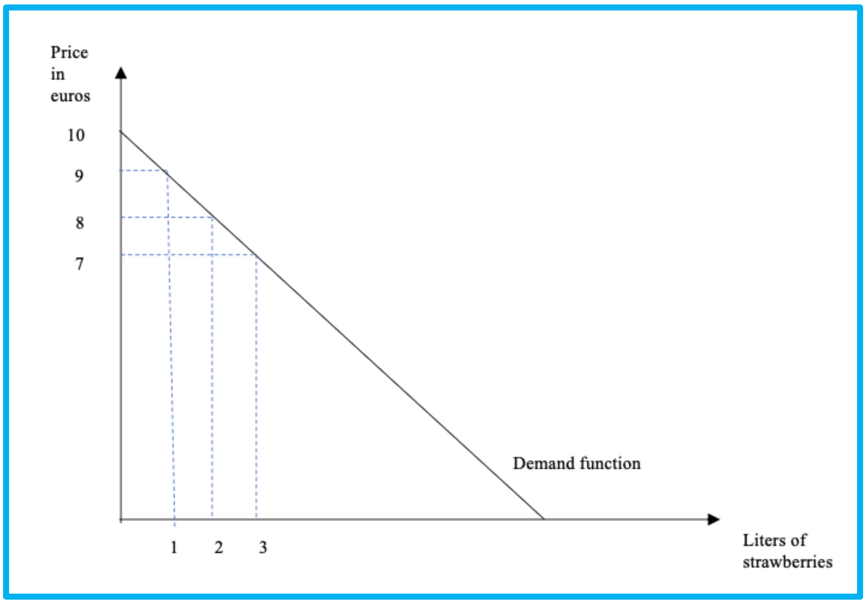
The demand function shows the relationship between the quantity demanded, price, and other **factors** (income, substitutes, complements, tastes, information) that influence purchases. The model explains the quantity demanded for a specific market (time, place and good/service).

Example:

$$Q^D = 10 - p$$

INVERSE DEMAND FUNCTION rewrites with a price as a function of quantity:

$$p = 10 - Q^D$$



Example of a demand function for coffee:

Q: quantity demanded, p: price of coffee, p_s: price of sugar, Y: consumers' income.

$$Q = D(p, p_s, Y)$$

Any other factors not explicitly listed in the demand function are irrelevant or constant.

$$Q = 8.56 - p - 0.3p_s + 0.1\,Y$$

Where Q is the quantity of coffee demanded in millions of tons per year, p is the price of the coffee in dollars per pound (lb), p_s is the price of sugar in dollars per pound ($0.20), and Y is the average annual household income in high-income countries in thousands of dollars ($35 thousand per year).

$$Q = 8.56 - p - (0.3 \cdot 0.2) + (0.1 \cdot 35)$$
$$Q = 8.56 - p - 0.6 + 3.5$$
$$Q = 12 - p$$

12 is the quantity demanded (in millions of tons per year) if the price of coffee is zero. If p equals to $2, then Q would be 10.

CHANGE IN PRICE: If the price falls from p_1 to p_2 the change in price is: $\Delta p = p_2 - p_1$

CHANGE IN QUANTITY: If the quantity demanded falls from Q_1 to Q_2 the change in price is: $\Delta Q = Q_2 - Q_1$

QUANTITY DEMANDED at p_1 is $Q_1 = D(p_1)$

CHANGE IN QUANTITY DEMANDED: $\Delta Q = -\Delta p$

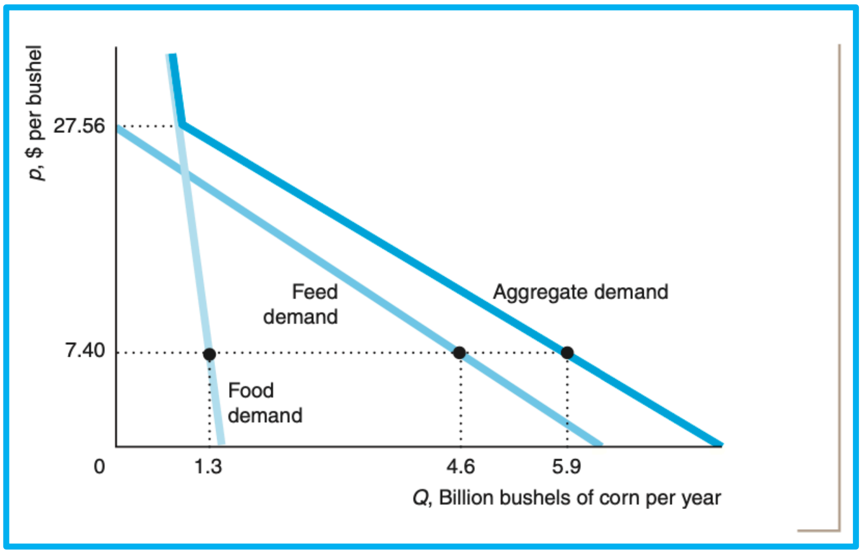
A decrease in price follows an increase in quantity demanded. An increase in price follows a decrease in quantity demanded.

SLOPE OF DEMAND CURVE: $\frac{\Delta p}{\Delta Q}$; the negative result of the slope is consistent with the Law of Demand.

SUMMING DEMAND CURVES: The total quantity demanded at a given price is the sum of the quantity each consumer demands at that price. The demand curves are added horizontally.

$$Q_1 = D^1(p)$$
$$Q_2 = D^2(p)$$
$$Q = Q_1 + Q_2 = D^1(p) + D^2(p)$$

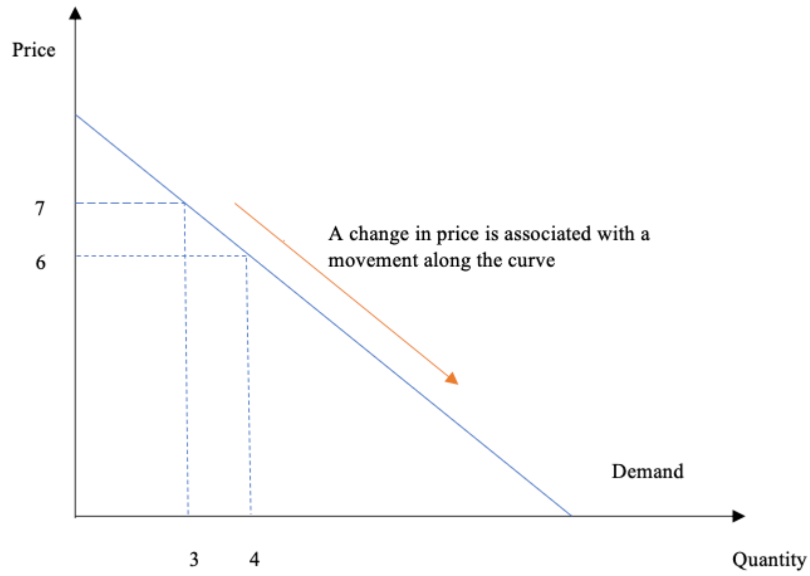
It only makes sense to add the quantities demanded when all consumers face the same price.



At $7.40 per bushel, the food demand is 1.3 and the feed demand is 4.6, which makes the aggregate demand 5.9 bushels of corn per year.

EFFECT ON DEMAND OF CHANGES

CHANGES IN THE PRICE OF THE GOOD often results in a downward curve, where the price is lower when higher quantities are demanded.



CHANGES IN INCOME: when the income is higher the demand will typically also be higher. This will often result in the demand curve **shifting outwards**, which is determined as **normal goods** - this could be a house. When income increases and demand **shifts inward**, the goods er **inferior goods,** which could be instant noodles, because rich people do not buy that.

Figure 2.4: An outward shift in the demand curve as income increases (normal goods)

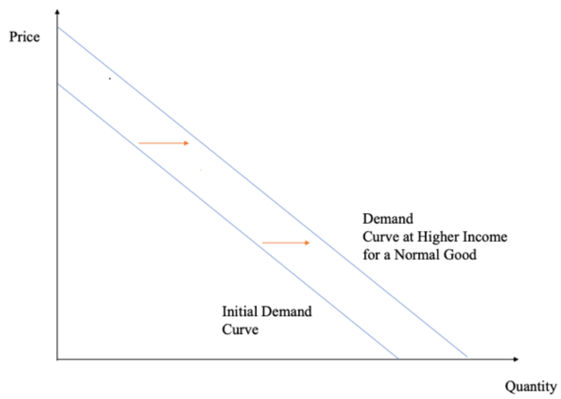
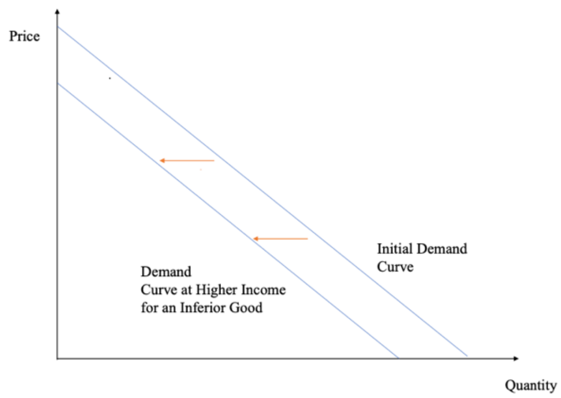


Figure 2.5: An inward shift in the demand curve as income increases (inferior goods)



CHANGES IN THE PRICE OF OTHER GOODS: at a given price, will consumers demand more or less if the price of another increases. Goods are **substitutes** when demand for 1 good increase if price of another good increases. This is called an **outward shift** in the demand curve. There may also be **inward shifts** in demand as the price of another product increases, which is when goods are **complements**. This is often cereal and milk.

Figure 2.6: An outward shift in the demand curve as the price of a substitute product increases

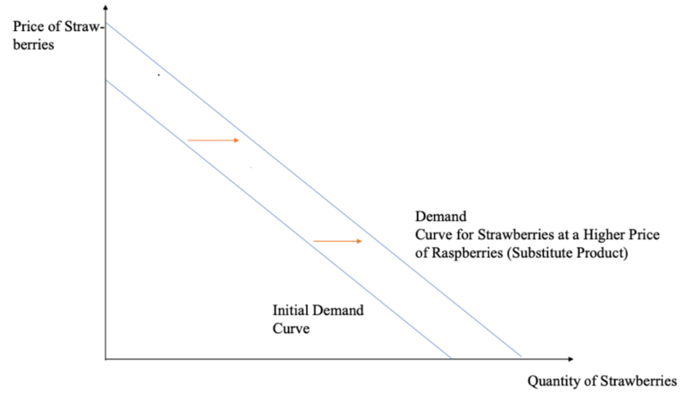
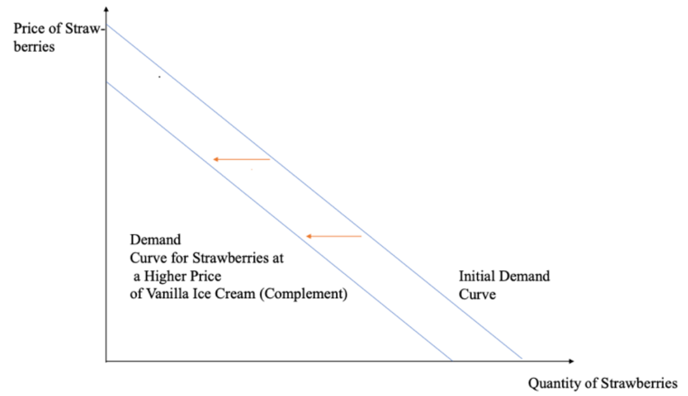


Figure 2.7: An inward shift in the demand curve as the price of a complement product increases



TAXES: the price for suppliers would be $\boldsymbol{p}$, but the price for the consumers would be $\boldsymbol{p+2}$ because the 2 are added from the taxes. The demand function is now:

$$\boldsymbol{Q^D = 10 - (p+2) = 8 - p}$$

OTHER FACTORS THAT SHIFT DEMAND FUNCTIONS

GENERAL FORM OF DEMAND FUNCTIONS:

$$\boldsymbol{Q^D = f(p, T, p_r, I)}$$

Where Q^D is quantity demanded, p is price for strawberries, T is temperature, p_r is price for raspberries and I is income.

SPECIFIC FORM OF DEMAND FUNTIONS:

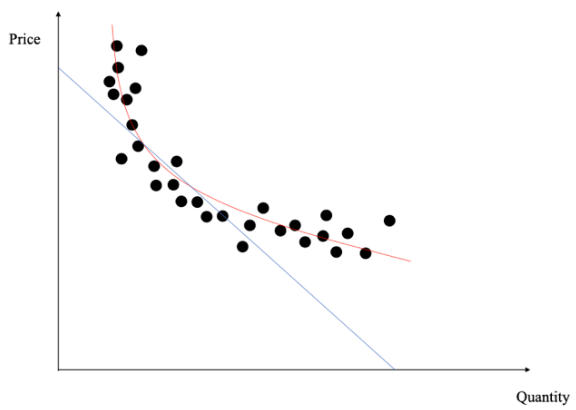
$$Q^D = 1 - p + T \cdot 0.25 + p_r \cdot 0.75 + I \cdot 0.5$$

If $T = 20$, $p_r = 2$, and $I = 5$, then the form for quantity demanded would be $Q^D = 10 - p$. The demand depends positively on temperature, the price of raspberries and the income. Had it been negative numbers, it would have a negative impact on the demand.

$$Q^D = 1 - p + (20) \cdot 0.25 + (2) \cdot 0.75 + (5) \cdot 0.5) = 10 - p$$

DIFFERENT SHAPES occur in demand functions. Often the curve will flatten at the lower prices, but a linear model is great at explaining the "middle prices". Special care is needed when making inferences about what happens as either the number of units goes to 0 or the price goes to 0.

Figure 2.8: Demand: Different shapes



SUPPLY

...is the amount of a good that sellers are willing to sell at different prices. The supply curve typically **slopes upward**. At higher prices suppliers are willing to supply more.

Firms, whose decisions can be described by a supply curve, are not setting the price, they are **price takers**.

GENERAL FORM OF SUPPLY CURVE:

$$Q^s = f(p)$$

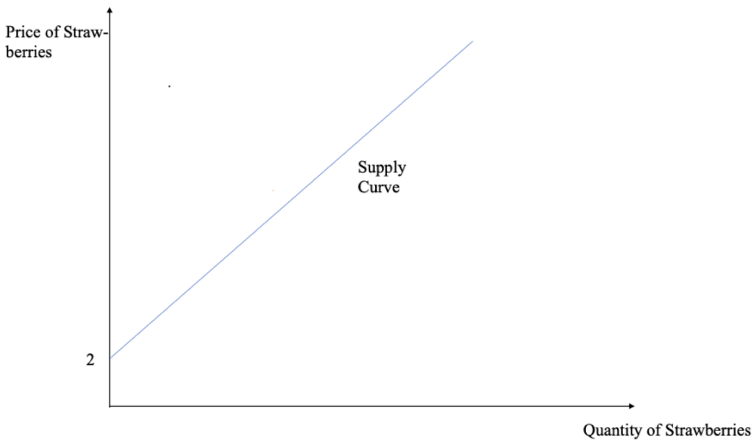
SPECIFIC FORM OF SUPPLY CURVE:

$$Q^s = -2 + p$$

INVERSE SUPPLY CURVE:

$$p = 2 + Q^s$$

Figure 2.9: Supply curve: An example

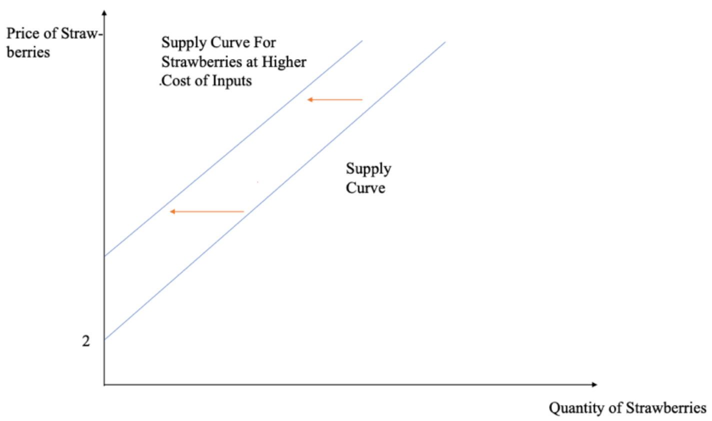


EFFECT OF CHANGES ON THE SUPPLY CURVE

CHANGES IN THE PRICE: As price changes, we move along the supply curve.

CHANGES IN THE PRICE OF INPUTS: If costs increase firms will want a higher price to supply the same quantity or the other way around. If costs increase, it will lead to an inward shift in the supply curve and the opposite way around.

Figure 2.10: Supply churve: The effect of higher input prices



OTHER FACTORS THAT SHIFT SUPPLY FUNCTIONS: Many other factors can also affect the supply. For instance, closed local market and disruptions of production.

TAXES: the price faced by suppliers is going to be $p - 2$. The supply function will now be:

$$Q^s = -2 + (p - 2) = -4 + p$$

When analyzing a market, you have to move the line of either a shift in quantity supply or quantity demanded.

MARKET EQUILIBRIUM

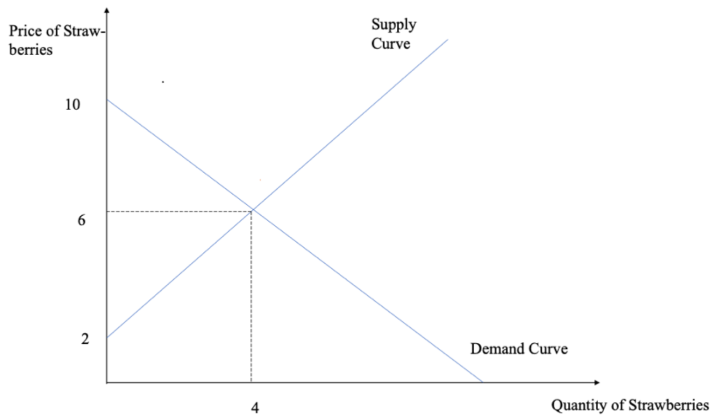
The market is in **equilibrium** when the price is such that quantity demanded equals the quantity supplied. This is also the **market clearing price**.

Using the expressions from above:

$$Q^D = 10 - p \text{ and } Q^s = -2 + p$$
$$12 = 2p$$
$$6 = p$$

The market equilibrium is at 6 euros.

Figure 2.11: Market equilibrium

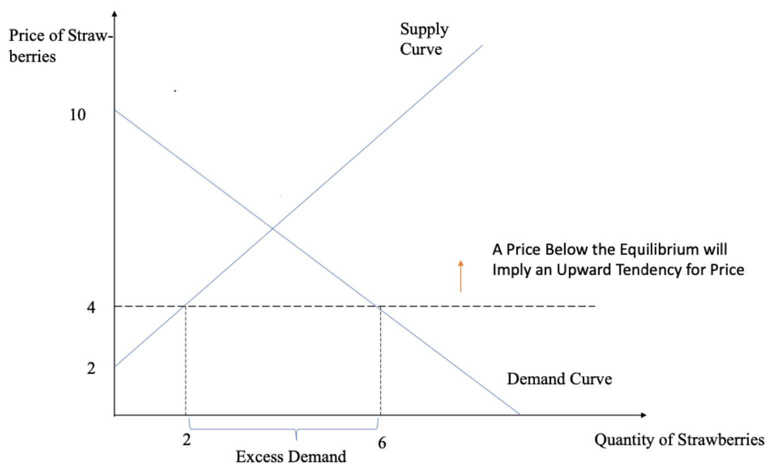


If the price is **below** the equilibrium the quantity supplied. There is **excess demand**, and the excess demand is the **difference between the quantity supplied and quantity demanded**. (If 6 liters were demanded, and 2 liters were supplied, the excess demand would be 4 liters). This can lead to resellers. As long as prices is **below** the equilibrium, we expect **upward pressure**.

FORCES THAT DRIVE THE MARKET TO EQUILIBRIUM:

- **Disequilibrium:** the quantity demanded is not equal to the quantity supplied.
- **Excess demand:** the amount by which the quantity demanded exceeds the quantity supplied at a specified price.
- **Excess supply:** the amount by which the quantity supplied is greater than the quantity demanded at a specified price.

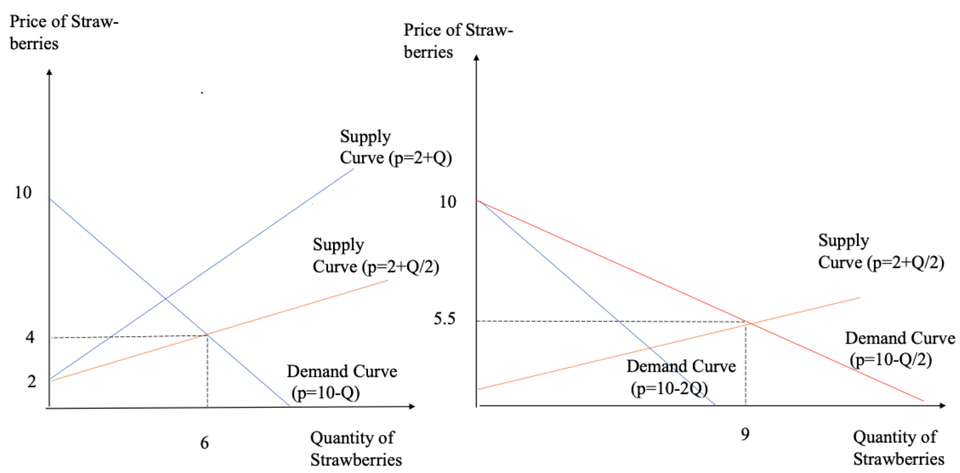
Figure 2.12: A price below the market equilibrium: Upward pricing pressure



If prices are **above** the equilibrium we expect a **downward pressure** on price. The difference will then be an **excess supply**. There will be **too many goods** that are not being sold.

Price is determined by both supply and demand.

Figure 2.14: Demand and supply jointly determine price and quantity



SHIFTS IN THE EQUILIBIRUM

COMMODITIES are goods that are produced by many, and prices move by the day or sometimes by the minute. This could be the metal Palladium.

Figure 2.15: An example of price movements for a commodity

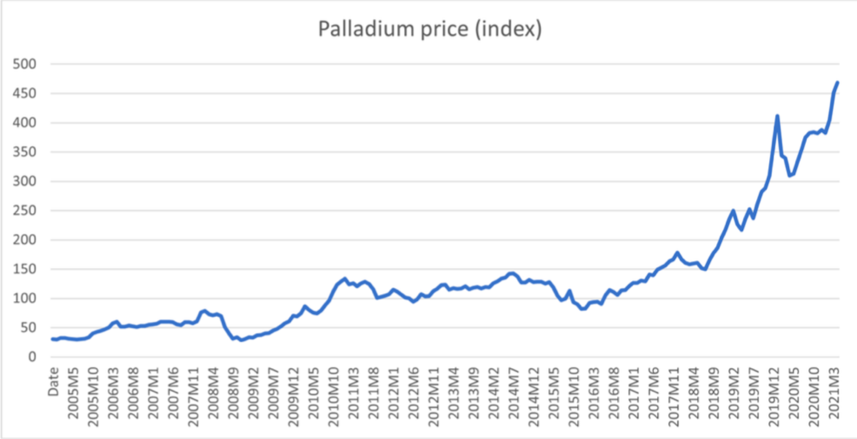
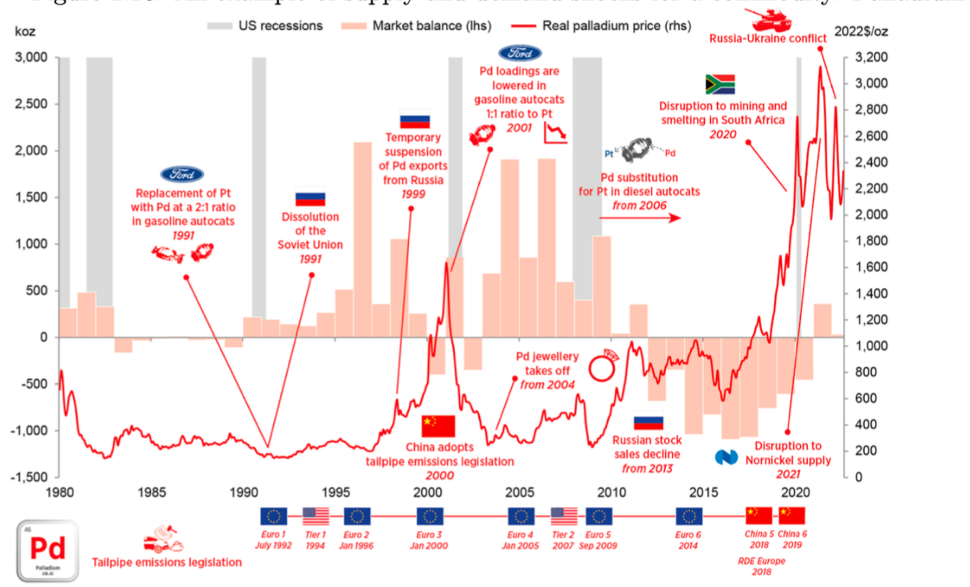


Figure 2.16: An example of supply and demand shocks for a commodity: Palladium



HOW TO ANALYZE THE EFFECT OF SHOCKS ON THE MARKET EQUILIBRIUM:

- Is it mostly demand OR supply that is affected?
  - Are incomes falling? Then it must be demand.
  - Are prices of close substitutes changing? This must be demand.
  - Are producers closing? This must be supply.
  - *Other things equal* is often used.
- Find the direction of change
  - At a given price, do we expect a particular change to lead to higher or lower demand/supply?
- Then at last jump to thinking "what happens to price and quantity?"

$$\boldsymbol{D_0 = \text{initial demand} \ \& \ S_0 \ \text{initial supply} \ \& \ p_0 \ \text{for the associated equilibrium price}}$$

Figure 2.17: Change in equilibrium: An increase in demand

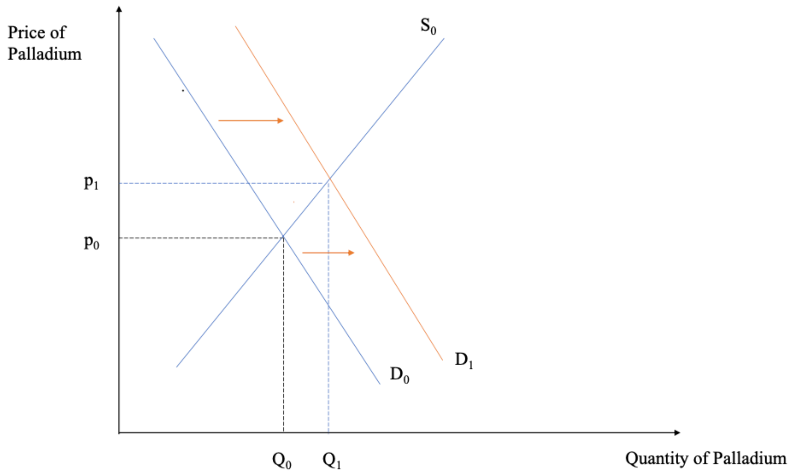
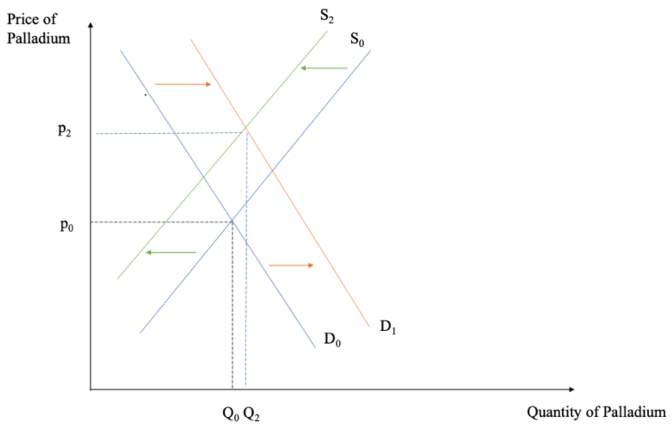
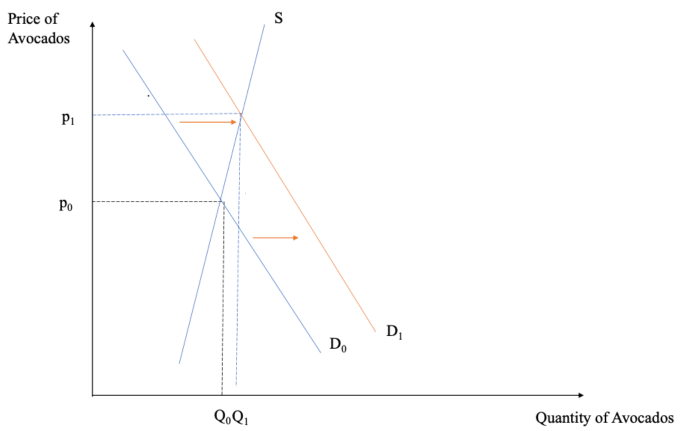


Figure 2.18: Change in equilibrium: An increase in demand and a decrease in supply



The **SIZE** of the shift and the **SLOPE** of the supply curve is important for the quantitative impact of a demand shock.

Figure 2.19: Change in equilibrium: A shift in demand when the supply curve is steep



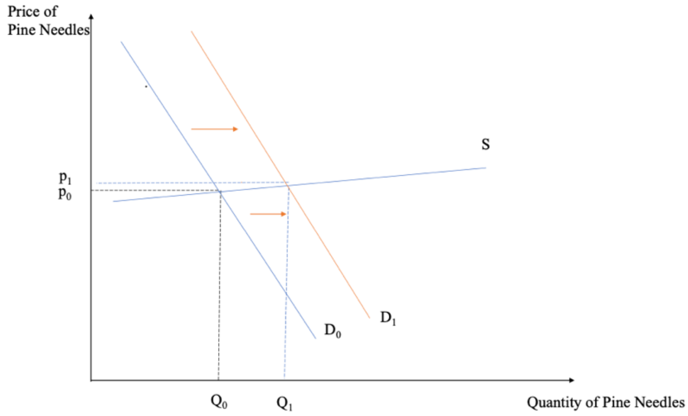


Figure 2.20: Change in equilibrium: A shift in demand when the supply curve is relatively flat

ELASTICITY

How much one variable affects another variable.

INELASTICY: It is a good idea to increase the price, if it is inelastic. The demand will be steep.

ELASTICY: It is not a good idea to increase the price, if it is elastic. The demand will be flat.

You always start from a given point, and we are interested in measuring how much x affects y. At given values of x and y, by what percentage does one percent increase in the value of x change the value of y?

$$e_{y,x} = \frac{\%\text{change in y}}{\%\text{change in x}} = \frac{\frac{\Delta y}{y}100}{\frac{\Delta x}{x}100} = \frac{\frac{\Delta y}{y}}{\frac{\Delta x}{x}} = \frac{\Delta y}{\Delta x}\frac{x}{y}$$

Also interpreted as "the percentage change in y given a 1% change in x", or "the percentage change in y given a very small percentage in x".

$$e_{y,x} = \frac{\mathrm{d}y}{\mathrm{d}x}\frac{\mathrm{x}}{y}$$

Elasticity is unit-free.

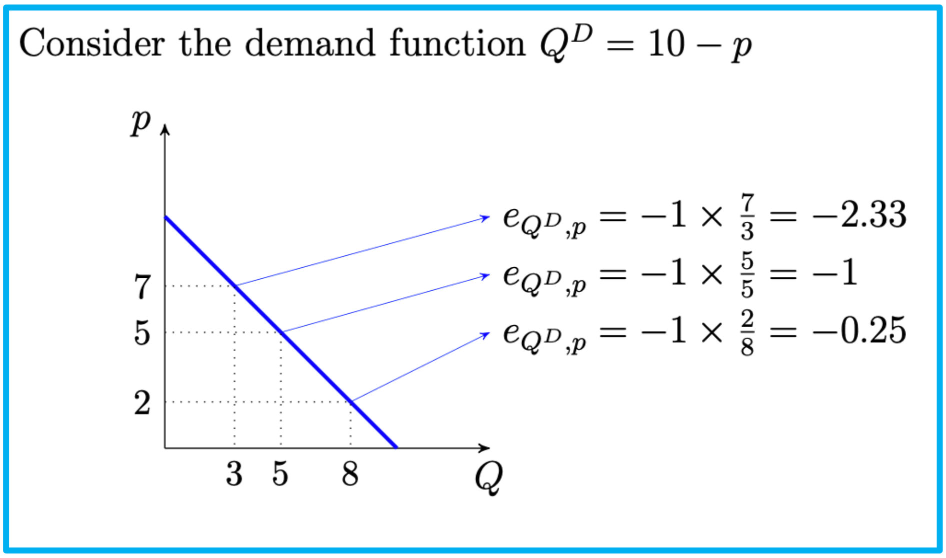
PRICE ELASTICITY OF DEMAND for a good given is $e_{Q^D,p}$ where Q^D is the quantity of the good demanded and p is the price of the good.

PRICE ELASTICITY OF SUPPLY for a good given is $e_{Q^S,p}$ where Q^S is the quantity of the good supplied and p is the price of the good.

INCOME ELASTICITY OF DEMAND for a given good is $e_{Q,I}$ where Q is the quantity of the good demanded and I is a measure of income (is sometimes denoted as Y).

CROSS PRICE ELASTICITY OF DEMAND for a given good is e_{Q,p_0} where Q is the quantity of the good demanded and p_0 is the price of another good.

Example of price elasticity of demand:



How much does Q^D when p changes? (answers and formulas on the figure).

$$e_{Q^D,p} = \frac{dQ^D}{dp} = \frac{p}{Q^D}$$

-1 is the slope of the price, which is multiplied by the difference.

7 is the x-value and 3 is the y-value (because the x- and y-variables is changed around, because p is on the y-axis).

The values are **negative** in a **demand function** - in a **supply function** it will be **positive**.

Let $T = 20$ degrees, $p_r = 2$ euros, and $I = 5$ is income in thousands of euros.

$$Q^D = 1 - p + T \cdot 0.25 + p_r \cdot 0.75 + I \cdot 0.5 \text{ and } Q^D = 10 - p$$

Example of income elasticity of demand:

$$e_{Q^D,I} = 0.5 \cdot \frac{5}{Q^D}$$

5 is the income in thousands of euros, and 0.5 is the slope of the income.

Example of cross price elasticity of demand:

$$e_{Q^D,p_r} = 0.25 \cdot \frac{2}{Q^D}$$

2 is the price for raspberries, and 0.25 is the slope of the p_r.

WHEN IS IT ELASTIC AND INELASTIC?

When the price and quantity are such that **the absolute value of** $e_{Q^D,p}$ **exceed 1**, we say that the demand is **elastic**, and otherwise it is **inelastic**.

A **vertical** demand is **perfectly inelastic**, and a **horizontal** demand is said to be **perfectly elastic**.

LINEAR DEMAND

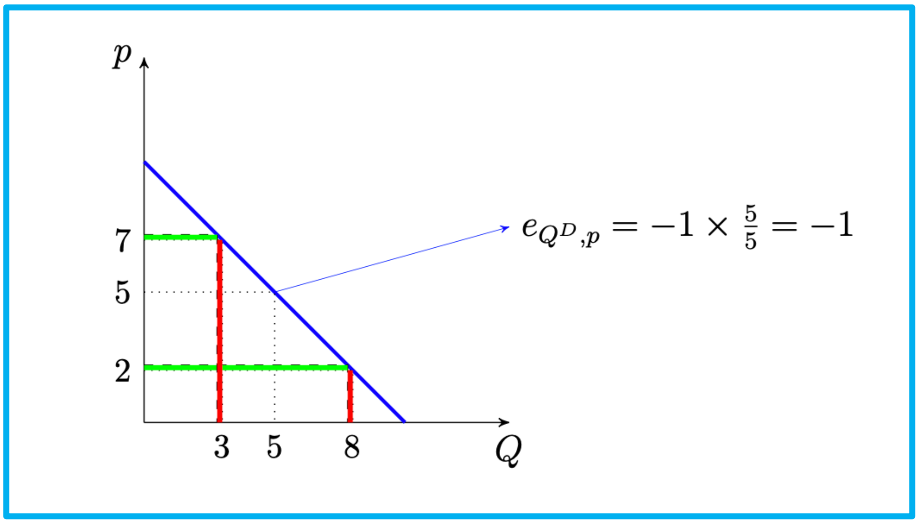
The inverse demand function $p = a - b \cdot Q^D$ for constants $a, b > 0.$

The direct demand is $Q^D = \frac{a}{b} - \frac{p}{b}$

FORMULA FOR THE PRICE ELASTICITY OF DEMAND:

$$e_{Q^D,p} = -\frac{1}{b} \cdot \frac{p}{Q^D}$$

REVENUE is what is collected for selling Q units at a price p

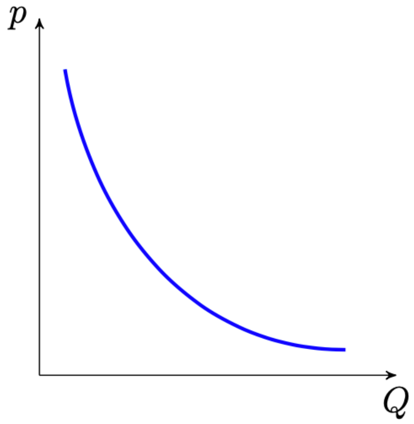


Increasing price when demand is **inelastic increases revenues. Increasing price** when demand is **elastic decreases revenue.**

CONSTANT PRICE ELASTICITY OF DEMAND:

$$Q^D = a \cdot b^{-b} \text{ for constants } a, b > 0$$

$Q^D = ap^{-b}$ for constants $a, b > 0$.
For example, $Q^D = 3p^{-2}$



$e_{Q^D,p} = -b$

CHAPTER 3 - FROM TECHNOLOGY TO COSTS

KEY CONCEPTS

GOODS are physical products.

SERVICES are activities provided by other people such as a haircut, yoga instruction etc.

In a restaurant you pay for a **COMBINATION** of goods and services.

A **FIRM** is the decision maker who decides what and how to produce. It could be both profit and non-profit. Anything that produces an output. The firm is equipped with a **PRODUCTION TECHNOLOGY**.

FACTORS OF PRODUCTION

The firm buys **PRODUCTION INPUTS (OR FACTORS)** to produce the good or service.

LABOR is the time devoted to production by humans.

CAPITAL is used to denote resources that are used in the production but that are not spent. This could be buildings, computers, and machinery.

INTELLECTUAL CAPITAL is patents, trademarks, or designs (also referred to as intangible capital) - these are highly important for firms in entertainment or pharmaceutical markets.

LAND is a factor of production clearly crucial in agricultural production.

INPUTS is a synonym for factors of production.

RAW MATERIALS are an important input for some goods.

INTERMEDIATE INPUTS are manufactured products that are used in the production.

THE PRODUCTION FUNCTION

OUTPUT is measures in the number of units of the good or service, Q. The set of inputs needed differ across firms. The focus is on 2 inputs: capital, K, and labor, L. Specifies what can be produced with given inputs and production technology.

For each combination of input (labor and capital), how many units is the output?

GENERAL FORM OF PRODUCTION FUNCTION, that states that the amount of L and K used gives some number of units of output Q for the firm.**:**

$$\boldsymbol{Q = f(K, L)}$$

MORE GENERAL FORM, where M denotes materials:

$$\boldsymbol{Q = f(K, L, M)}$$

SPECIAL FORM OF PRODUCTION FUNCTION: (Cobb-Douglas)

$$\boldsymbol{Q = \sqrt{K, L}}$$

It can also be described by a matrix as shown below.

Table 3.1: A representation of a simple production function

		L		
		1	**2**	**3**
	1	10	14	16
K	**2**	14	20	24
	3	16	24	30

THE MARGINAL PRODUCT OF LABOR is the concepts of the change in output as the amount of labor used increases by a small amount (one input) while keeping other inputs fixed. It is denoted as: MP_L. This is also the slope of a function at a particular point. The marginal product of labor depends on the values taken by the inputs.

The marginal product of labor is the change in output from a small change in the amount of labor used, holding other inputs fixed. This is also the **PARTIAL DERIVATIVE** of the production function with respect to labor, which is denoted as $\frac{\partial Q(K,L)}{\partial L}$. An example:

$$Q(K,L) = \sqrt{KL} \rightarrow \frac{\partial Q(K,L)}{\partial L} = \frac{1}{2} L^{\frac{1}{2}-1} K^{\frac{1}{2}} \rightarrow \frac{1}{2} L^{-\frac{1}{2}} K^{\frac{1}{2}} \rightarrow \frac{1}{2}\sqrt{\frac{K}{L}}$$

GENERAL FORM OF MARGINAL PRODUCT OF LABOR:

$$Q(K,L) = AK^a L^b$$

If capital is important, then a is high → if labor is important, then b is high.

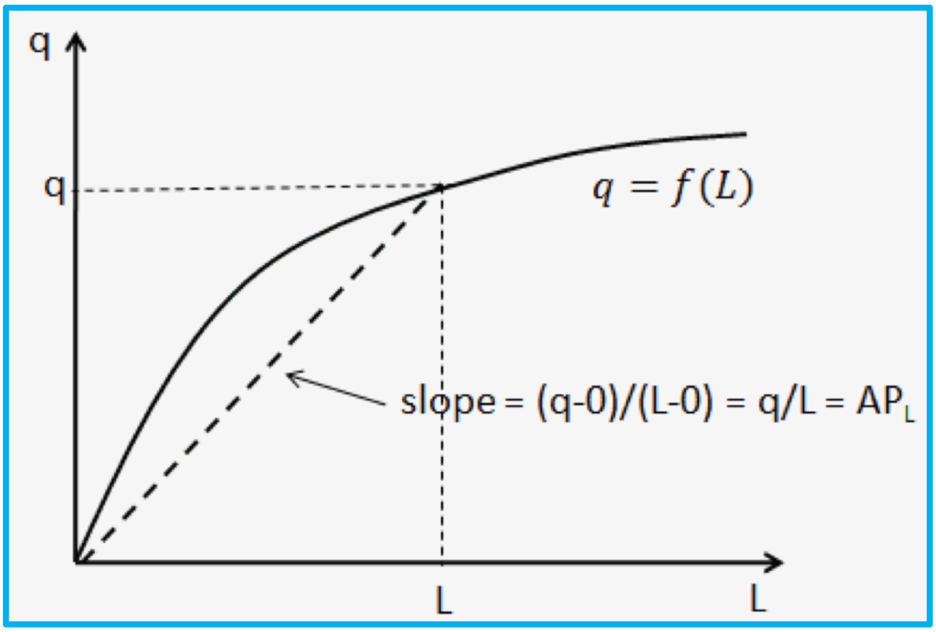
$$MP_L = \frac{\partial Q}{\partial L} = \frac{b}{L} \cdot Q$$
$$MP_K = \frac{\partial Q}{\partial K} = \frac{a}{K} \cdot Q$$

You should hire an extra unit of labor, as long as the benefit from hiring $p \cdot MP_L$ is at least as great as wage.

As an example from the Black Death in the 1300s, less labor in relation to land drove up marginal product of labor, and hence wages.

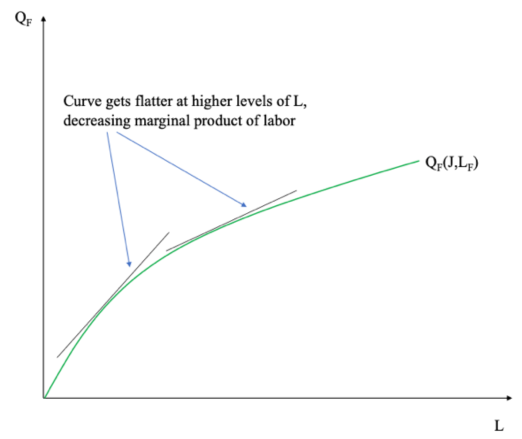
THE AVERAGE PRODUCT OF LABOR is the slop of the line that goes from origin to the point on the production function that corresponds to that quantity of labor. It is denoted as: AP_L

$$AP_L = \frac{q}{L}$$



DECREASING MARGINAL PRODUCT OF LABOR is a pattern that shows that each additional worker adds less than the previous worker. This pattern is also shown in the figure below. Decreasing marginal product is not the same as decreasing product.

Figure 3.1: An example of a production function and the marginal product of labor



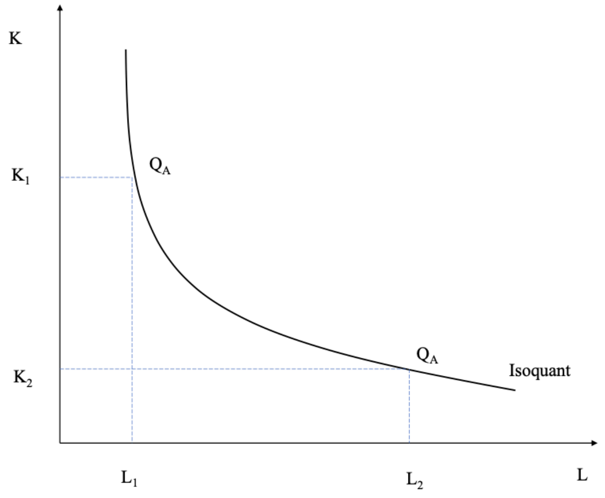
DESCRIBING THE TECHNOLOGY

When different combinations of inputs (e.g. capital and labor) give the same output, it is **ISOQUANT**. This is shown as the two different combinations of capital and labor that gives the same output in the figure below.

MARGINAL RATE OF TECHNICAL SUBSTITUTION (MRTS) is the slope of the isoquant, and it reflects how easy it is to substitute one input for another.

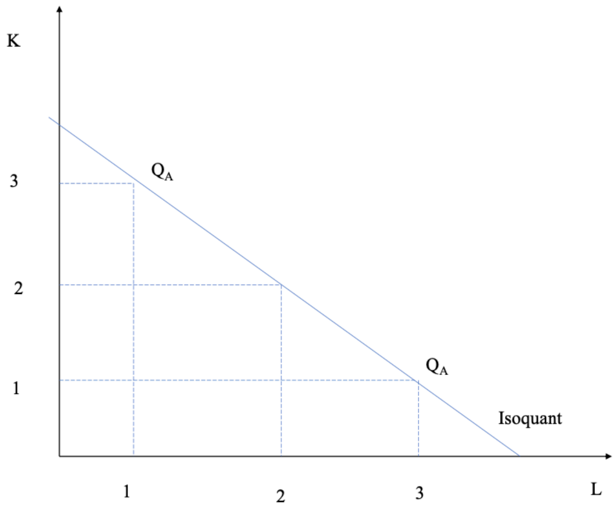
$$MRTS = slope\ of\ isoquant = \frac{MP_L}{MP_K}$$

Figure 3.3: Different combinations of inputs that produce the same output



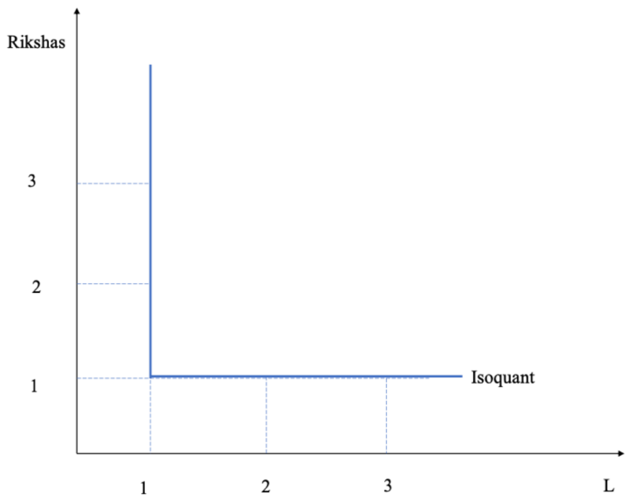
PERFECT SUBSTITUTES is when e.g. the change 1 baker for one unit of capital produces the same output. They are perfectly substitutable.

Figure 3.4: Isoquants for perfect substitutes



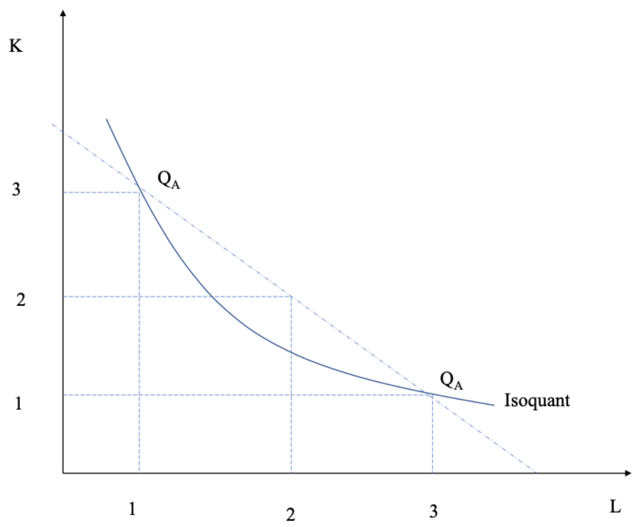
Two inputs are **PERFECT COMPLEMENTS**, when the things cannot be substituted (a taxi needs a car, and cannot use 2 cars, and 2 taxi drivers would also not change anything with one car).

Figure 3.5: Isoquant for perfect complements



If they are not perfect substitutes or perfect complements, they are **IMPERFECT SUBSTITUTES**, and this is the most common type of situation for the relation between inputs. These graphs are strictly convex

Figure 3.6: Isoquant for imperfect substitutes



TOTAL DIFFERENTIATION

To find out the change of both inputs, we need to find the partial derivative of the function with respect to K, while keeping L fixed in the function: $\boldsymbol{Q = f(K, L)}$. This is the **TOTAL DIFFERENTIATION:**

$$dQ = \frac{\partial f(K, L)}{\partial K} dK + \frac{\partial f(K, L)}{\partial L} dL$$

Along the isoquant $\boldsymbol{dQ = 0}$. Changes in capital and labor inputs that leave the quantity unchanged. Thus, along the isoquant:

$$dQ = 0 = \frac{\partial f(K,L)}{\partial K} dK + \frac{\partial f(K,L)}{\partial L} dL$$

The first term on the right-hand side is moved to the left:

$$-\frac{\partial f(K,L)}{\partial K} dK = \frac{\partial f(K,L)}{\partial L} dL$$

Divided by the partial derivative and dL:

$$-\frac{dK}{dL} = \frac{\frac{\partial f(K,L)}{\partial L}}{d\frac{\partial f(K,L)}{\partial K}}$$

The term on the right is the marginal products of labor and capital which is denotes by MP_L and MP_K.

$$-\frac{dK}{dL} = \frac{\frac{\partial f(K,L)}{\partial L}}{d\frac{\partial f(K,L)}{\partial K}} = \frac{MP_L}{MP_K}$$

As we move along the isoquant, the slope is equal to the marginal product of labor over the marginal product of capital.

Figure 3.7: The slope of the isoquant

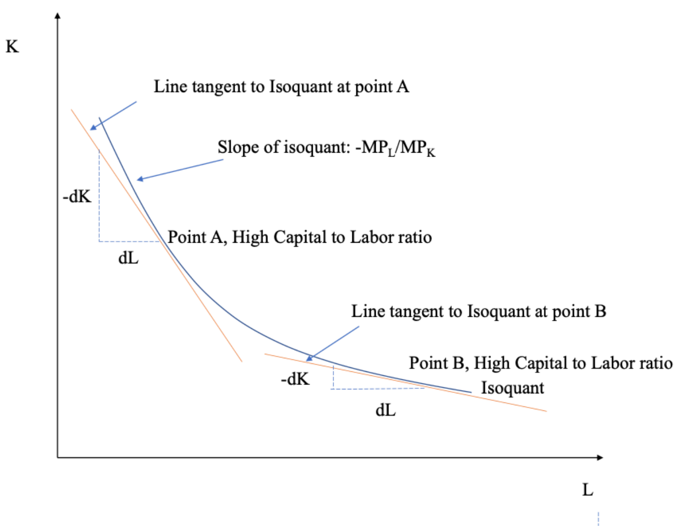
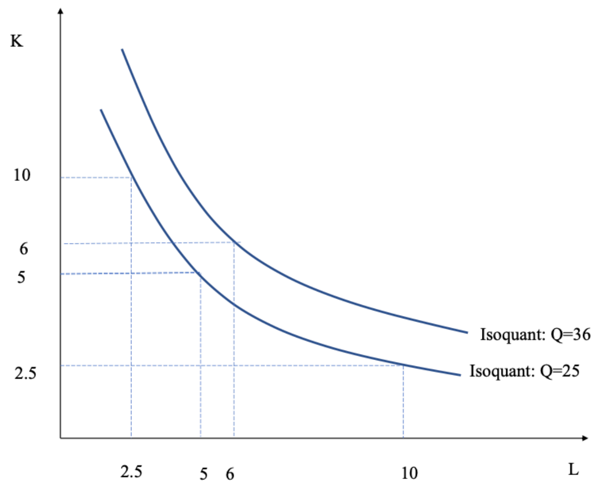
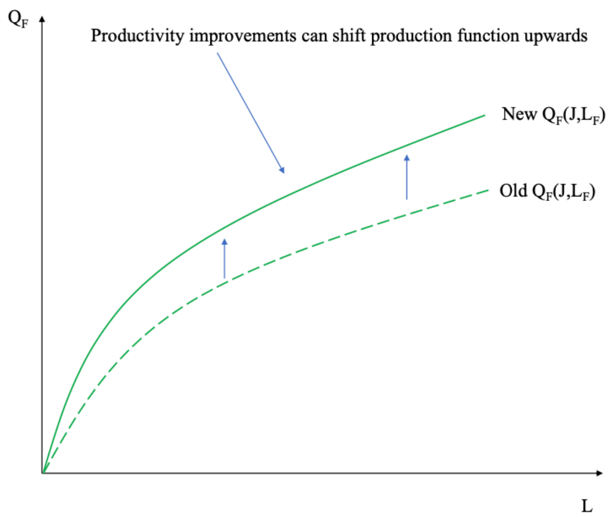


Figure 3.8: Two different isoquants



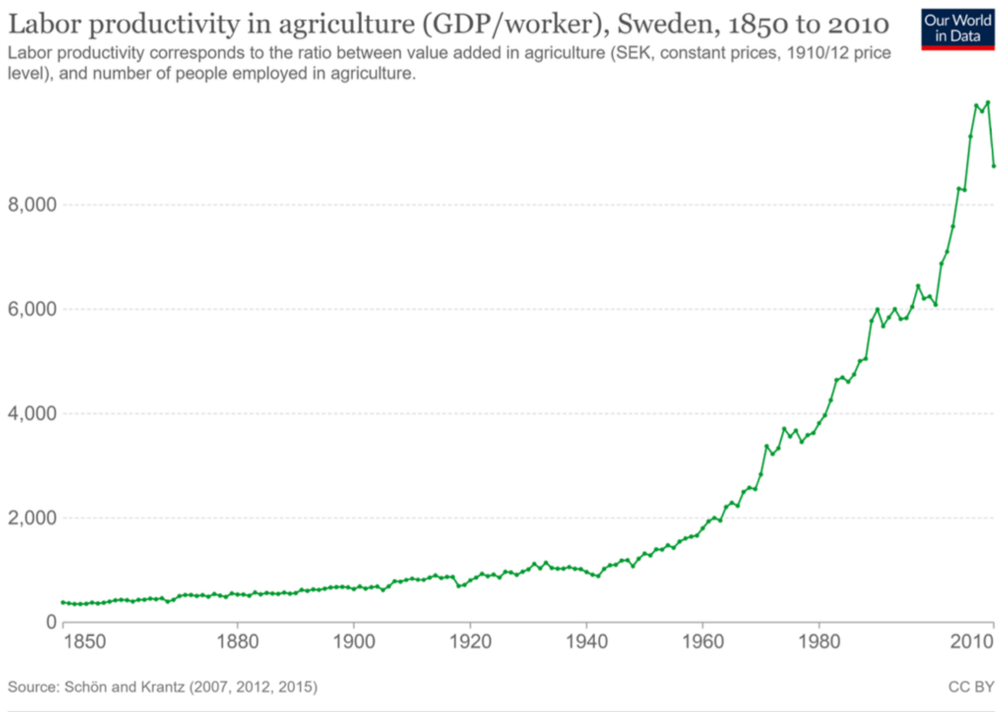
PRODUCTIVITY

Figure 3.10: The effect of shifts in the production function



A change in technology can increase the productivity, which is the case in the graph shown under:

Figure 3.12: Labor productivity in agriculture, Sweden



FROM TECHNOLOGY TO COSTS

We assume that firms choose how to operate with the aim of minimizing costs - to produce a given quantity as cheaply as possible.

A firm pays for the inputs that it uses. For simplification in economics we think of a firm as renting the capital it needs.

The price for an hour of labor is $\boldsymbol{w}$ and the rental rate for a unit of capital is $\boldsymbol{r}$. $\boldsymbol{C}$ is used to denote cost and the cost of $\boldsymbol{K}$ and $\boldsymbol{L}$ units are given by:

$$\boldsymbol{C = wL + rK}$$

Different combinations of L and K that give the same cost are said to be on the same **ISOCOST**.

ISOCOST LINE is all the combinations $(\boldsymbol{K}, \boldsymbol{L})$ such that the total expenditure on those inputs $\boldsymbol{wL + rK}$ is constant at a certain level.

$$\boldsymbol{C = wL + rK}$$

Solving for capital:

$$\boldsymbol{K = \frac{C}{r} - \frac{w}{r}L}$$

The **MINIMIZATION PROBLEM** is how to produce a given quantity at the lowest possible cost. The firm finds the lowest possible isocost line at which it can produce a given level of output.

$$\min_{K,L} wL + rK \text{ subject to } f(K,L) = \overline{Q}$$

At optimum (interior solution), isoquant is tangent to isocost:

$$\frac{MP_L}{MP_K} = \frac{w}{r} \to \frac{MP_L}{w} = \frac{MP_K}{r}$$

This can be solved mathematically by **THE LANGRANGE METHOD**.

$$C = wL + rK \to rK = C - wL \to K = \frac{C}{r} - \frac{w}{r}L$$

The isoquant represents the desires quantity to produce, and then two isocost lines are illustrated. The solution - the cost minimizing choices of K and L - must be that they represent a point that is both on an isoquant and isocost.

The solution can be found in different ways:

- Graphically the solution is the lowest possible isocost that we can reach for a given isoquant. This will represent the lowest cost.
- Typically, it is when the isocost is tangent to the isoquant.
- The slope of the isocost is $-\frac{w}{r}$. This is the **RELATIVE PRICE** of inputs, wages in relation to the cost of capital. The slope of the isoquant is $\frac{MP_L}{MP_K}$, the ratio of marginal products, so the **OPTIMAL COMBINATION OF INPUTS** is:

$$\frac{w}{r} = \frac{MP_L}{MP_K}$$

Both the slope of the isocost and isoquant are negative, but this does not matter when both negative signs are deleted, as it gives the same.

Figure 3.14: The cost minimizing choice

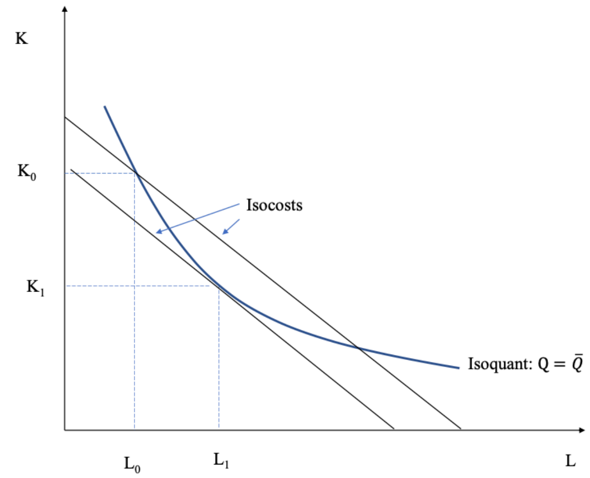
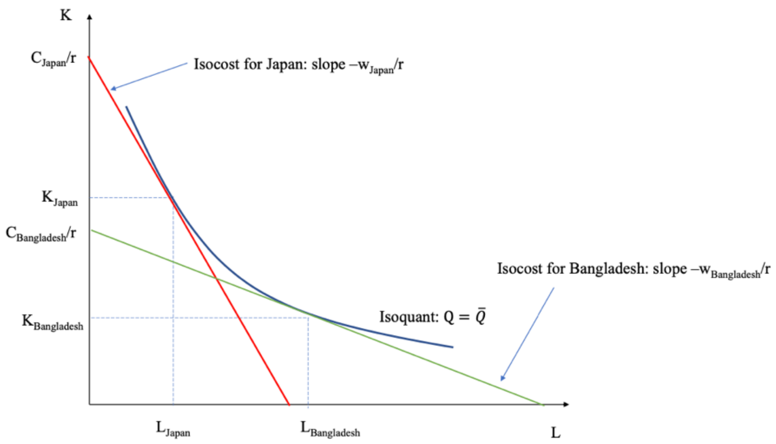


Figure 3.15: The cost minimizing solution under two different levels of input costs



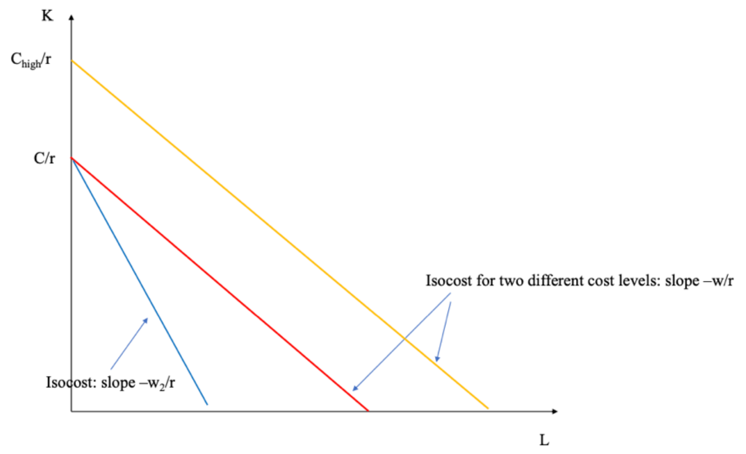
ISOCOST can be written as:

$$K = \frac{C}{r} - \frac{w}{r}L$$

Changes in w will shift the slope of the isocost. If only w changes the intercept on the vertical axis will not change: if the firm only uses capital its cost will not change in that case, the intercept is given by $\frac{C}{r}$. A lower r flattens the isocost and a higher r makes it steeper.

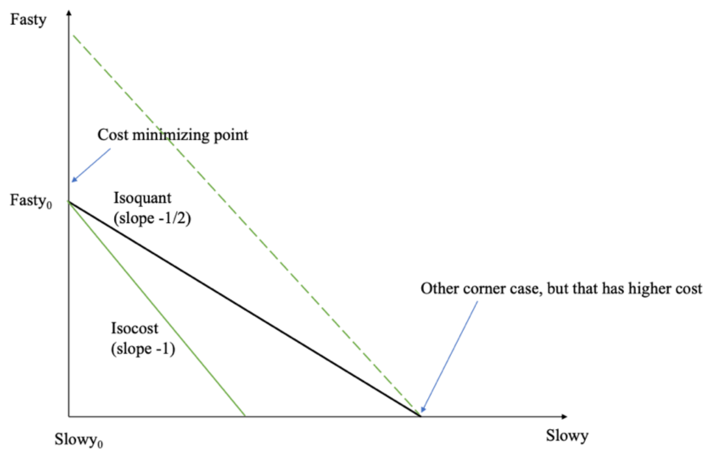
A higher cost, where w and r are unchanged, on the other hand will be associated with a parallel shift outward.

Figure 3.16: Changes in the isocost



Sometimes a **CORNER SOLUTION** is relevant. When the corner solution is better, because there is no tangent available to choose from.

Figure 3.17: A corner solution

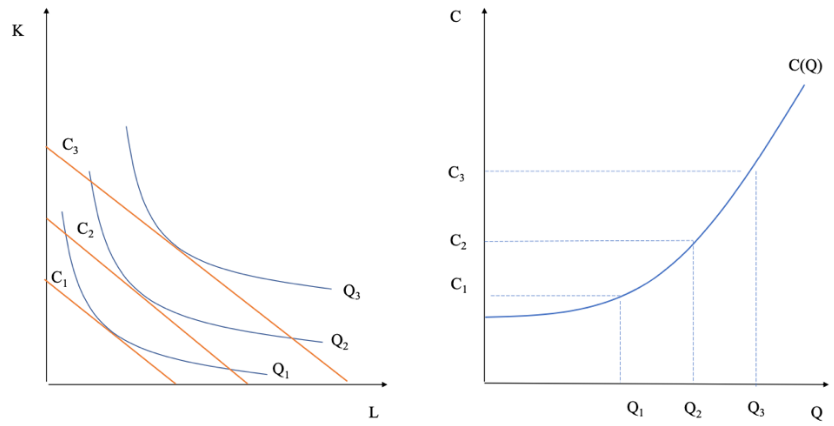


COST FUNCTION

COST FUNCTION describes the cost of producing a certain number of units, and it is denoted by:

$$C(Q)$$

Figure 3.18: From cost minimization to a cost function



AVERAGE COST AND MARGINAL COSTS

An example of a cost function could be:

$$C(Q) = 30 + Q^2$$

Table 3.4: An example of a cost function

In words	Quantity	Total cost	Average total cost	Marginal cost	Variable cost	Fixed cost	Average fixed cost
Standard abbreviation			ATC	MC	VC	FC	AFC
General form	Q	C(Q)	C(Q)/Q	dC/dQ	C(Q)-F	F	F/Q
Specific form (example)	Q	$30+Q^2$	$(30+Q^2)/2$	2Q	Q^2	30	30/Q
	0	30			0	30	
	1	31	31	1	1	1	30
	2	34	17	3	4	2	15
	3	39	13	5	9	3	10
	4	46	11.5	7	16	4	7.5
	5	55	11	9	25	5	6
	6	66	11	11	36	6	5
	7	79	11.29	13	49	7	4.29
	8	94	11.75	15	64	8	3.75
	9	111	12.33	17	81	9	3.33

The cost function is two aggregating parts: the **FIXED COST**, which are the costs that do not depend on how much is produced. And then there is **VARIABLE COSTS** that vary with the quantity produced.

$$Total\ cost = fixed\ cost + variable\ cost$$

MARGINAL COST is the change in cost associated with producing slightly more (one additional unit). Marginal cost refers to the derivative of the cost function. In this example it is:

$$\frac{dC}{dQ} = 2Q$$

This marginal cost is upward sloping (the more that is produced, the higher the total cost is), because it constantly increases. The **DISCRETE CHANGE** from 2 to 3 units is associated with going from a total cost of 34 to 39 euros which is 5 euros - this is an approximation.

AVERAGE TOTAL COST is the average of the total costs.

$$\frac{C(Q)}{Q}$$

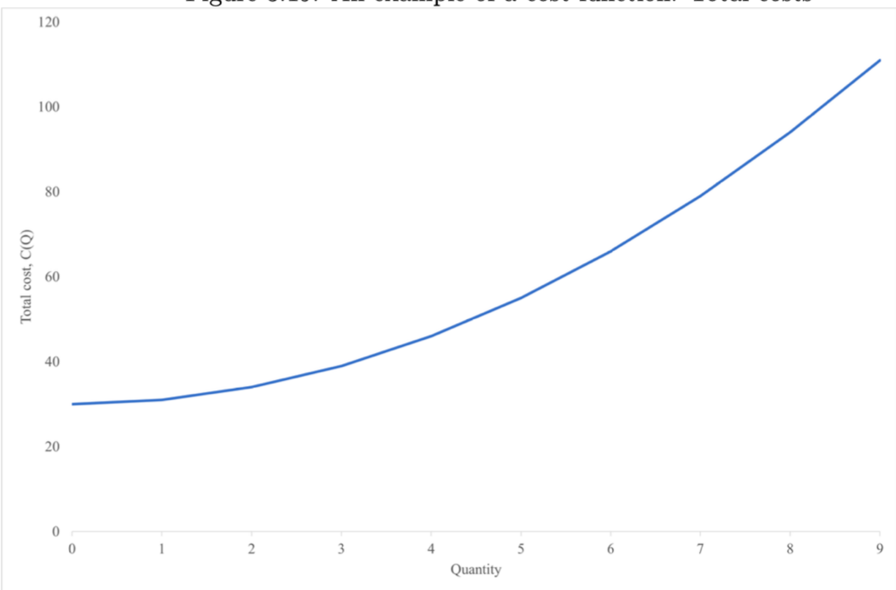
AVERAGE VARIABLE COST is the variable cost divided by the number of units produced.

AVERAGE FIXED COSTS is the fixed cost divided by the number of units.

$$F/Q$$

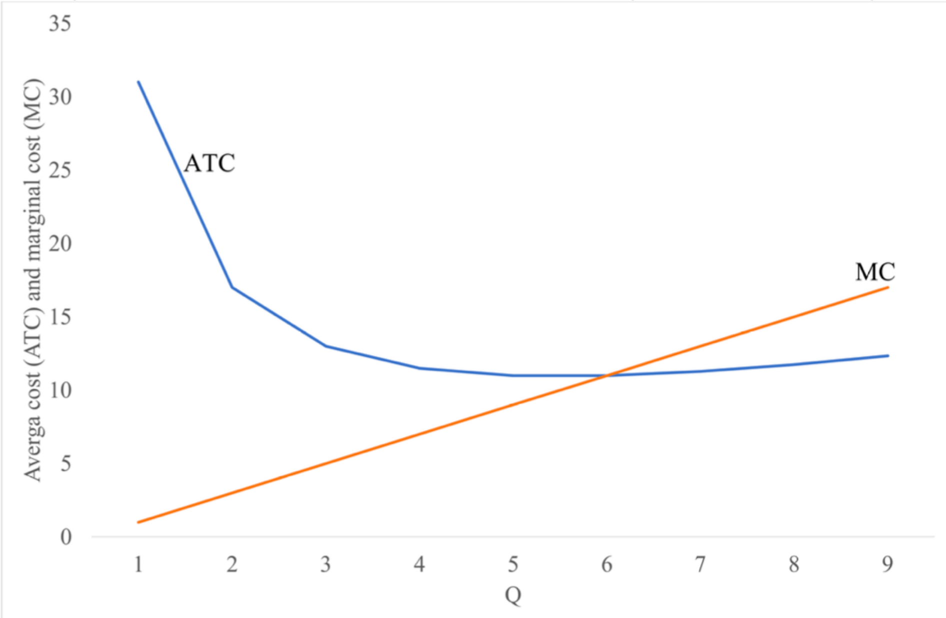
THE TANGENT OF THE TOTAL COST CURVE is the **MARGINAL COST.**

Figure 3.19: An example of a cost function: Total costs



AVERAGE COSTS are falling at first, because the fixed costs are spread on more and more units. But marginal costs are increasing. Therefore, the graph will start to increase eventually.

Figure 3.20: An example of a cost function: Marginal cost and average total cost

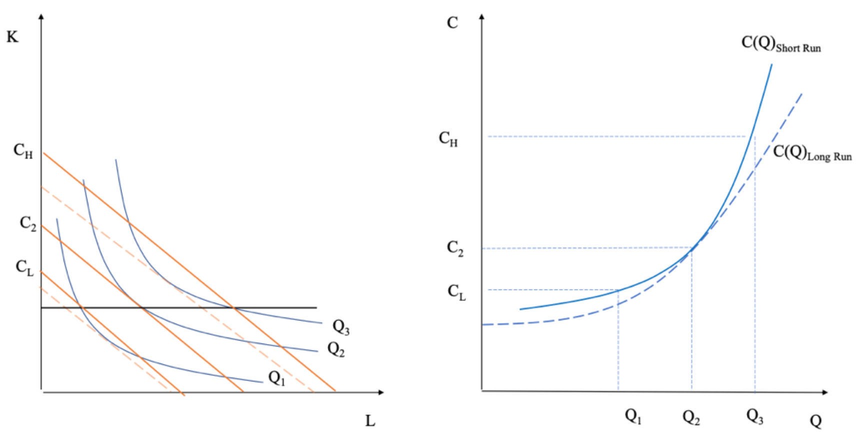


The MC curve cuts the ATC curve at its lowest point. As long as we are adding units that are below the average, they help pull the average down.

COSTS IN THE LONG AND SHORT RUN

In the short run, some factor of production may be hard to adjust, and economists often define the short run as the period during which one factor (typically capital) is fixed.

Figure 3.21: Cost function in the long and short run



In the short run costs are at least as high as the long run costs. The long run costs are flatter than short run costs. K is fixed at the horizontal line, so now it is relevant to look at the intersect between the horizontal line and isoquants, rather than the dashed alternative.

In the **SHORT RUN** some factors of production are typically fixed.

Long run defined by that all factors of production are variable, rather than by a pre-determined time measure such as 1 year.

LONG RUN COST CURVE is flatter than a short run cost curve. It can expand production at lower cost is all inputs can be chosen optimally.

ECONOMIES OF SCALE

The focus is on long-run costs of production, implying that input variables such as capital and labor can be adjusted. If the long-run average total cost curve is decreasing this implies that a producer of larger volumes will have lower average costs. This is **ECONOMIES OF SCALE**. A large-scale producer will have lower costs than a smaller producer, and then the large-scale producer will have an advantage in competition. Economies of scale refer to how average costs relate ot the number of units produced.

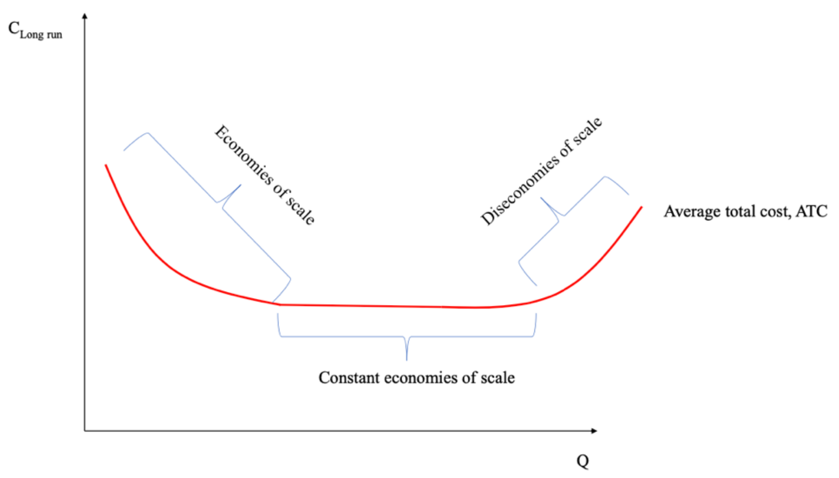
If the long-run average total cost is roughly flat, we say that there are **CONSTANT ECONOMIES OF SCALE**.

DISECONOMIES OF SCALE refer to the case where the average total costs are increasing when quantities produced increase.

RETURNS TO SCALE refers to the production function (refers only to input and output - NOT cost function) - what happens to **QUANTITY PRODUCED** if the amount of inputs used change in the same proportion. If the amount of inputs used and output both doubles, the technology has constant returns to scale.

If the amount of input doubles and the output more than doubles, then the technology has **INCREASING RETURNS TO SCALE**. An if output less than doubles, the technology has **DECREASING RETURNS TO SCALE**.

Figure 3.22: Economies of scale



As an example (where $\alpha = 2$, because both sides - input and output should double)

$$\alpha Q(K_0, L_0) \overset{?}{=} Q(\alpha K_0, L_0)$$
$$\alpha Q(K_0, L_0) \overset{?}{=} (\alpha K_0)^{\frac{1}{2}} (\alpha L_0)^{\frac{1}{2}}$$
$$\alpha Q(K_0, L_0) \overset{?}{=} \alpha^{\frac{1}{2}+\frac{1}{2}} K_0^{\frac{1}{2}} L_0^{\frac{1}{2}}$$
$$\alpha Q(K_0, L_0) = \alpha (K_0)^{\frac{1}{2}} (L_0)^{\frac{1}{2}}$$

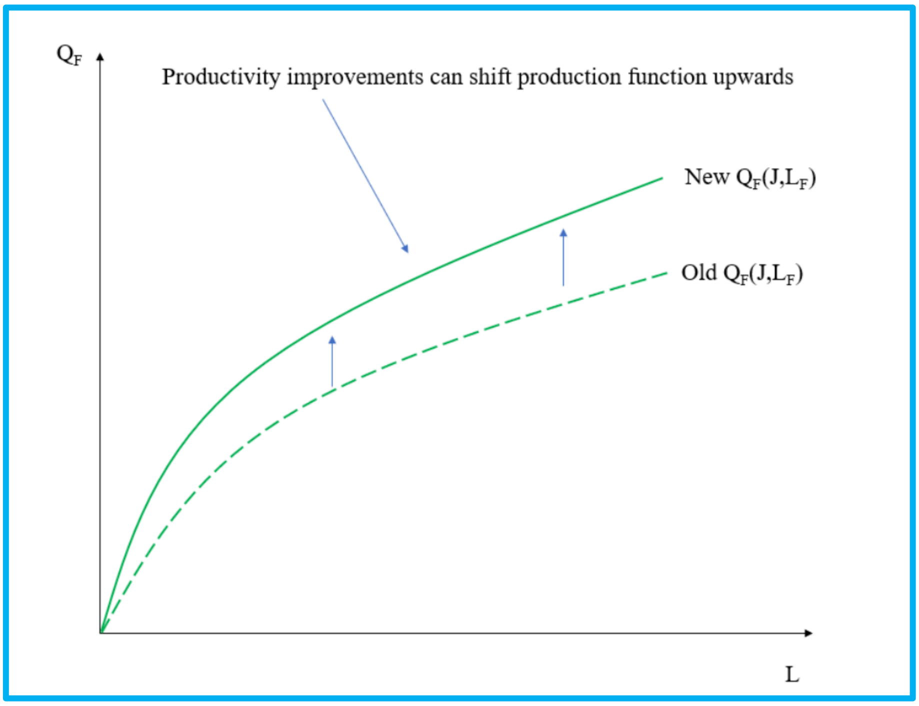
It can be concluded that $Q(K, L) = \sqrt{KL}$ exhibits constant returns to scale. Similarly checking $Q(K, L) = K^2 L^2$ we find that it exhibits increasing returns to scale:

$$\alpha Q(K_0, L_0) \overset{?}{=} Q(\alpha K_0, L_0)$$
$$\alpha Q(K_0, L_0) \overset{?}{=} (\alpha K_0)^2 (\alpha L_0)^2$$
$$\alpha Q(K_0, L_0) \overset{?}{=} \alpha^{2+2} K_0^2 L_0{}^2$$
$$\alpha Q(K_0, L_0) < \alpha^4 K_0^2 L_0{}^2$$

PRODUCTIVITY

Technological and organizational changes can lead to higher quantities produced with the same number of inputs. The term A in the following production describes the productivity:

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



CHAPTER 4 - SUPPLY BY PRICE TAKING FIRMS

MAXIMIXING PROFIT

The standard assumption in economics is that firms want to maximize profit.

PROFIT is the difference between revenue and costs.

REVENUE is whatever income that is generated to the firm by selling goods and services. Often it is just the price $\boldsymbol{p}$ times the quantity sold of that good, $\boldsymbol{q}$.

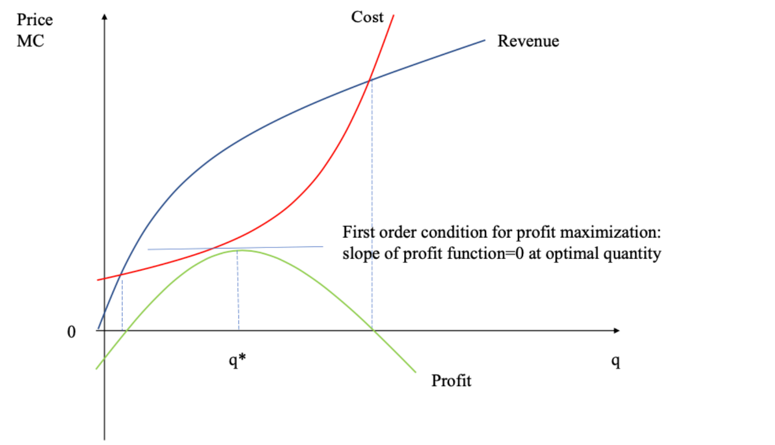
COSTS can be direct outlays, but it can also be more subtle cost associated with that resources are not used where they are most profitable.

Quantity is denoted by $\boldsymbol{q}$, and we assume that both $\boldsymbol{Revenue(q)}$ and cost $\boldsymbol{C(q)}$ are increasing in quantity produced. Profit is often written as $\boldsymbol{\pi}$.

PROFIT ON GENERAL FORM:

$$\boldsymbol{\pi = Revenue(q) - C(q)}$$

Figure 4.1: Profit maximization in the general case



Profits are highest at the top, which is the same as when the derivative of the profit function is equal to zero.

$$\boldsymbol{\frac{d\pi}{dq} = \frac{dRevenue}{dQ} - \frac{dC(q)}{dq} = 0}$$

Or in words that $\textbf{Marginal Revenue (MR)} = \textbf{Marginal Cost (MC)}$.

The distance between the curve of the cost and revenue are increasing up to the point at which they have the same slope, after which they are decreasing.

HOW MUCH SHOULD BE PRODUCED?

Two questions are to be answered: should the firm produce the good at all, and if so, how much should it produce?

The firm is a **PRICE TAKER**, because the firm acts as if its decisions on how much to produce does not affect market price.

The revenue for a price taker is given by q times the $price$ per unit.

GENERAL FORM OF PROFIT

$$\pi(q) = pq - C(q)$$

REVENUE

$$Revenue(q) = pq$$

MARGINAL REVENUE

$$MR(q) = \frac{dRevenue(q)}{dq}$$

MARGINAL COST

$$MC(q) = \frac{dCost(q)}{dq}$$

To **MAXIMIZE** it needs to

$$\frac{d\pi(q)}{dq} = p - \frac{dC(q)}{dq} = MR(q) - MC(q) = 0$$

The condition for the **OPTIMAL CHOICE OF QUANTITY** is

$$p = MC$$

EXAMPLE with costs $C(q) = 10 + q^2$. Considering the case where $p = 12$.

$$\max_q 12q - (10 + q^2)$$

Differentiating with respect to q yields

$$12 - 2q = 0$$

...or writing

$$12 = 2q$$

The optimal quantity will be

$$q^* = 6$$

Figure 4.2: Profit maximization for a price taker: Example

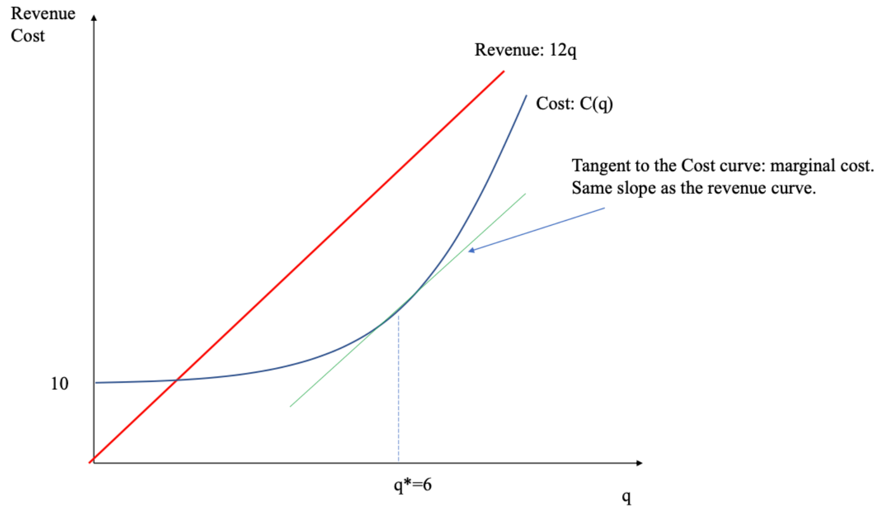
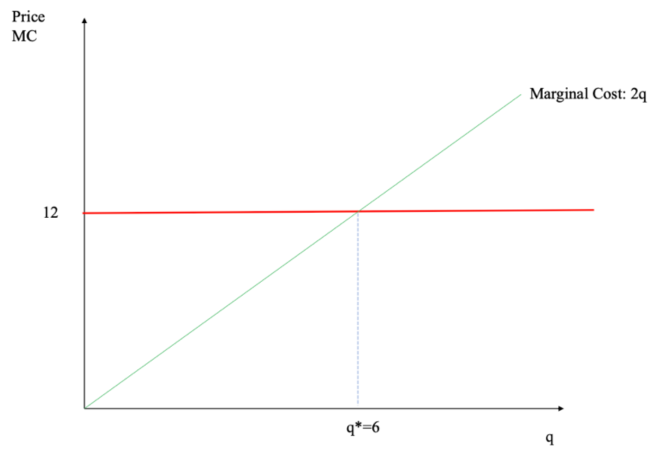


Figure 4.3: Profit maximization for a price taker: Example portrayed in another way



The quantity supplied is determined by the marginal cost and the price.

THE SUPPLY CURVE OF A PRICE TAKING FIRMS IS GIVEN BY ITS MARGINAL COST CURVE.

Figure 4.4: The supply of a price taking firm is given by its marginal cost curve

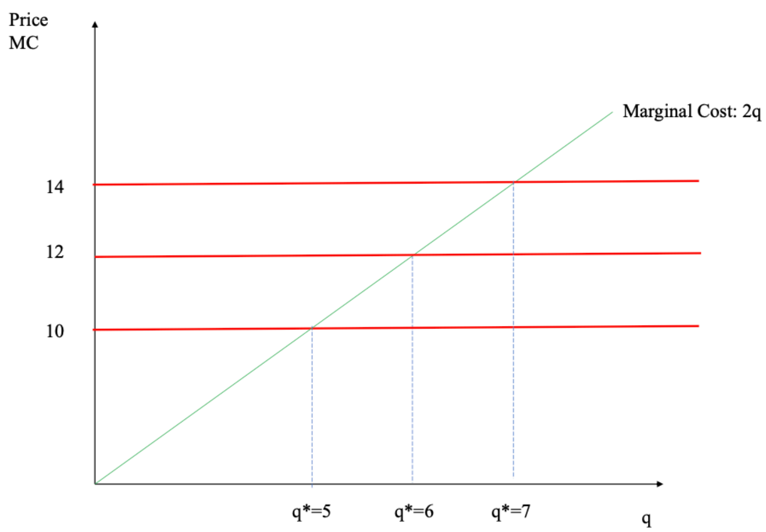
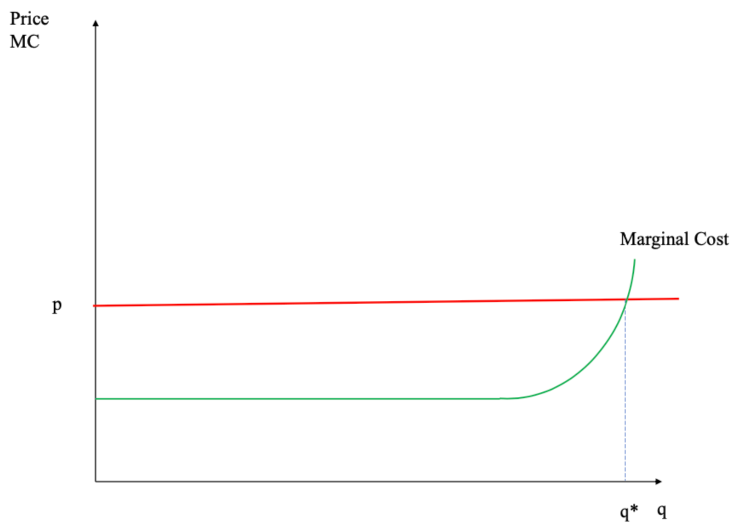


Figure 4.5: The shape of the marginal cost curve and profit maximizing quantity



SHULD THE GOOD BE PRDUCED AT ALL?

The optimal value of quantity can be plugged into the profit function with the cost function $C(q) = 10 + q^2$. $p = 12$ and $p* = 6.$

$$\pi = 12 \cdot 6 - (10 + 6^2) = 26$$

GENERAL FORM

$$\pi = pq - C(q)$$

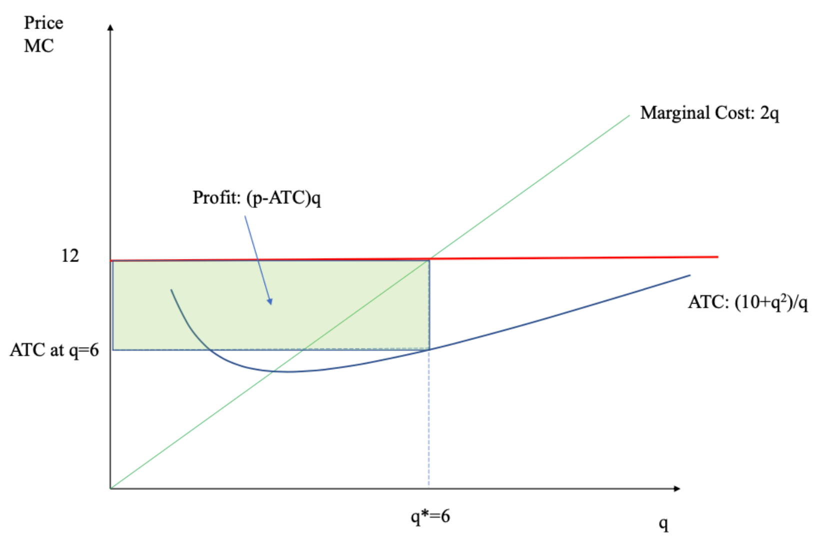
PROFIT AS PRICE MINUS AVERAGE COST TIMES QUANTITY

$$\pi = \left(p - \frac{C(q)}{q}\right) \cdot q$$

Where $\frac{C(q)}{q}$ is ATC (average total cost).

$p = MC$ means that the firm produces up to the point where $p = MC$. As long as $p > MC$ the firm is increasing profit as it increases production. It might not make money on the very last unit that is produces but makes money on all the units leading up to that point.

Figure 4.6: Profit at the profit maximizing quantity



IN THE SHORT RUN, produce if price if over average variable costs.

IN THE LONG RUN, produce if the price is over a combined line of average variable costs and average total costs (average total cost).

PROFITS: POSITIVE, NEGATIVE OR ZERO?

Profits can be positive, negative or 0.

Figure 4.7: Zero profit

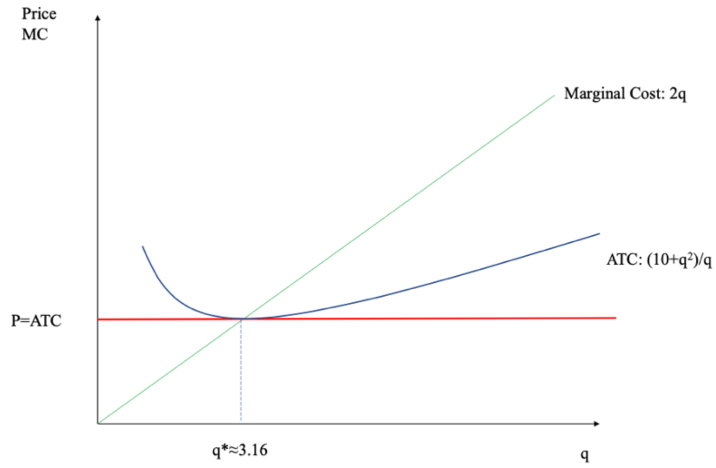
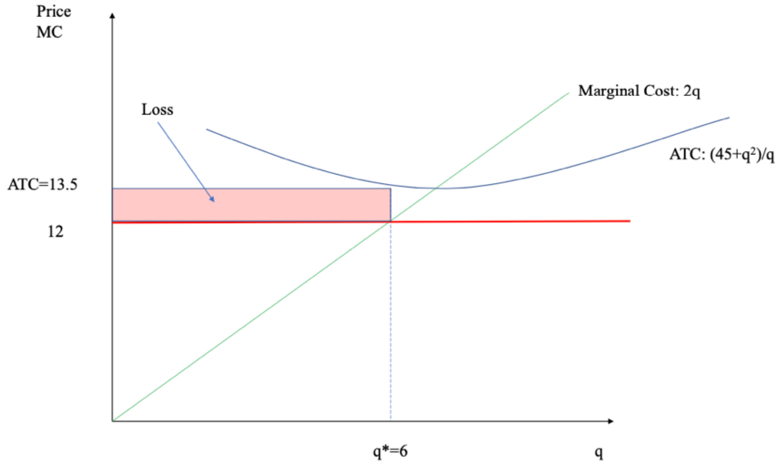


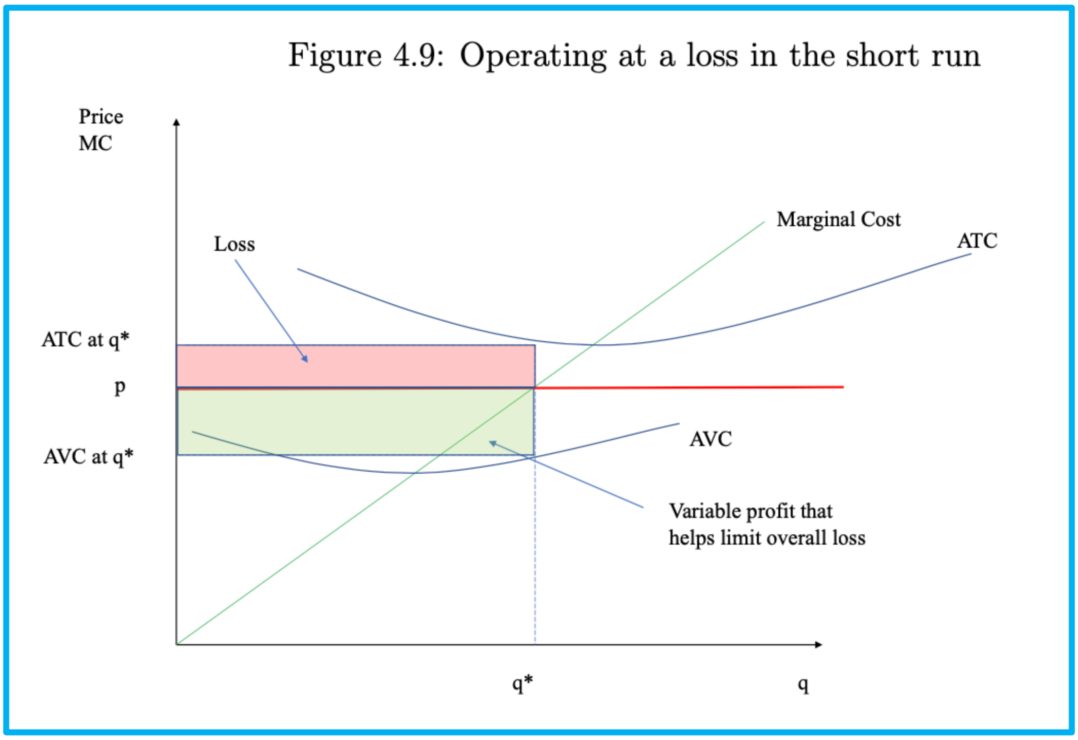
Figure 4.8: A loss



Sometimes it may be better to produce at a lost, because the fixed costs are lost anyways.

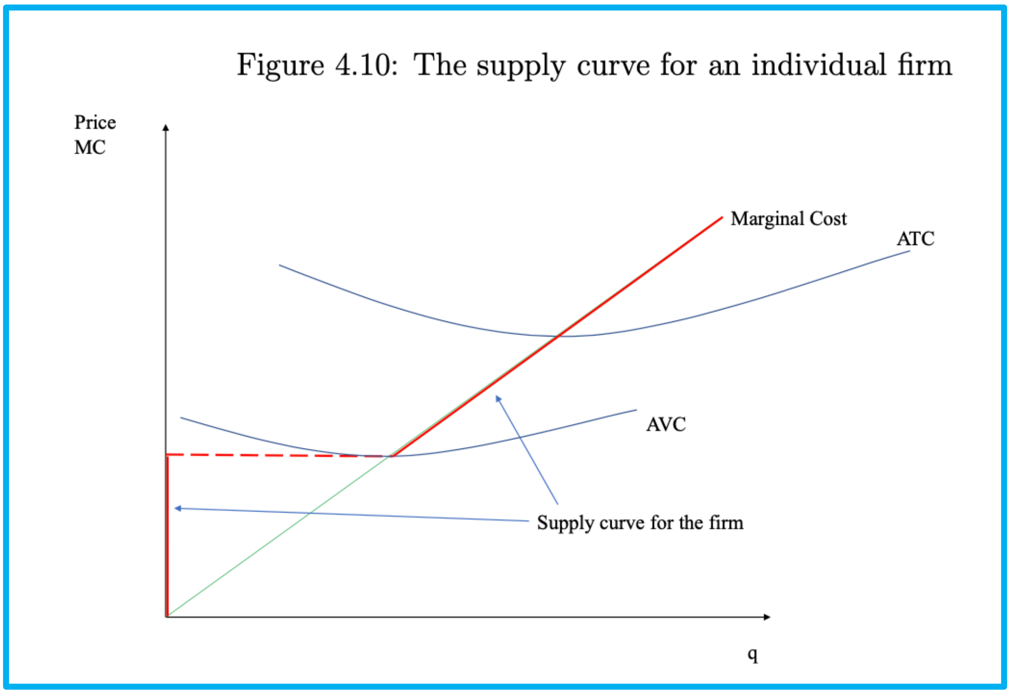
Table 4.1: Why a firm may produce at a loss

	No production	**Production**
Revenue	0	$p \times q$
Cost	Fixed cost	Fixed cost + variable cost
Profit	-Fixed cost	- Fixed cost + ($p \times q$ - variable cost)



FROM FIRM SUPPLY TO THE MARKET SUPPLY

We conclude that **A FIRM'S SUPPLY CURVE IS GIVEN BY ITS MARGINAL COST CURVE AS LONG AS PRICE IS ABOVE THE AVERAGE VARIABLE COST**.



The **MARKET SUPPLY** is the amount firms want to supply at a given point.

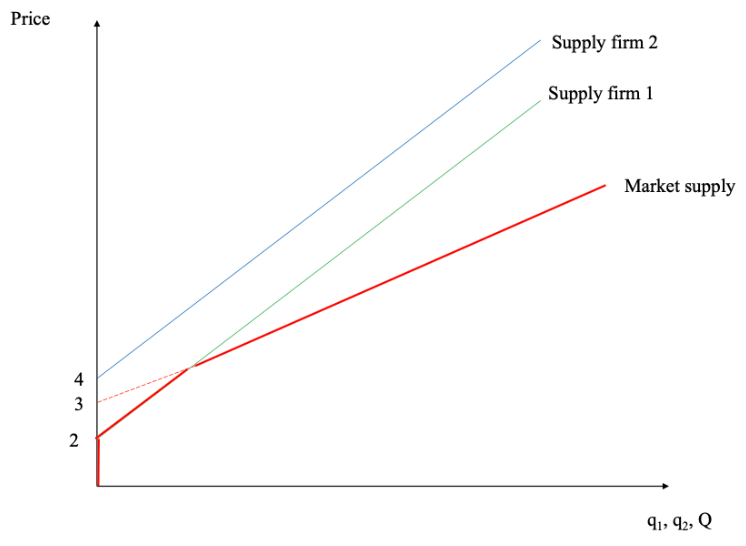
Table 4.2: Market supply is the sum of individual firms' supply

price	Firm A	Firm B	Firm C	Market supply (A+B+C)
5	4	2	1	7
4	3	1	0	4
3	2	0	0	2
2	1	0	0	1
1	0	0	0	

EXAMPLE of two firms where supply from firm 1 is given by $q_1 = -2 + p$ and that of firm 2 of $q_2 = -4 + p$. **MARKET SUPPLY** is $Q = q_1 + q_2$.

$$Q(p) = \begin{cases} 0, & \text{if } p < 2 \\ -2 + p, & \text{if } 2 \leq p < 4 \\ -6 + 2p & \text{if } p \geq 4 \end{cases}$$

Figure 4.11: The market supply curve



FREE ENTRY AND PROFITS

An additional assumption behind perfectly competitive markets is that there is **FREE ENTRY**. This means that it is easy for new firms to enter the market and for old ones to exist.

Figure 4.12: The market supply curve

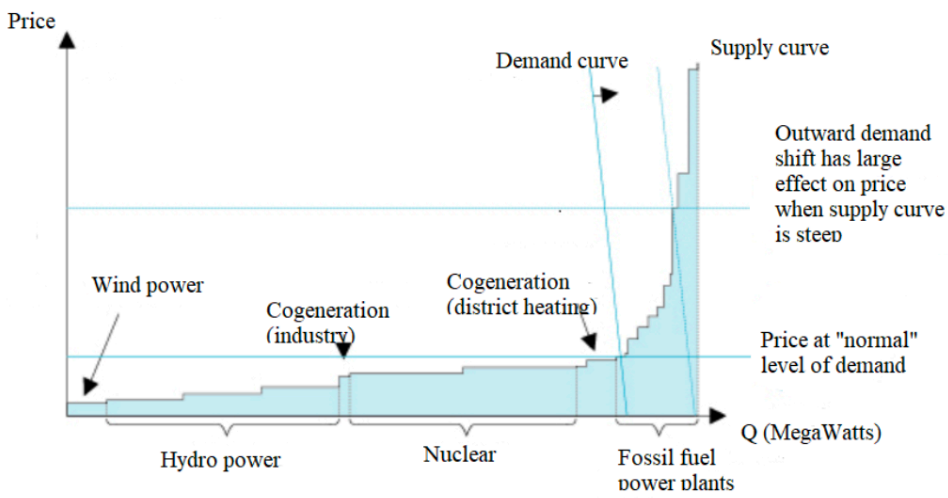


Figure 4.13: A market in long-run equilibrium and a representative firm

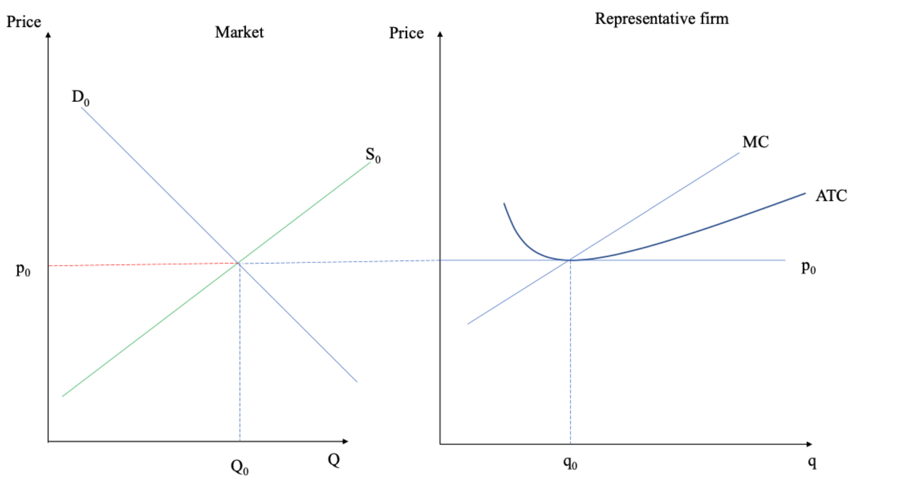
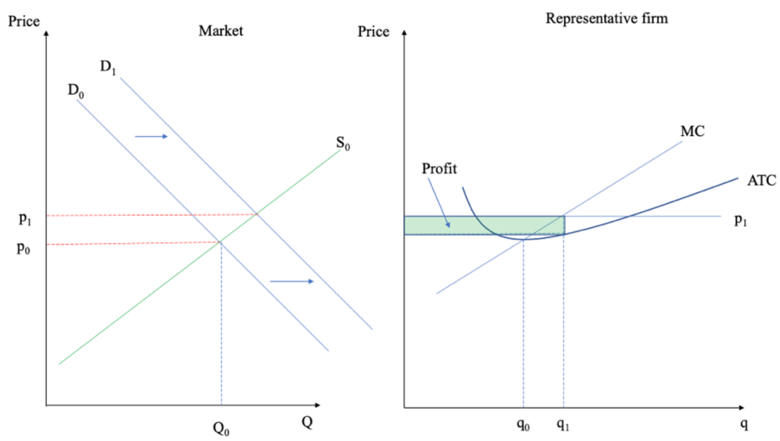
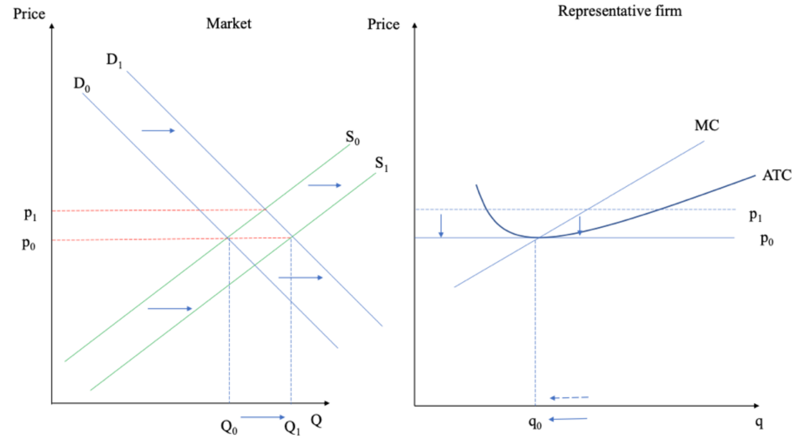


Figure 4.14: The short-run effect of a positive demand shock on the market and on a representative firm



In a perfectly competitive market profit is zero because of free entry, not because quantity is set at a point where $p = MC$.

Figure 4.15: The effect of entry on the market equlibrium



ZERO PROFIT with economic costs.

ECONOMIC COST is both **ACCOUNTING** and **OPPORTUNITY COSTS**. Opportunity cost is the payoff from best alternative use of a resource.

OPPORTUNITY COSTS

The cost of what you are giving up by using a resource - the payoff from the best alternative use of a resource.

ECONOMIC COST is defined as the sum of accounting costs and opportunity costs.

ACCOUNTING PROFITS can differ a lot between firms in a market with free entry.

The return to owning a scarce resource is **ECONOMIC RENT**.

CHAPTER 5 - CONSUMER CHOICE

MODELING OF CHOICES

When building a demand system, we rely on three basic premises:

- We know how we value things, and those valuations are stable. We use the term **PREFERENCES** to describe what we want and like.
- We face constraints in terms of e.g. **TIME** and **MONEY** (preferences, **BUDGET CONSTRAINTS**, and **UTILITY MAXIMIZATION**)
- We try to be as well of as possible given the constraints that we are facing.

PREFERENCES

- **PREFERENCES ARE COMPLETE:** given two bundles A and B, we can say if we prefer A to B, B to A or whether we are indifferent between them.
- **PREFERENCES ARE TRANSITIVE:** If A is preferred to B, and B is preferred to C, then A must be preferred to C.

We often assume that **"MORE IS PREFERRED TO LESS"**. We want more goods and services.

INDIFFERENCE CURVES connects all the bundles, that a consumer views as equally attractive. Indifference curves are closely related to isoquants. Both connect points in a diagram that are equivalent in some way. Indifferent curves further from the origin are preferred to those closer to the origin. They are an **INDIVIDUAL'S PREFERENCES**. The slope of the indifference curves (**MARGINAL RATE OF SUBSTITUTION**) describes how an individual is willing to substitute one good for another and still be equally well of.

Just as with isoquants:

- **PERFECT COMPLEMENTS** are goods that are consumed as a fixed combination. Indifference curves for perfect complements are L-shaped. Often associated with left and right shoes.
- **PERFECT SUBSTITUTES** are goods where the consumer is always willing to trade off one good against the other at a constant rate. Indifference curves are straight lines. You would be willing to trade one 20€ bill for 4 5€ bills.
- **IMPERFECT SUBSTITUTES** are preferences that are between the two extremes. The individual is willing to trade off one good against the other but in what proportion depends on how much of the respective good she has in the bundle.

Figure 5.2: Ranking of bundles

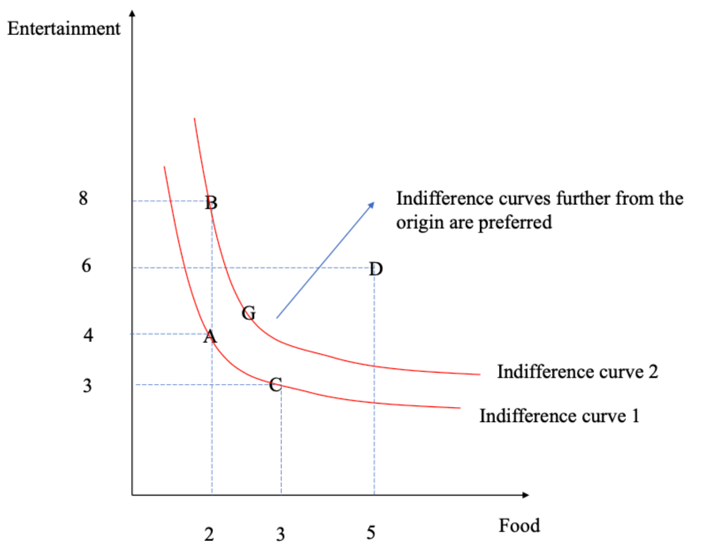
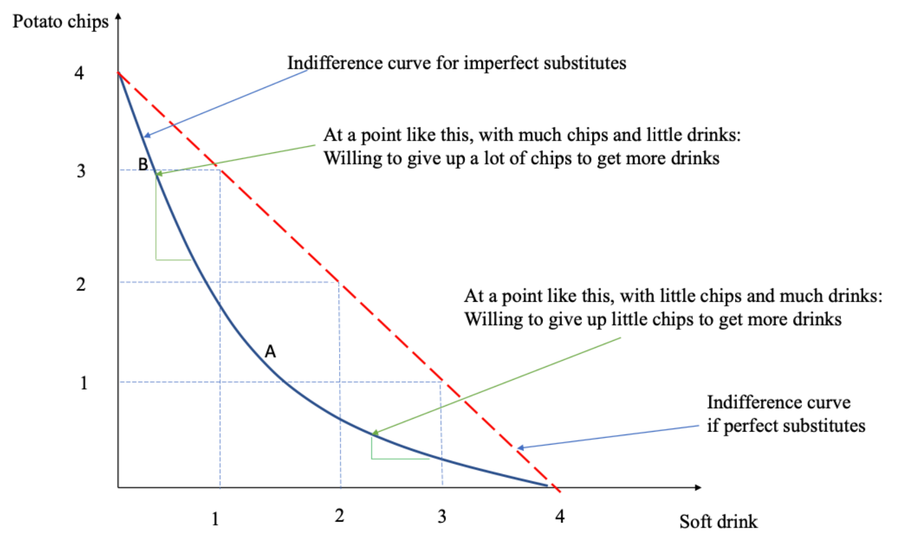


Figure 5.3: Indifference curve for imperfect substitutes

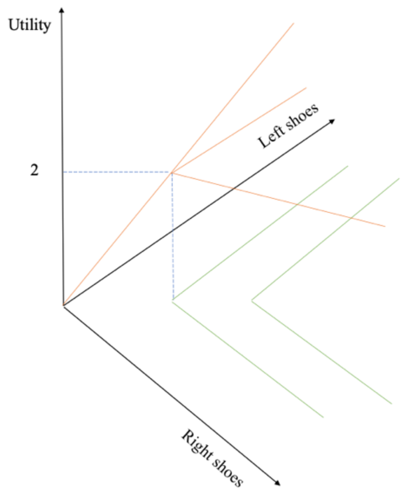


UTILITY FUNCTION

A utility function is used to assign values to different bundles. A **UTILITY-FUNCTION** is given by:

$$U = U(E, F) \text{ or } U = \sqrt{EF}$$

Figure 5.4: A utility function and indifference curves for perfect complements



IMPERFECT SUBSTITUES as an example with $U = \sqrt{EF}$ where $E = 2$ and $F = 8$.

$$U = \sqrt{2 \cdot 8} = 4$$
$$U = \sqrt{4 \cdot 4} = 4$$
$$U = \sqrt{8 \cdot 2} = 4$$

Combinations that give a higher utility are on a higher indifference curve. We use numerical values of utility to rank bundles, but we do not attach any quantitative meaning to the actual numbers beyond the ranking.

Utility functions are **ORDINAL**; we only care about the ranking, not the specific number.

MARGINAL UTILITY is a measure of how much utility changes when you increase the consumption of one good, all else equal:

$$MU_E = \frac{\partial U(E,F)}{\partial E}$$

TOTAL DIFFERENTIATION of the utility function:

$$dU = \frac{\partial U(E,F)}{\partial E} dE + \frac{\partial U(E,F)}{\partial F} dF$$

The **CHANGE IN UTILITY** as we change the amounts of goods consumes depends on how much consumption changes. Along the indifference curve, utility is the same, and the change in utility along the indifference curve is equal to 0:

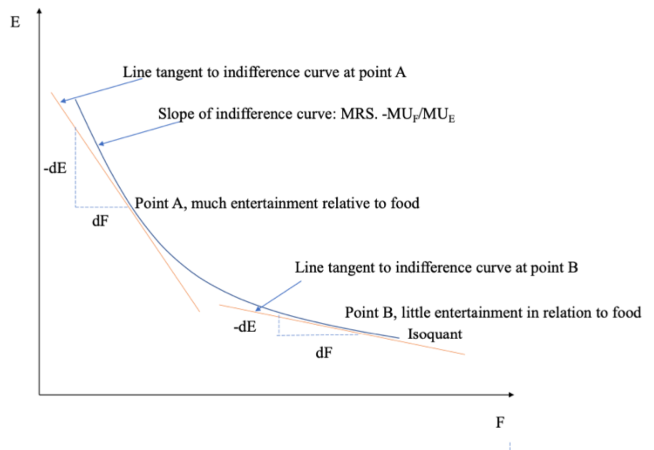
$$-\frac{dE}{dF} = \frac{\frac{\partial U(E,F)}{\partial F}}{\frac{\partial U(E,F)}{\partial E}} = \frac{MU_F}{MU_E}$$

The term on the right, is the ratio between the marginal utilities. These are frequently assumed to be decreasing.

The marginal utility of entertainment and food is $\frac{MU_F}{MU_E}$.

The **MARGINAL RATE OF SUBSTITUTION** is $-\frac{MU_F}{MU_E}$

Figure 5.5: The slope of the indifference curve: Marginal rate of substitution (MRS)



Along the indifference curve, the slope is equal to the marginal utility of food over the marginal utility of entertainment.

THE MARGINAL RATE OF SUBSTITUTION (MRS) is the slope of the indifference curve.

BUDGET CONSTRAINTS

A budget constraint tells us how much we can purchase of different goods and services.

Let income be denoted by $\boldsymbol{I}$, the price of food by $\boldsymbol{p_F}$ and the price of entertainment $\boldsymbol{p_E}$. These are all in a currency and prices are per unit. An income allows to purchase:

$$I = p_F F + p_E E$$

Isolating for entertainment to plot in a diagram (so we can plot in the budget constraint):

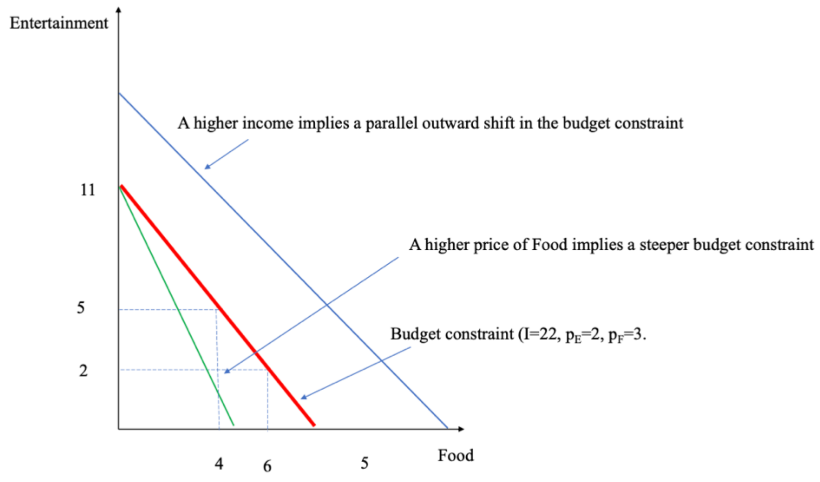
$$E = \frac{I}{p_E} - \frac{p_F}{p_E} F$$

The **SLOPE** of the budget line is:

$$-\frac{p_F}{p_E}$$

Changes in income are associated with parallel shifts in the budget constraint. The change in the price of one good relative to the other changes the steepness of the constraint.

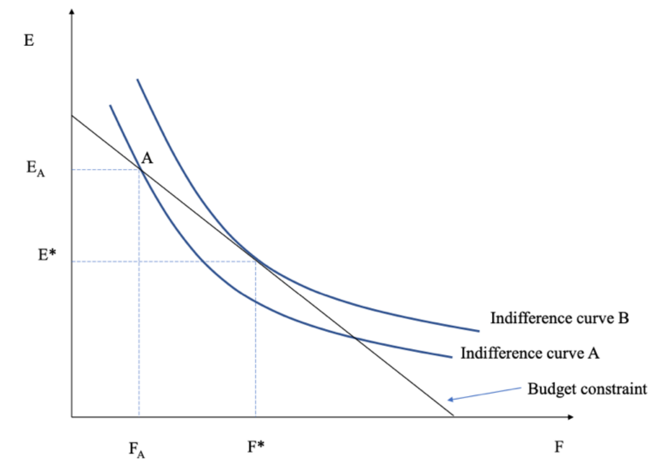
Figure 5.6: A budget constraint



MAXIMAZATION OF UTILITY SUBJECT TO CONSTRAINTS

$$\max_{E,F} U(E, F) \text{ subject to } I \geq p_F F + p_E E$$

Figure 5.7: Utility maximization



At the **OPTIMAL POINT (IF INTERIOR SOLUTION)**, the indifference curve is tangent to the budget constraint it holds that

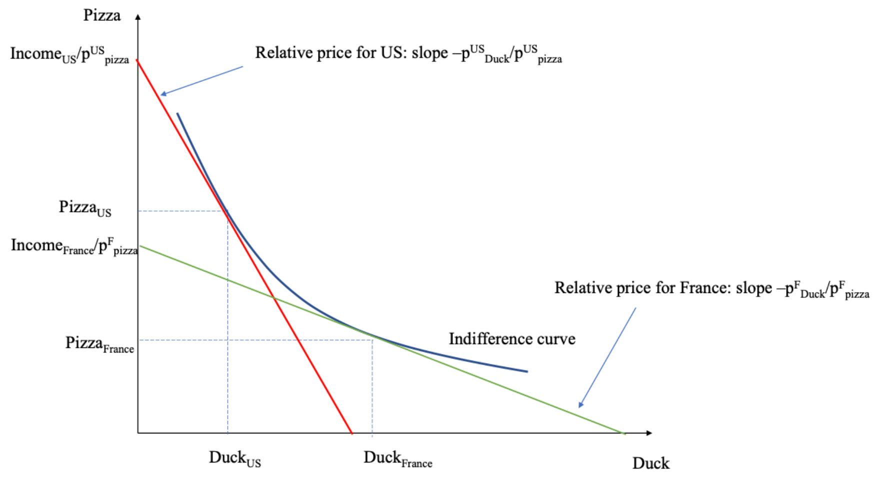
$$\frac{MU_F}{MU_E} = \frac{p_F}{p_E}$$

The slope of the indifference curve is also known as the marginal rate of substitution, the slope of the budget constraint as the marginal rate of transformation, so the condition can also be:

$$MRS = MRT$$

Price changes are also important determinant of differing choices.

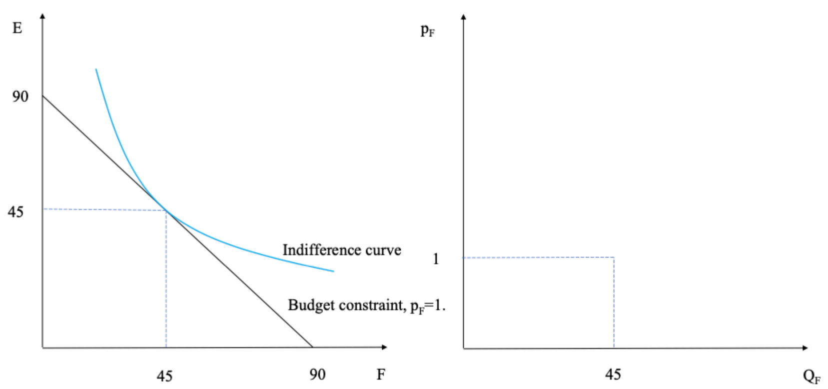
Figure 5.8: Different choice despite the same preferences



CHAPTER 6 - DEMAND CURVES AND ELASTICITIES

FROM CONSTRAINED OPTIMIZATION TO DEMAND CURVES

Figure 6.2: Optimal choice as a point on a demand curve



We can consider any price of ***F*** and find the optimal associated quantity. The following figure has a different **BUDGET CONSTRAINT** than the first picture.

Figure 6.3: Optimal choice as a point on a demand curve

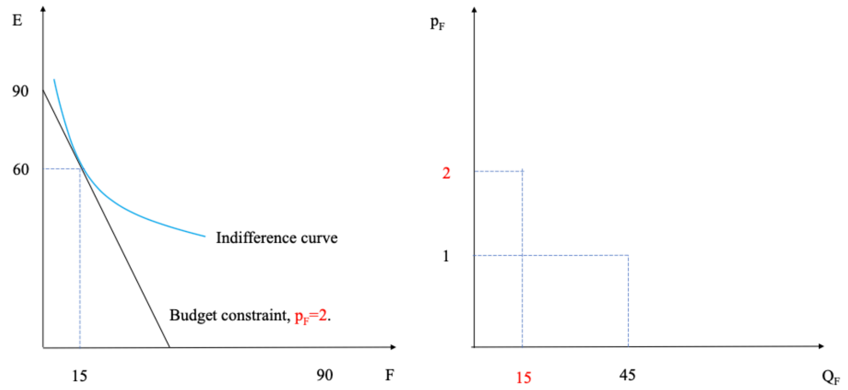


Figure 6.4: Optimal choice as a point on a demand curve

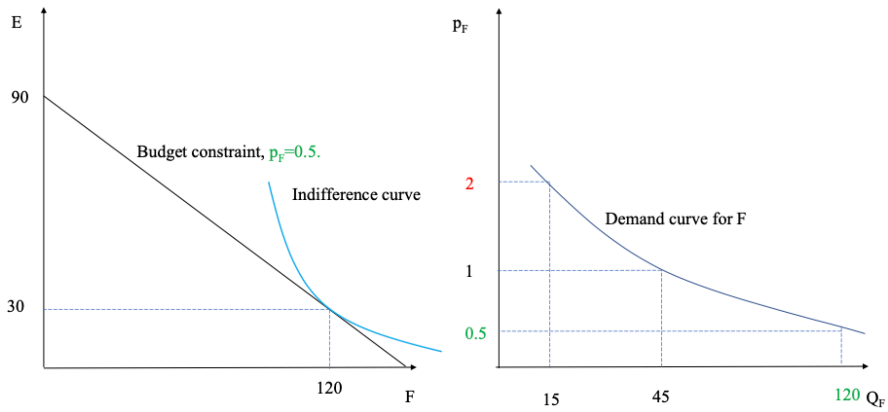
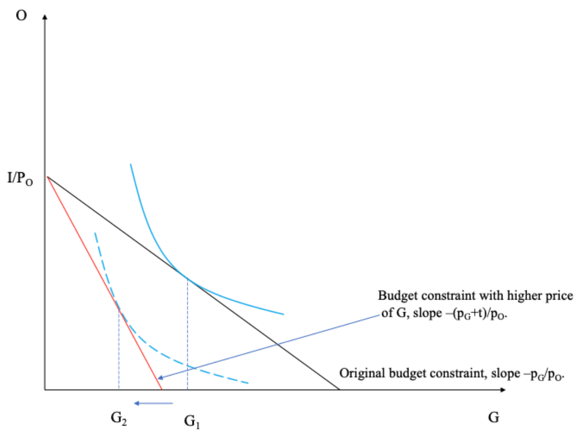
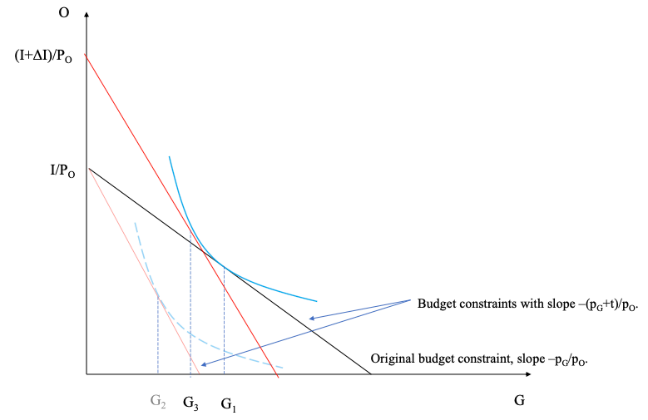


Figure 6.5: The effect of a higher price of gasoline on choices and indifference curve reached



The steeper budget constraint reflects that a consumer has to give up more other goods to buy gasoline.

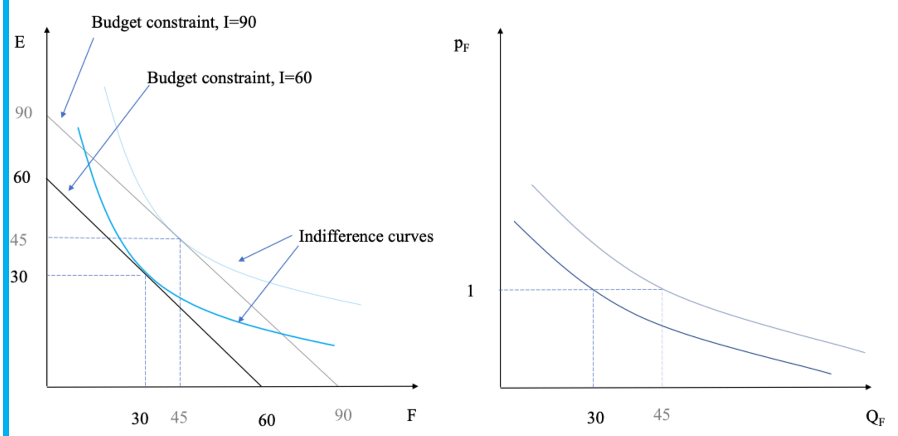
Figure 6.6: The effect of a higher price of gasoline on choices and indifference curve reached with a lump-sum compensation



EFFECT OF CHANGES IN INCOME AND DEMAND

A higher income, other things equal, will be associated with an outward parallel shift in the budget constraint, which will be associated with a new optimal quantity.

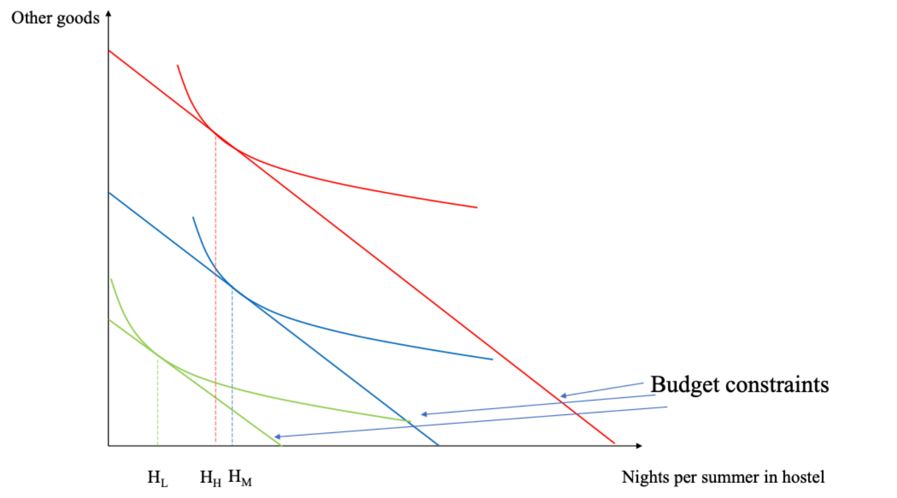
Figure 6.7: The effect of lower income on demand



If higher income is associated with higher quantities demanded, it is a **NORMAL GOODS**, and if higher income is associated with lower quantities demanded, it is **INFERIOR GOODS**.

An example of shifting status between normal and inferior goods is hostels. At the lowest income, there is not much demand, at intermediate income the demand I highest, and at the highest income, the demand is a bit less than the intermediate (because they switch to hotels).

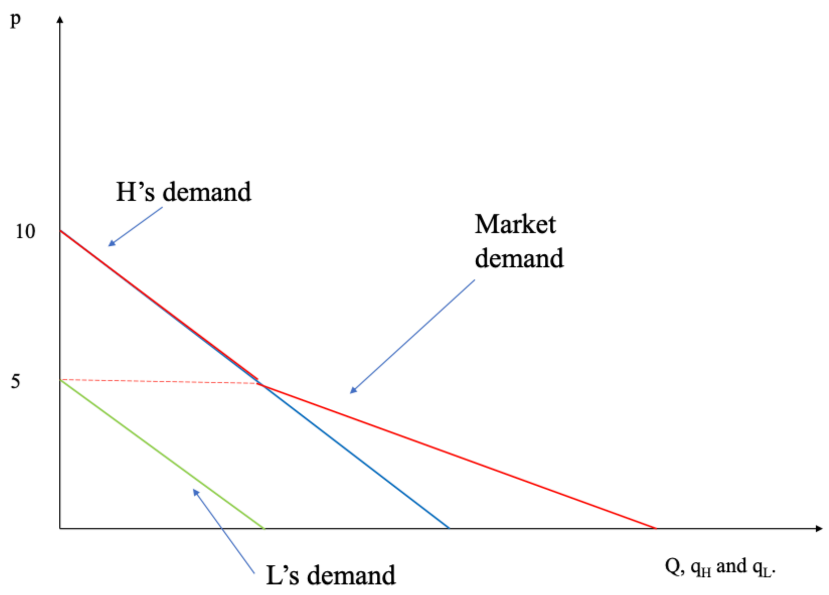
Figure 6.8: A good can be normal at low incomes and inferior at higher incomes



FROM INDIVIDUAL TO MARKET LEVEL DEMAND

Market demand is the sum of individuals' demand. Market demand is the sum of the quantities that all consumers together are willing to demand at a given price.

Figure 6.9: Adding of demand curves



If the price is above 5, the market demand is the same as demand from H, but if a price is 5 or lower, both H and L demand the good. As typically, market demand is flatter than individual demand. The total response of many to a change in price is greater than the response of one individual.

ELASTICITES

A steep demand curve makes changes in price lead to little change in demand. A flat demand curve makes changes in price lead to large change in demand.

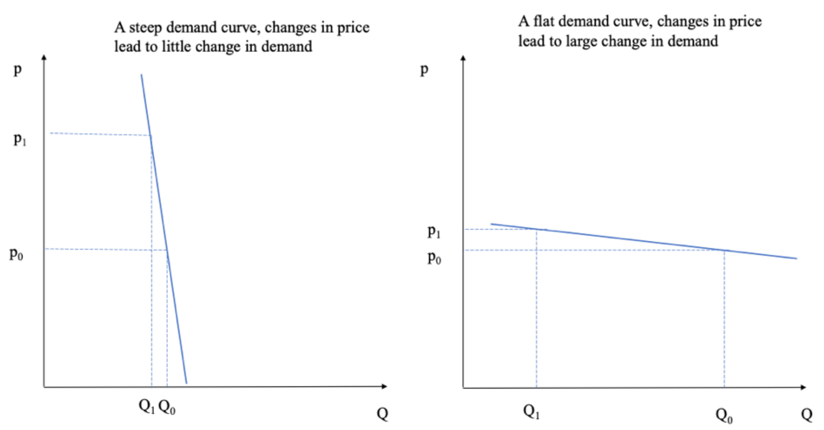


Figure 6.10: Slope of demand curves

FORMULA FOR CHANGE IN PRICE if the elasticity is -1.37 and we want to target a decrease in demand of 15%, by how much would price need to change?

$$\frac{\Delta p}{p} \cdot 100 = \frac{15\%}{1.37} = 10.95\%$$

The price would need to increase by around 11% for quantity to fall by 15%.

CONSTANT ELASTIC DEMAND FUNCTION:

$$Q = ap^{\epsilon}$$

Where ϵ is the elasticity of demand.

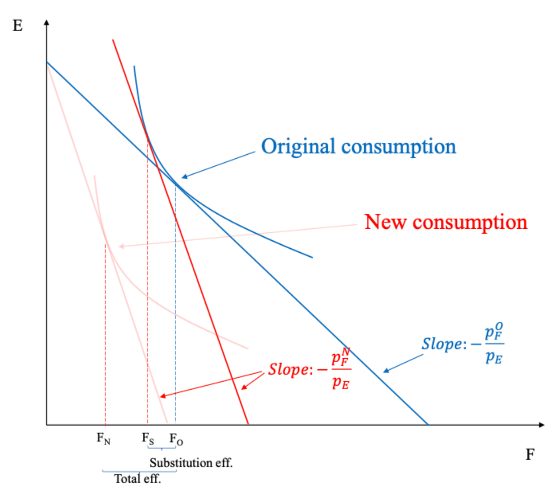
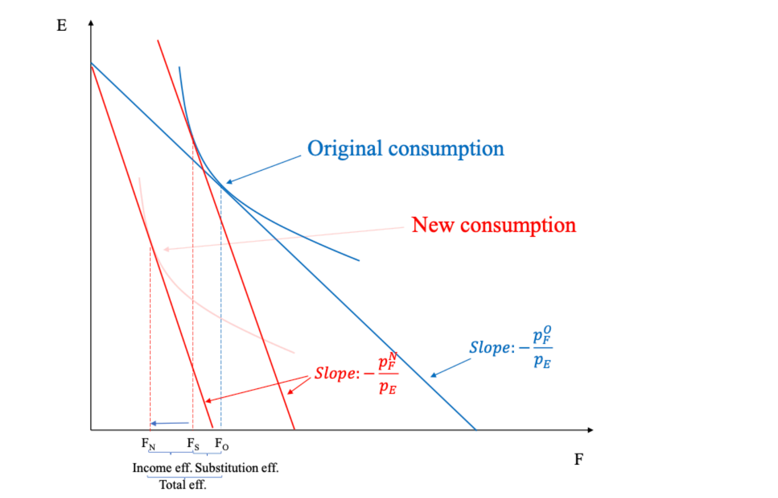


Figure 6.12: The substitution effect

- The price of E is the same, but the price of F changes to a higher, therefore it only changes intercept at F and not E.

- The indifference curve is lower at the new bundle.
- The government collects money from the tax and gives some money back - just enough to return to the original utility-level.
- With only increasing income, and not the taxes, the budget line is moved parallel to the right upwards.
- This should hit the original budget line. The bundle line is the same, but he consumes less E, because the indifference line hits the new budget line at a higher point.
- The consumer has the same welfare, but he consumes less. Could be efficient at the wish to lessen gasoline consumption.
- This is called the **COMPENSATION VARIATION**
- The **TOTAL EFFECT** is the difference between F_0 and F_N
- The **SUBSTITUTION EFFECT** is the difference between F_0 and F_S
- The **INCOME EFFECT** is the difference between F_N and F_S

Figure 6.13: The income effect for a normal good



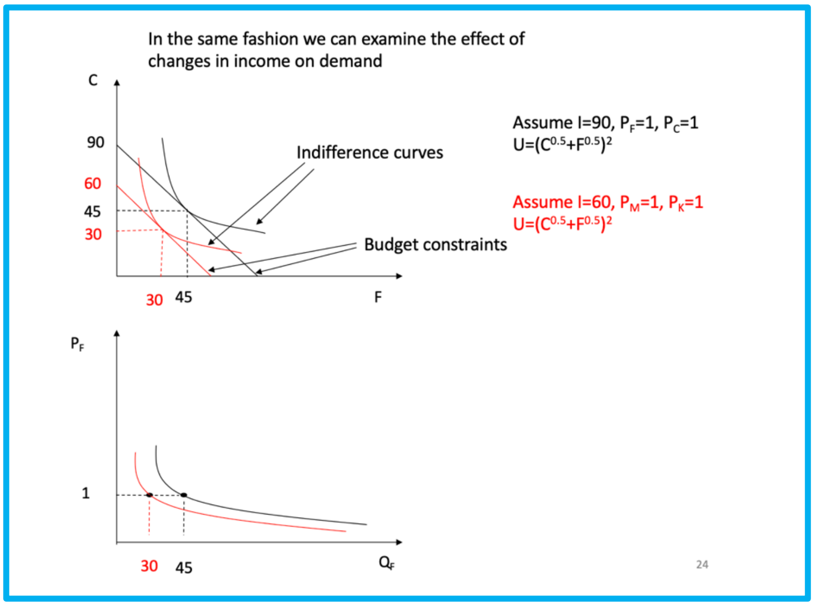
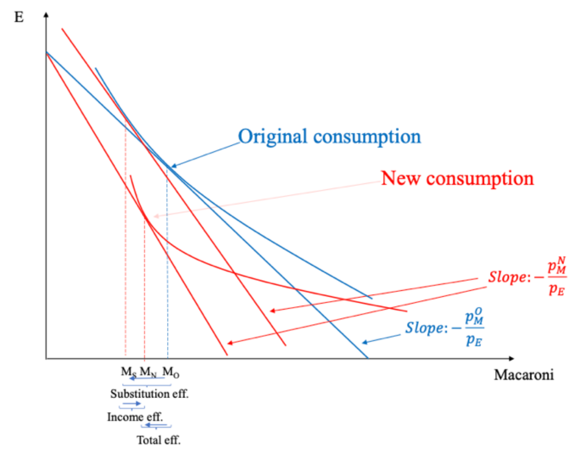


Figure 6.14: Income and substitution effects for an inferior good



CONSUMER’S PROBLEM

$$(Y, p_y, p_y)$$
$$\text{Income: } Y$$
$$\text{Price of good x: } p_x$$
$$\text{Price of good y: } p_y$$
$$\text{Intercept at y} - \text{axis: } \frac{Y}{p_y}$$
$$\text{Intercept at x} - \text{axis: } \frac{Y}{p_x}$$

To maximize your welfare, choose the point where the budget constraint is tangent to the indifference line. The slope of the budget constraint is $\text{MRS} = -\frac{p_x}{p_y} \rightarrow \frac{MU_x}{p_x} = \frac{MU_y}{p_y}$

This holds for an **INFERIOR SOLUTION**, where you should have goods of both kinds.

Corner (**NON-INTERIOR SOLUTION**) → when only 1 good should be consumed.

EXAMPLE OF UTILITY FUNCTION

$$6 = \left(\frac{0.5}{0.5 + 0.5}\frac{I}{180}\right)^{0.5}\left(\frac{0.5}{0.5 + 0.5}\frac{I}{30}\right)^{0.5}$$

Mehment consumes two goods, pizza (P) and soda (S). He has the following utility function $U(P,S) = P^{0.5}S^{0.5}$

Price of pizza is 180 dkk and price of soda is 20 dkk

Mehmet receives 720 dkk from his parents to spend on pizza and soda per month

How will Mehment spend his allowance, i.e. how many pizzas and how much soda will he buy?

And what will his utility from this consumption be?

Now suppose that the government wants to discourage soda consumption. It implements a policy that leads the proce of soda to increase to 30 dkk. Mehment's parents want to increase his allowance such that he will be able to consume the same bundle of goods before. What will his new allowance be?

Given the new price, and his new allowance, how much soda and how many pizzas will Mehmet buy?

What will his new utility be?

Justify each of your answers briefly.

CHAPTER 7 - EFFICIENCY IN PARTIAL EQUILIBRIUM

EFFICIENCY OF A COMPETITIVE MARKET

Maximizing the value that is created in a market.

CONSUMER SURPLUS

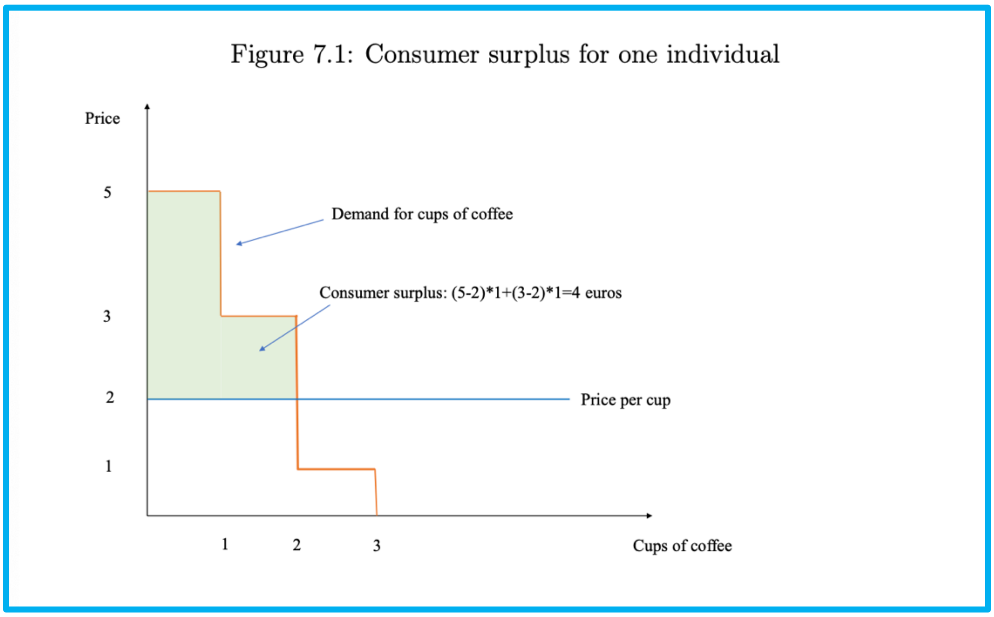
Value created to consumers of consuming a particular good at a particular price. It measures the difference between what consumers would be willing to pay for a good and what they actually pay.

RESERVATION PRICE is the price I am willing to pay for a good. Also called the **WILLINGNESS TO PAY (WTP)**.

$$\boldsymbol{WTP_i(q_i)}$$

The willingness to pay in a market for at total quantity:

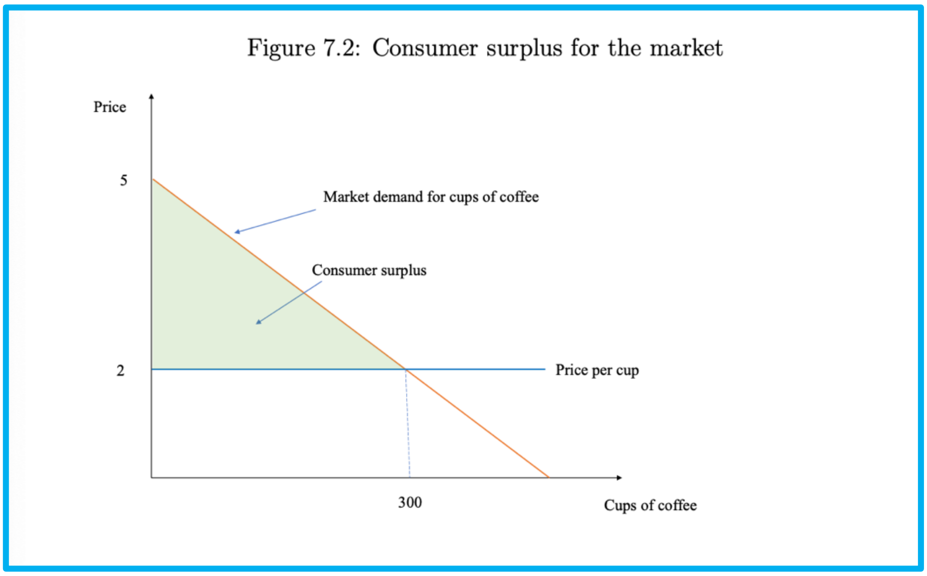
$$\boldsymbol{WTP(q)}$$



Consumer surplus of an individual consumer for a quantity is the difference between what a consumer is willing to pay for the quantity and what the consumer actually pays, where $R_i(q_i)$ is the total payment:

$$CS_i(q_i) = WTP_i(q_i) - R_i(q_i)$$

The **CONSUMER SURPLUS** for the market is the area between the market demand curve and the price line.



Consumer surplus (in a market) is the sum of the consumer surpluses of all the individual consumers in a market. Given a total quantity consumes Q for all the consumers and a total payment of $R(Q)$:

$$CS(Q) = WTP(Q) - R(Q)$$

When the price is higher, the consumer surplus will be smaller.

Figure 7.3: Consumer surplus for the market

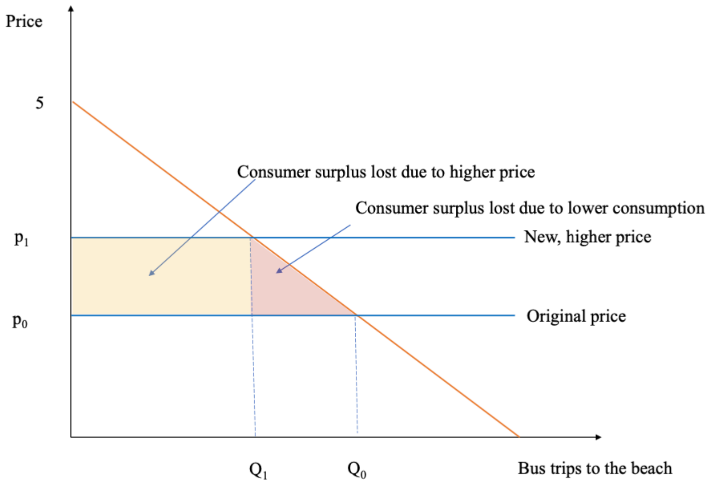
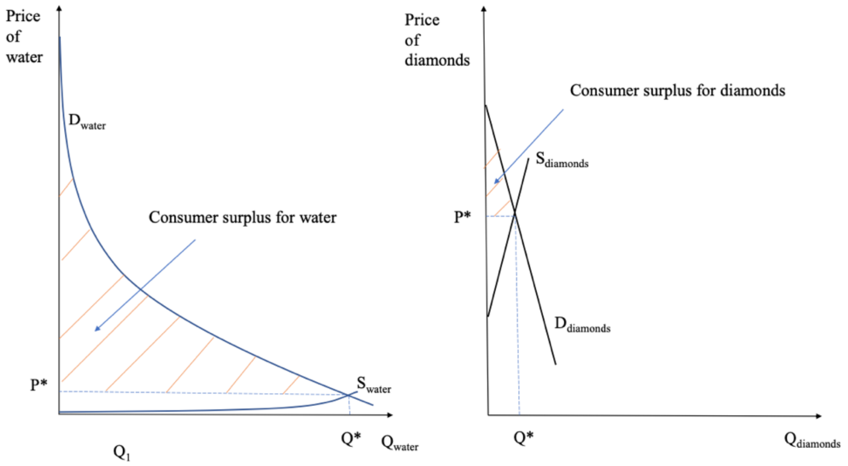
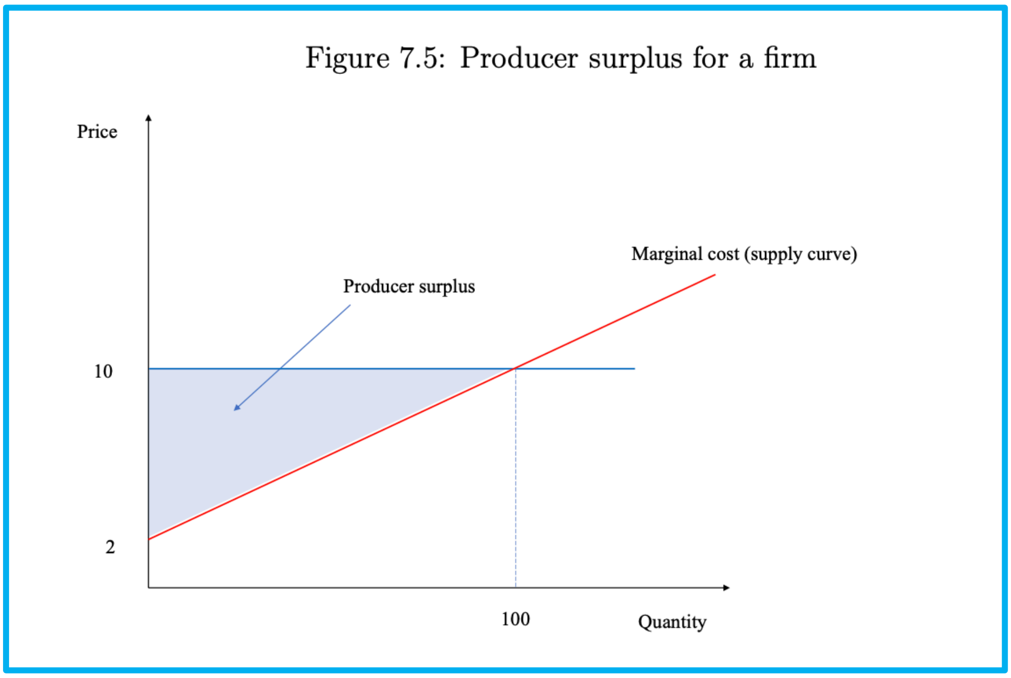


Figure 7.4: Diamonds and water – The difference between price and consumer surplus as measures of value



PRODUCER SURPLUS

The difference between price and marginal costs can be viewed as a measure of the value created on the supply side. The **PRODUCER SURPLUS** is the difference between the price and the associated marginal cost aggregated over all the units produced by the firm.



The area of producer surplus is the **TOTAL VARIABLE COST**.

In the short run it is total cost minus variable cost:

$$\Pi = p \cdot q - Variable\ cost \rightarrow PS_j(q_j) = R_j(q_j) - VC_j(q_j)$$

In the long run it is total cost of consumers minus total cost of producers:

$$\Pi = p \cdot q - Variable\ cost - Fixed\ cost \rightarrow PS_j(q_j) = R_j(q_j) - C_j(q_j)$$

Total surplus in a market in the short run:

$$PS(Q) = R(Q) - CV(Q)$$

Total surplus in a market in the long run:

$$PS(Q) = R(Q) - C(Q)$$

EFFICIENCY IN PARTIAL EQUILIBRIUM

The sum of producer surplus and consumer surplus is the value of those taken at the price equilibrium (which is found by equaling supply and demand function). **WELFARE** is measured as:

$$Welfare = Consumer\ surplus + Producer\ surplus$$

In the short run, the welfare corresponding to a market output is:

$$CS(Q) + PS(Q) = WTP(Q) - VC(Q)$$

In the long run, the welfare corresponding to a market output is:

$$CS(Q) + PS(Q) = WTP(Q) - C(Q)$$

Figure 7.6: Consumer and producer surplus in a perfectly competitive market

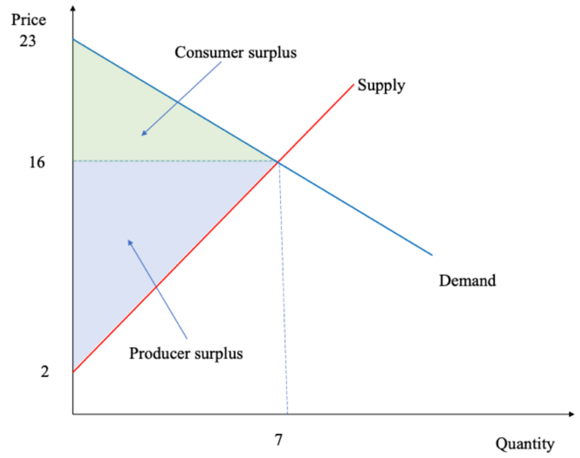
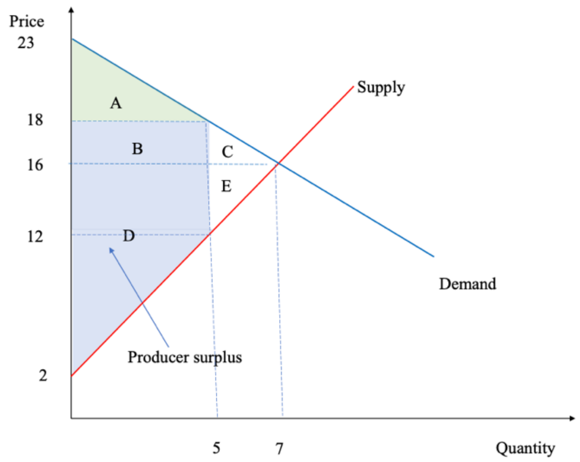


Figure 7.7: Lower welfare with an alternative price and quantity



WELFARE MAXIMIZATION for both short- and long-run:

$$\frac{\Delta WTP(Q)}{\Delta Q} = MC(Q)$$

If $P(Q)$ denotes the inverse demand curve,

$$MWTP(Q) = \frac{\Delta WTP(Q)}{\Delta Q} = P(Q)$$

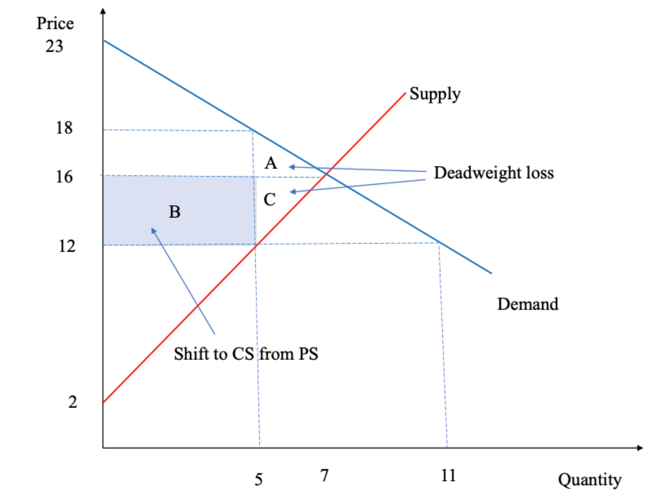
Therefore,

$$MC(Q) = P(Q)$$

PRICE CAP

A price cap sets a limit on how high a price can be.

Figure 7.8: Welfare effects of a price cap



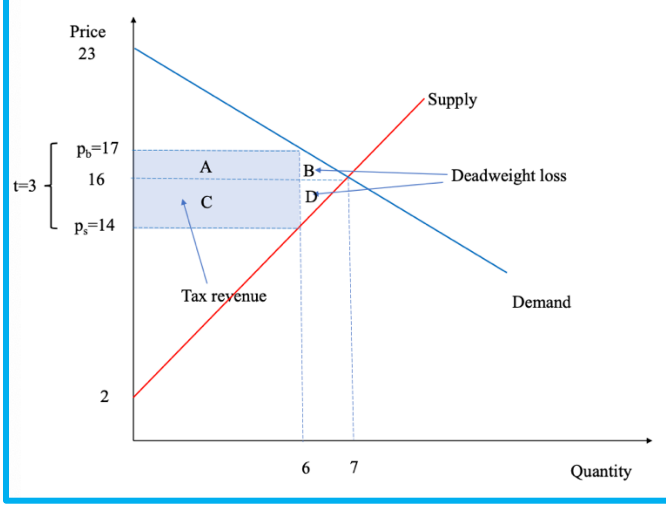
UNIT TAX

Taxed are used to finance redistribution an insurance, as well as to finance a number of governmental tasks such as defense and other collectively supplied goods. A **UNIT TAX** is a tax that is a certain amount per unit sold. A tax creates a **DIFFERENCE** between the price that buyers pay (p_b)and the price that sellers receive (p_s). Using t to denote tax, we have:

$$p_b = p_s + t$$

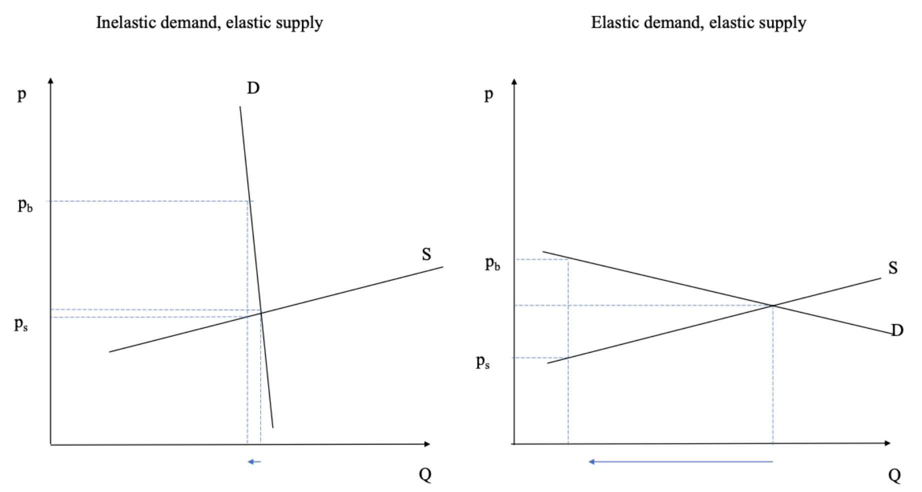
The tax drives a wedge between the price that buyers pay and that sellers receive. The tax lowers consumer surplus and lowers producer surplus. These losses partly represent a transfer to the government budget.

Figure 7.9: Calculating the effects of a unit tax



TAX INCIDENCE is the effects of taxes on prices and quantities. Tax incidences depend on the relative slopes of supply and demand. The more price sensitive either supply or demand, the less will price to that side of the market be affected, but the more will quantity change.

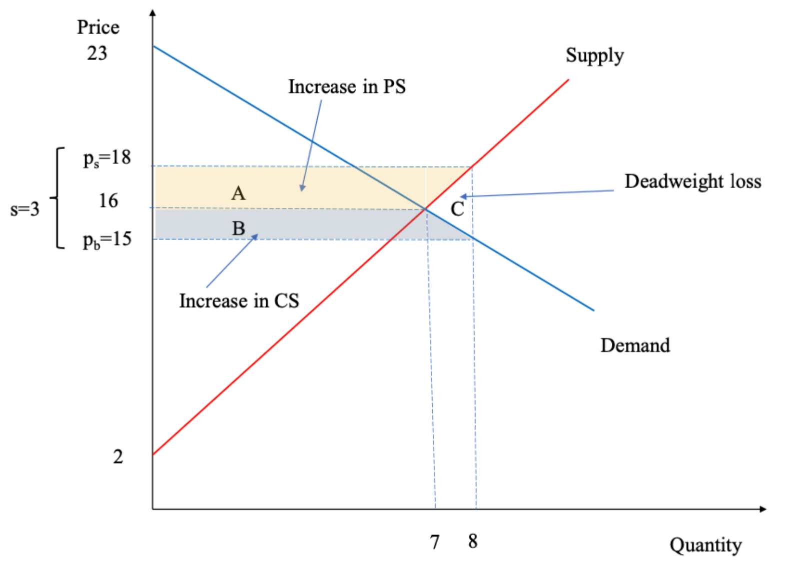
Figure 7.10: Tax incidence



SUBSIDIES

A subsidy is a payment from the government. The quantity demanded will be greater than the equilibrium quantity, because the government is covering some of the expenses, so the good will be cheaper and the demand higher.

Figure 7.11: Effect of a subsidy



CHAPTER 8 - EFFICIENCY IN GENERAL EQUILIBRIUM

HOW RESOURCES ARE ALLOCATED IN AN ECONOMY

PARTIAL EQUILIBRIUM is studying only a single market but studying several or all markets is **GENERAL EQUILIBRIUM**.

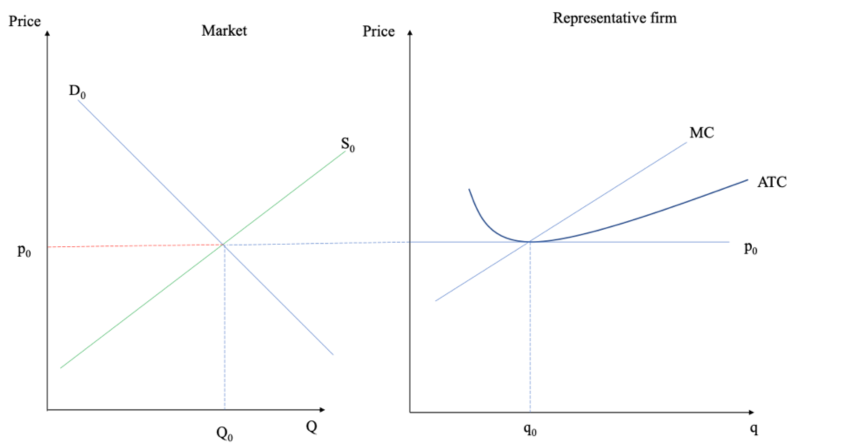
ASSUMPTIONS:

- All markets are perfectly competitive
- Many firms and consumers; everyone is a price taker
- Free entry
- No information asymmetries
- No externalities
- No public goods
- People engage in voluntary trade rather than stealing

A **SOCIAL PLANNER** is and unbiased decision maker that wanted to achieve an efficient solution.

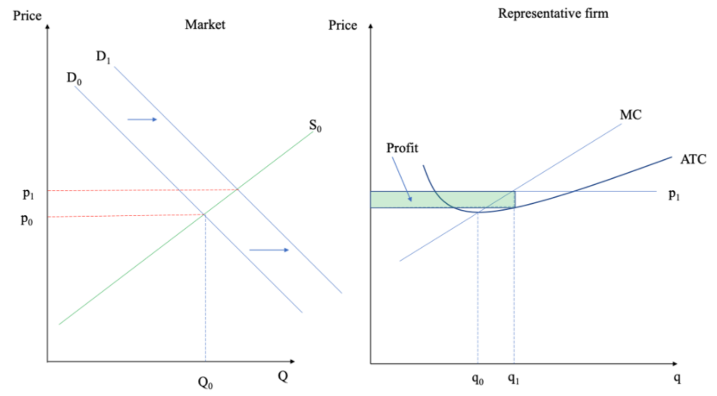
Prices carry information.

Figure 8.1: A market in long-run equilibrium and a representative firm



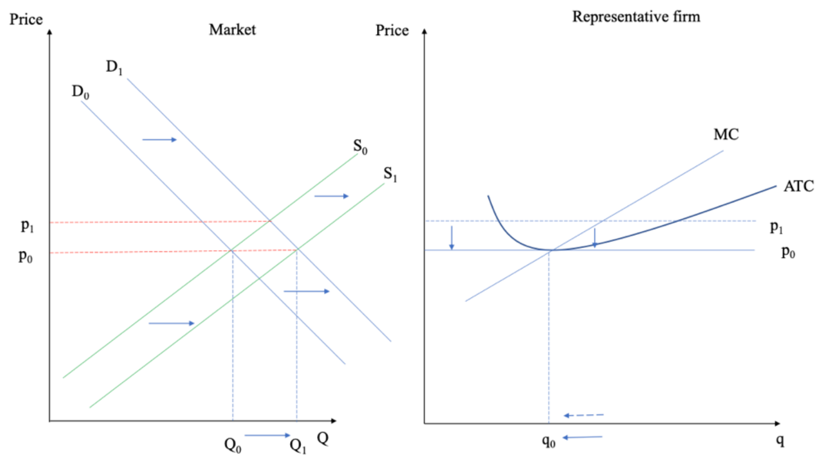
If a positive demand shock for bread happens to the example above, the short-run effect on market and firm would be this:

Figure 8.2: The short-run effect of a demand shock on the market and on a representative firm



The firm supplies more in response to the rise in demand. The firm now makes a profit. These profits will attract entering firms. This will result in an outward shift in the market supply curve.

Figure 8.3: The effect of free entry on the supply



EFFICIENCY IN CONSUMPTION

PARETO EFFICIENCY is if there is no way of making someone better off without someone else worse off.

Figure 8.5: The initial allocation for Red

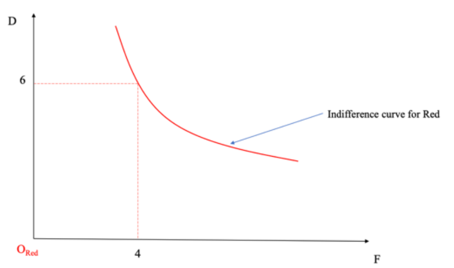
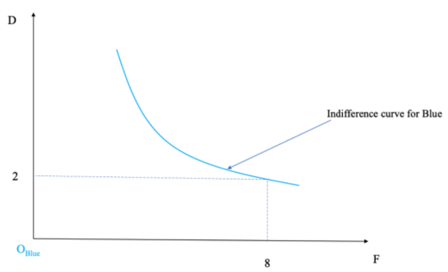


Figure 8.4: The initial allocation for Blue



EDGEWORTH BOX: to measure efficiency the indifference curves are put together, where one is flipped.

Figure 8.7: Trade in an Edgeworth box

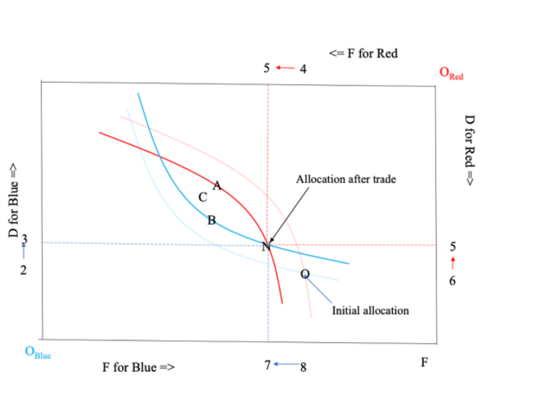
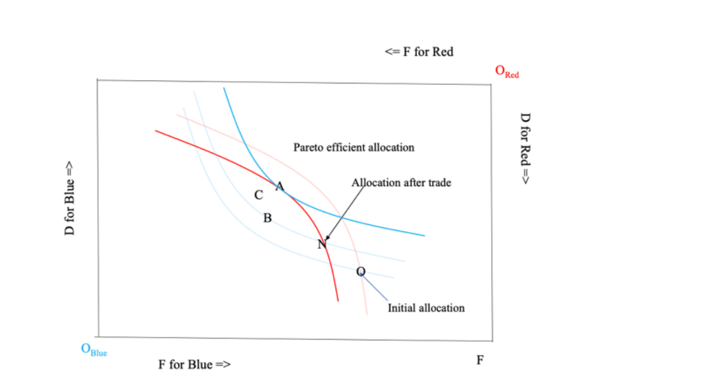


Figure 8.8: Trade in an Edgeworth box



DESCRIPTION of an allocation that is **PARETO EFFICIENT**:

- No one can reach a higher indifference curve without someone else needing to end up on a lower indifference curve.
- There are no more unexploited gains from trade.
- The two indifference curves are tangent to each other:

$$MRS_{Blue} = \frac{MU_F}{MU_D} = \frac{MU_F}{MU_D} = MRS_{Red}$$

There can be many points of tangency, many Pareto optimal points and a line, that connects them is called a **CONTRACT CURVE**.

The **OPTIMAL CHOICES** imply that the indifference curve is tangent to the slope of the budget constraint:

$$MRS_{Blue} = \frac{MU_F}{MU_D} = \frac{p_F}{p_D} = \frac{MU_F}{MU_D} = MRS_{Red}$$

FIRST WELFARE THEOREM: in the general equilibrium with perfect competition, the allocation of resources is Pareto efficient.

Figure 8.10: Trade in an Edgeworth box with perfect complements

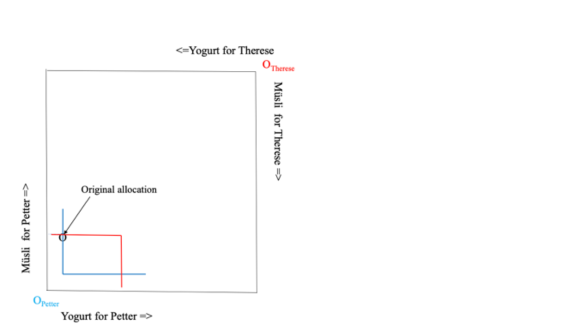
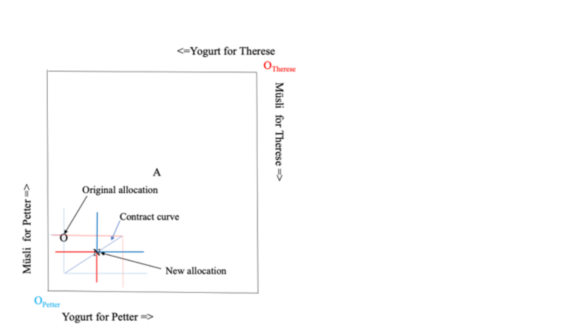


Figure 8.11: Trade in an Edgeworth box with perfect complements



SECOND WELFARE THEOREM: Every Pareto efficient allocation is a perfectly competitive equilibrium for some initial allocation of resources. This means that there is no tension between wanting an even distribution of utility and efficiency – a social planner would simply redistribute initial endowments and allow people to trade to reach an efficient outcome.

EFFICIENT USE OF INPUTS

Can the social planner reshuffle the use of production factors across industries and increase total production?

If all firms face the same wages and rental costs of capital, then firms in the production will have the same ratio of marginal product of labor to the marginal products of capital.

Figure 8.13: Efficient use of inputs in an Edgeworth box

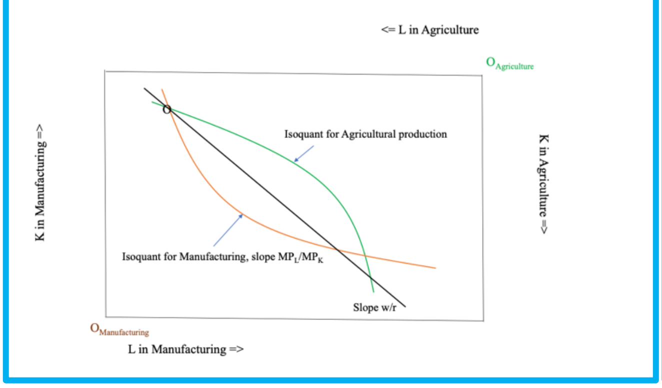
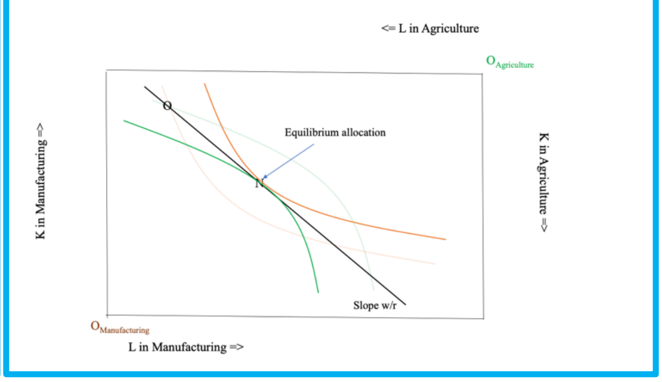


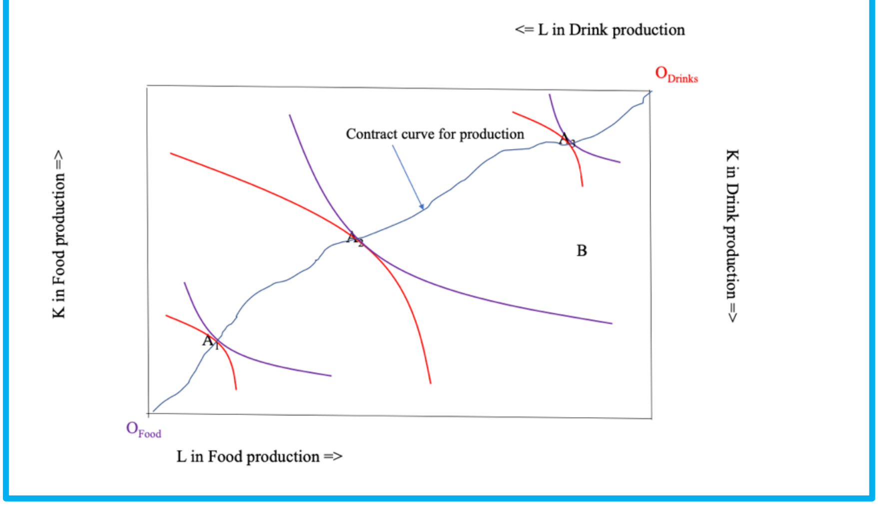
Figure 8.14: Efficient use of inputs in an Edgeworth box



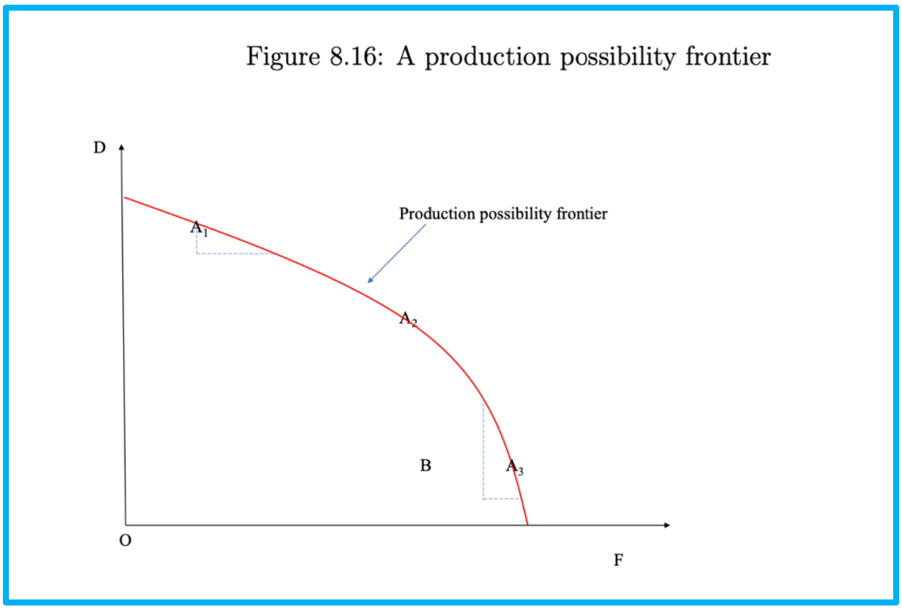
In a perfectly competitive equilibrium, adjustment comes via prices.

EFFICIENT COMBINATION OF GOODS

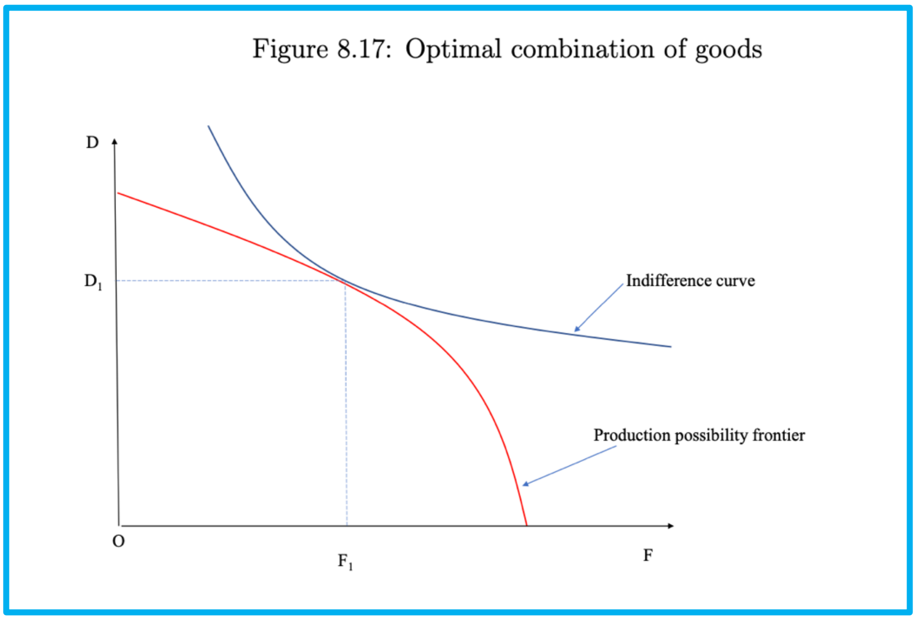
Figure 8.15: Efficient use of inputs in an Edgeworth box



PRODUCTION POSSIBILITY FRONTIER (PPF) is a line, that can be linear, bowed, and strictly concave. It illustrates the amounts of different goods produced. If inputs are used efficiently across sectors, we can only produce more of one good by producing less of another good.



The **OPTIMAL COMBINATION OF GOODS** also considers preferences and the indifference curve.



The slope of the PPF is **THE MARGINAL RATE OF TRANSFORMATION (MRT).**

$$MRT = \frac{MC_F}{MC_D} = \frac{p_F}{p_D} = \frac{MU_F}{MU_D} = MRS$$

The **OPTIMAL SOLUTION** implies that MRS equals MRT.

CHAPTER 9 - MONOPOLY AND MONOPOLISTIC COMPETITION

IMPERFECT COMPETITION is when firms have the power to set prices (no price-taking). These markets differ from perfect competition with respect to ease of entry, number of competitors, and product differentiation.

MARKET STRUCTURE

	Perfect Competition	Monopolistic Competition	Oligopoly	Monopoly
Number of Firms	Many	Many	Few	One
Type of Products Sold	Identical	Differentiated	Identical or differentiated	Unique
Barriers to Entry	None	None	Some	Many

A MONOPOLIST is sheltered from entry by competing firms.

MONOPOLISTIC COMPETITION has free entry.

A **MONOPOLY MARKET** is one in which a firm sells a good or service for which there are no close substitutes.

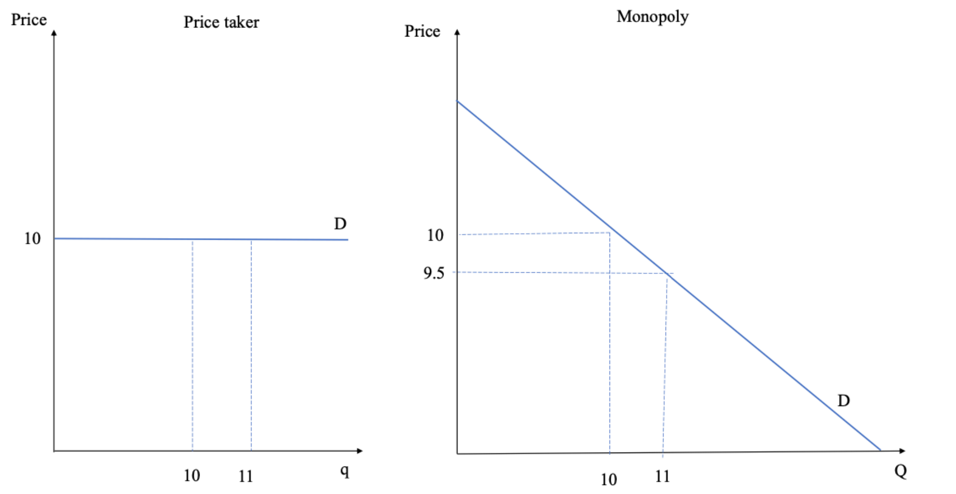
In a monopoly, the **FIRM-SPECIFIC DEMAND CURVE** is downward sloping.

The **MARGINAL REVENUE** for a **PRICE TAKER** is the change in revenue associated with a small increase in quantity and is equal to the price.

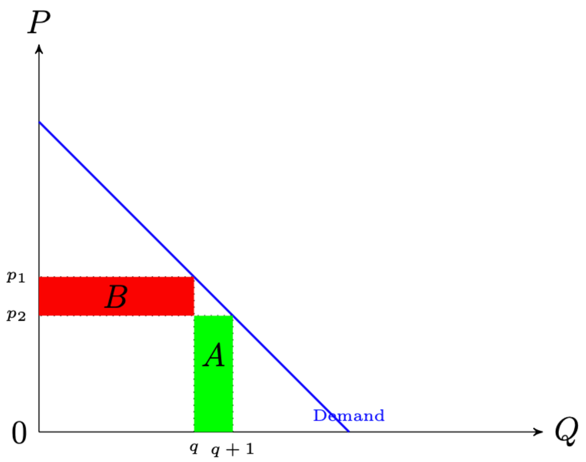
A firm has a **MONOPOLY** if its good or service is not produced by other firms. Thee good may be specific to a brand/company where monopoly reasoning applies. Only Apple makes and sells iPhones or MacBook's and has monopoly of these goods. Apple does not have a monopoly over smartphones.

For a **MONOPOLY** the firm meets the entire market demand for the good or service that it produces, and the market level demand is expected to slope downward. **THE MARGINAL REVENUE** for a **MONOPOLY** is lower than the price, because the greater quantity drives down the price, because the marginal costs are increasing.

Figure 9.1: Demand curve facing a single firm: Price taker vs. monopolist

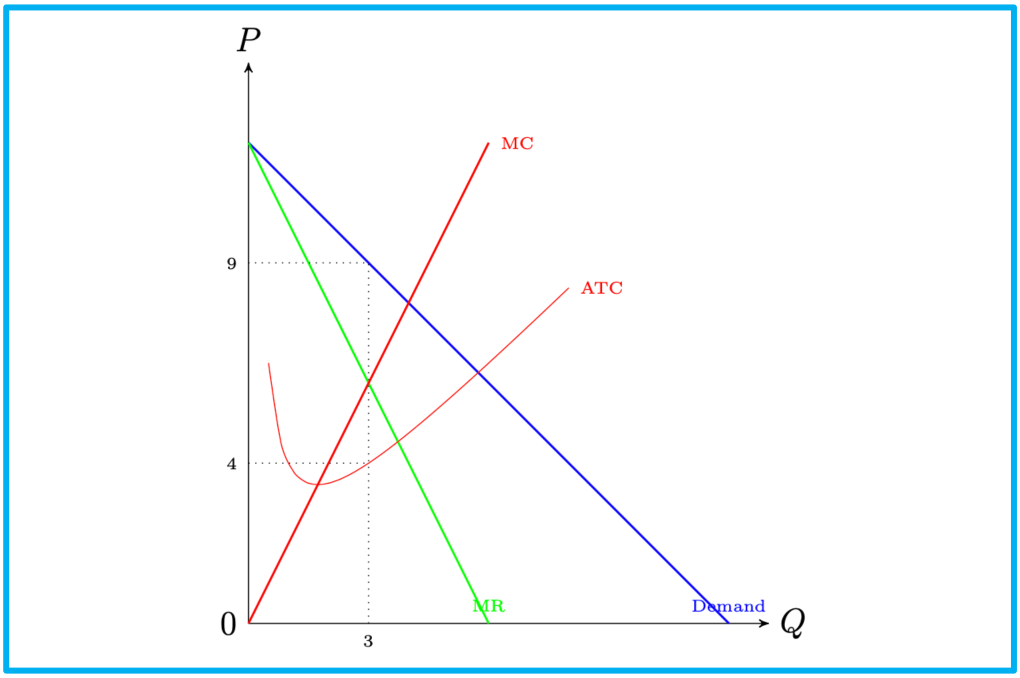


Marginal revenue for a monopoly firm



$A - B$ is the marginal revenue of increasing output from q to $q + 1$. Depending on the demand, the marginal revenue may be positive or negative.

PROFIT MAXIMIZATION FOR A MONOPOLIST



Marginal revenue has a **SLOPE** that is 2x as steep as the demand function. The quantity is 3 at a price of 9, and when the quantity is 3, the average cost will be 4. Profit per unit is $(9 - 4) \cdot 3$.

Demand curve expressed as $p = 12 - Q$ and the cost function as $C(Q) = 3 + Q^2$.

The profit maximization is **REVENUE** minus **COSTS**: $\max_Q (12 - Q) \cdot Q - (3 + Q^2)$

GENERAL FORM

$$\max_Q p(Q) - C(Q)$$

Profits can be expressed as:

$$\Pi(Q) = 12Q - Q^2 - 3 - Q^2$$

PROFIT MAXIMIZATION

$$\frac{d\Pi(Q)}{dQ} = 12 - 2Q - 2Q = 0$$
$$\rightarrow Q^* = 3 \text{ which gives } p^* = 12 - 3 = 9$$

GENERAL FORM marginal revenue minus marginal costs:

$$\frac{d\Pi(Q)}{dQ} = \frac{dp(Q)}{dQ} + p(Q) - \frac{dC(Q)}{dQ} = 0$$

$$\frac{dp}{dQ}\frac{Q}{p} + \frac{p - MC}{p} = 0$$

The first term is simply the inverse of the price elasticity of demand, which means:

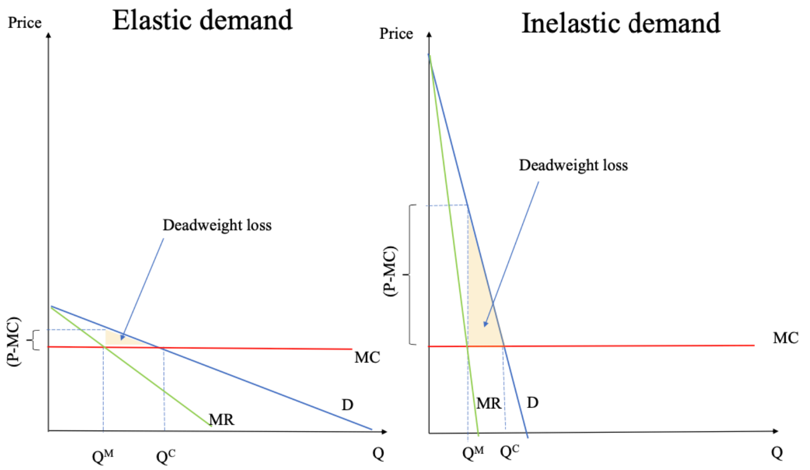
$$E^D = \frac{dQ}{dp}\frac{p}{Q} \rightarrow \frac{p - MC}{p} = -\frac{1}{E^D}$$

The term on the left is the **MARKUP**, which is the difference between price and marginal cost, in relation to the price. This is also known as the Lerner index, that runs from 0 to 1. As price gets closer to marginal cost, as markups are lower, then the index tends towards 0. Perfect competition is associated with a perfectly flat inverse demand and this case is thus associated with an index of 0.

Having a monopoly on products with a relatively low sensitivity of demand clearly can generate high profits.

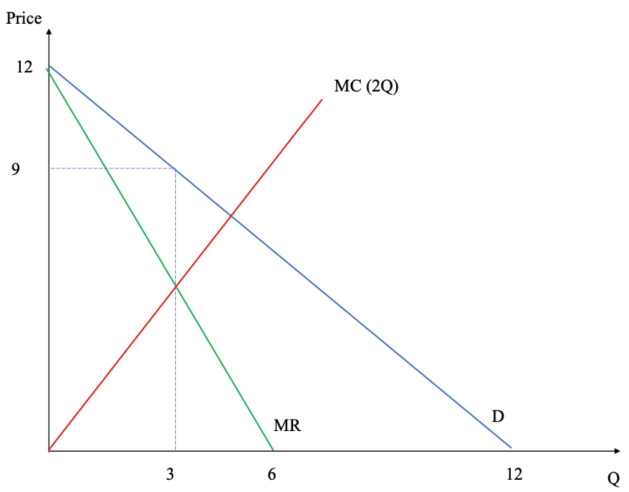
On the right-hand side minus 1 over price elasticity of demand.

Figure 9.5: Lerner index for high and low elastictity of demand



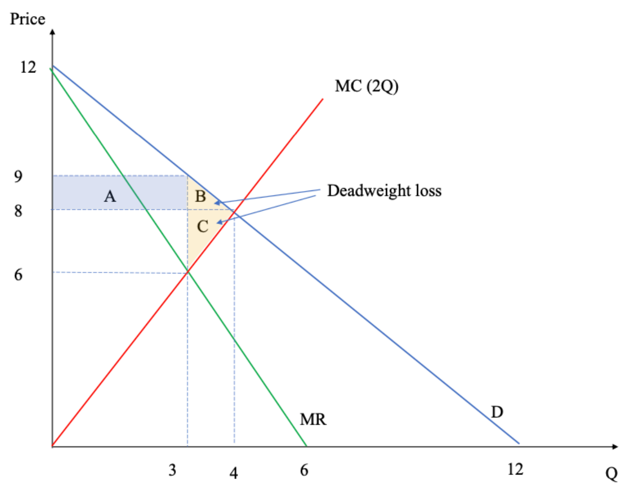
The firm maximizes profit by setting marginal revenue equal to marginal cost.

Figure 9.2: Profit maximization for a monopolist: Numerical example



If quantity is below 3, each additional unit increases revenue more than what it increases costs and profits therefore increase. It does not mean that the firm would not make a loss even if it did not set quantity such that marginal revenue is equal to marginal cost.

Figure 9.4: Deadweight loss of a monopoly: Numerical example



THE LATTER VALUE can be found by inserting 3 into the marginal cost function:

$$\frac{(9-6)\cdot(4-3)}{2} = 1.5 \text{ euros}$$

How much prices are elevated above marginal costs in a particular industry, or a particular firm says something about the **MARKET POWER** - the ability to in a profit maximizing way set a price above marginal cost - that a firm has.

MONOPOLY POWER is used as a synonym for market power (also in cases where firms are not monopolists).

HIGHER PRICES often means that the demand becomes more elastic.

Under **PERFECT COMPETITION** profit tended to be 0.

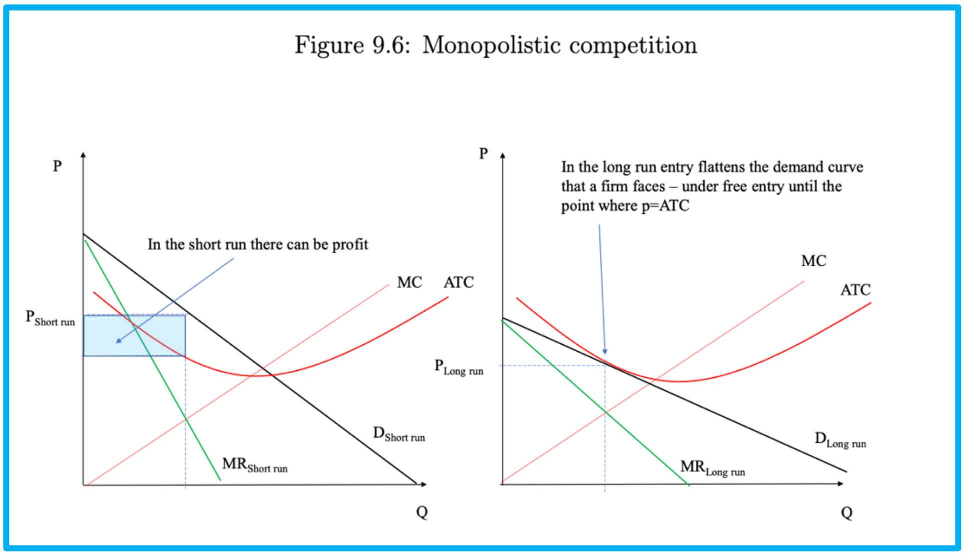
MONOPOLISTIC COMPETITION

When firms face downward sloping demand and there is free entry it is **MONOPOLISITC COMPETITION**.

Three key **ASSUMPTIONS**:

- Firms produce differentiated products. They can set price and if they raise price a little, they typically lose some customers but not all.
- Many competitors, so no strategic interaction, and do not try to model how what's optimal for me to do depends on what you're doing.
- Free entry. Easy for new entrants to come into the market

Local services such as restaurants and hair salons are examples of markets that is often described as monopolistic competition.



MONOPOLISTIC COMPETITION WHEN FIRMS DIFFER IN PRODUCTIVITY

The output Q from firm i at time t can be expressed as:

$$Q_{it} = A_{it} L_{it}^{\alpha L} K_{it}^{\alpha K}$$

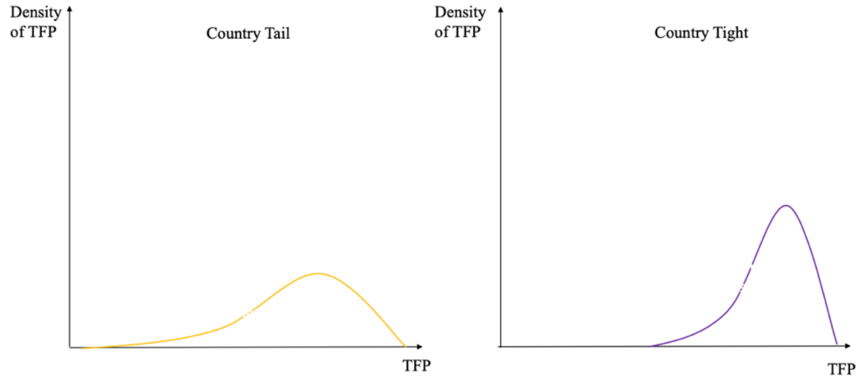
Taking the natural logarithm:

$$lnQ_{it} = lnA_{it} + \alpha_L lnL_{it} + \alpha_K lnK_{it}$$

Q_{it} can be a number of units produced by a firm of a particular type in a particular year. K is capital, L is labor. An estimates value of α_L of 0.5 for instance tells that id the amount of labor used increases by 10%, then the number of units produced increase by 5%. lnA_{it} captures productivity. A_{it} is **TOTAL FACTOR PRODUCTIVITY (TFP)**.

- There are large differences in TFP across firms within the same industry and country.
- Productivity is highly persistent - the most productive firms tend to stay the most productive.
- More productive firms tend to be more profitable, larger, grow faster as well as be more likely to survive and pay higher wages.

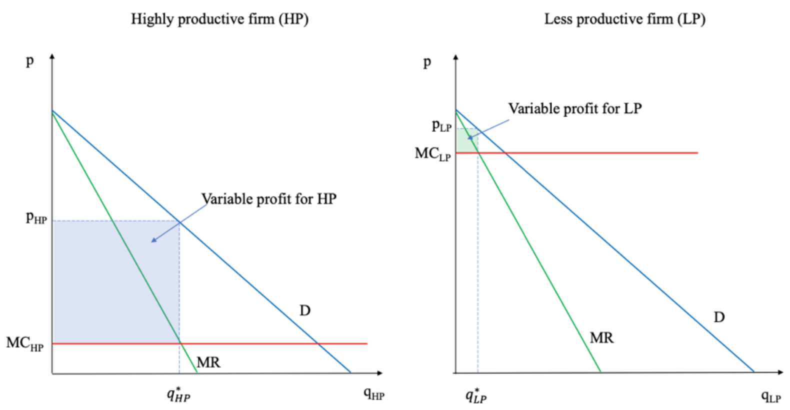
Figure 9.7: Two hypothetical TFP distributions



To model monopolistic competition and allow for differences across firms we assume:

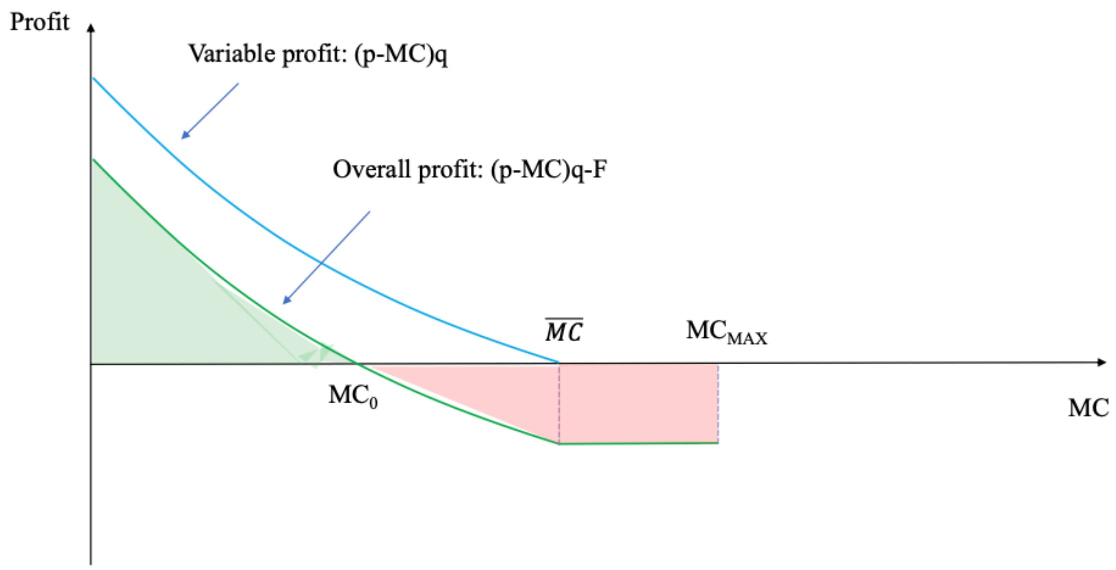
- There is monopolistic competition - goods are differentiated and there is free entry
- Differences in marginal costs across firms

Figure 9.8: Variable profit of firms with two different levels of marginal costs



The relation between profits and marginal costs for firms. The fixed entry cost is the price of the lottery ticket, and your winnings will be determined by the marginal cost that you draw. The upper curve is variable profit, the higher realization of marginal cost that a firm has, the further to the right along the horizontal axis is it and the lower is its variable profit. The lower curve gives profit also taking account of the fixed entry cost. The lowest possible marginal cost draw is 0, and the highest possible draw is maximum of marginal cost. If marginal cost is higher than the demand intercept there is no point in producing.

Figure 9.9: Profits of firms at different realizations of marginal costs



CHAPTER 10 - OLIGOPOLY

Every (few) firm sells the exact same thing - **HOMOGENEOUS PRODUCTS**.

Example of how to decide how much to produce in an oligopoly:

Two firms, Blue and Red, where Blue produces q_B units and Red produces q_R units. Market demand is given by $p = 70 - Q$ where quantity depends on the quantity of both firms: $Q = q_B + q_R$. The cost for Blue is given by $C(q_B) = 10q_B$ and symmetrically for Red. The maximization problem is given by:

$$\max_{q_B}(70 - q_B - q_R)q_B - 10q_B$$

Profit is revenue minus cost.

$$\frac{d\Pi_B}{dq_B} = (70 - 2q_B - q_R) - 10 = 0$$

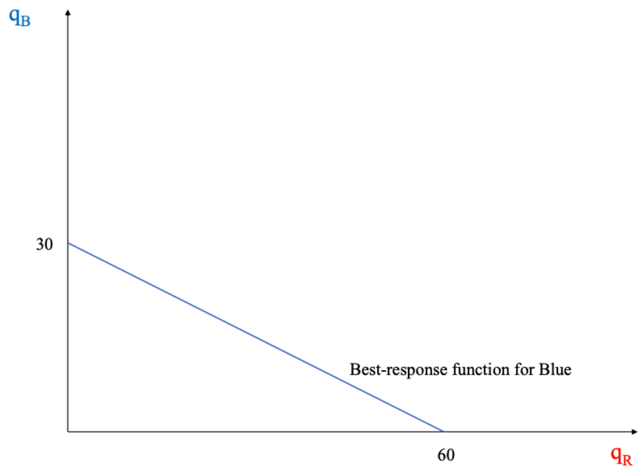
Which is MR minus MC.

$$q_B = 30 - \frac{q_R}{2}$$

This is called the **BEST-RESPONSE FUNCTION**.

The intercept on the vertical axis is the quantity that Blue would want to produce if it believed that Red produces nothing, this is the monopoly quantity.

Figure 10.1: The best-response Function for a Cournot Firm



If red also tries to maximize profits, Red’s maximization is given by:

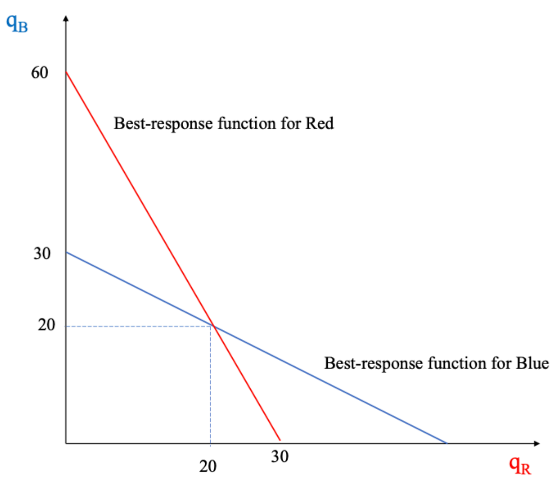
$$\max_{q_R}(70 - q_R - q_B)q_R - 10q_R$$

$$\frac{d\Pi_R}{dq_R} = (70 - 2q_R - q_B) - 10 = 0$$

$$q_R = 30 - \frac{q_B}{2} \rightarrow q_b = 60 - 2q_R$$

Total quantity supplied by these two firms is $20 + 20 = 40$ bottles at a price given by $70 - 40 = 30$ euros. The profits for both firms are then $30 \cdot 20 - 10 \cdot 20 = 400.$

Figure 10.2: The Cournot equilibrium quantities



A COMPARISON BETWEEN COURNOT AND OTHER MARKET FORMS

If the two firms had acted as a monopolist, they would have maximized the joint profit. A joint profit maximizing entity would set a quantity to maximize:

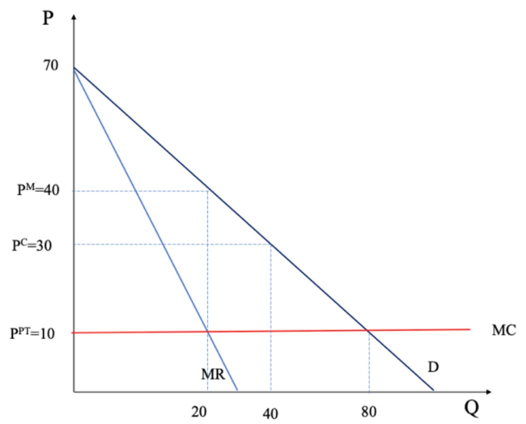
$$\max_{Q}(70 - Q)Q - 10Q \rightarrow 70 - 2Q - 10 = 0$$

The resulting monopoly profit would with a monopoly quantity of $Q^M = 30$ and a price of $70 - 30 = 30$ **euros** be:

$$40 \cdot 30 - 10 \cdot 30 = 900 \text{ euros}$$

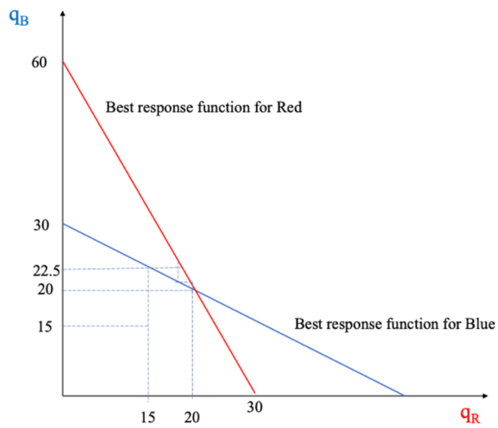
If a joint firm acted as a price taker, it would instead set quantity at the point where $p = MC$. The Cournot quantity is between the monopoly and price taking outcomes. Having two competitors rather than a monopoly is beneficial for society in the senses that prices fall, consumer surplus increases and the deadweight loss decreases.

Figure 10.3: Prices and quantities under different assumptions about how firms compete



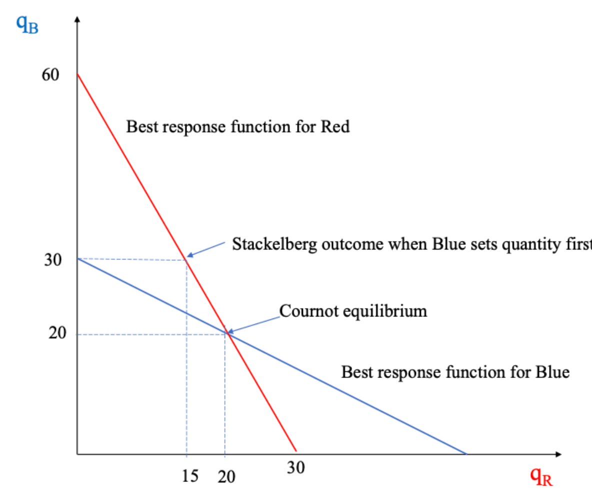
THE DEEPER INTUITION BEHIND THE COURNOT EQUILIBRIUM

Figure 10.4: One intuition for why the intersection of best-response functions is an equilibrium set of quantities



LETTING ONE FIRM DECIDE FRIST

Figure 10.5: Quantities when blue decides quantity first

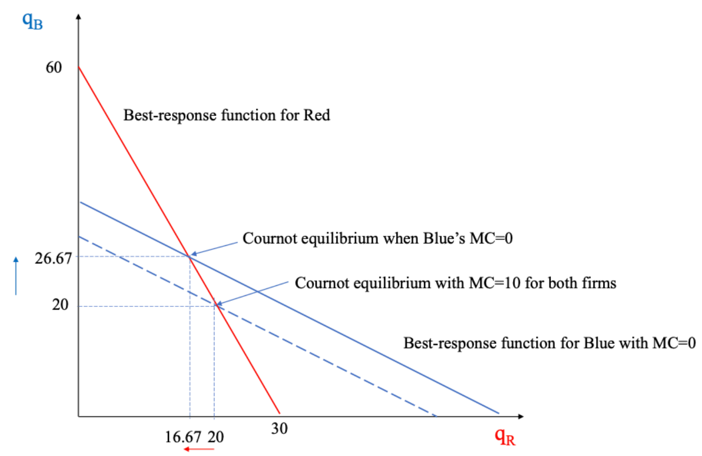


The response of the other firm changes from the Cournot equilibrium, so the new combination is 30 and 15 instead of 20 and 20.

DIFFERENCES IN MARGINAL COSTS

When there is a difference in marginal costs, the intercept will change. With Blue having marginal cost of 0 instead of 10, the new quantity will be 26.67 for Blue and 16.67 for Red. This is around 43 bottles, which is more and therefore it is beneficial for consumers.

Figure 10.6: Cournot equilibrium with differences in marginal costs across firms



PRICE SETTING

The only set of prices where no one has a unilateral incentive to deviate are when each firms sets price equal to marginal cost.

A COMPARION BETWEEN COURNOT AND BERTRAND

If a number of n firms that are identical and the demand intercept is given by a parameter a and that all firms have constant marginal costs of c.

$$\max_{q_1}((a-Q)q_1 - c_1q_1) \text{ where } Q = q_1 + q_2 + \cdots q_n$$

Profit maximizing quantity for each firm:

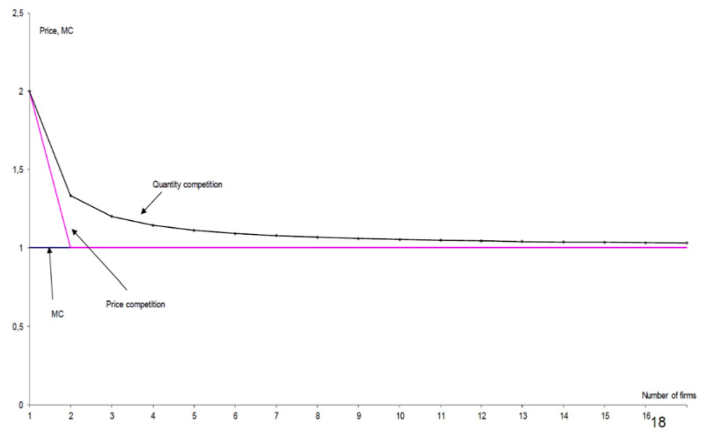
$$q = \frac{a-c}{1+n}$$

Inserting these equilibrium quantities into the demand function, we get that:

$$p = \frac{a}{1+n} + \frac{n}{1+n}c$$

As the number of firms grows, price gets closer and closer to marginal cost.

Figure 10.7: The relation between price and marginal costs for homogeneous goods as the number of firms change: Bertrand (price setting) vs. Cournot (quantity setting)



OLIGOPOLY WITH DIFFERENTIATED PRODUCTS

Different products are not perfect substitutes for each other.

VERTICAL PRODUCT DIFFERENTIATION is the case where one product is objectively better in some dimension, for instance a faster computer.

HORIZONTAL PRODUCT DIFFERENTIATION is the case where different consumers differ in their valuation of the product because of taste differences.

$$q_B = 85 - p_B + \frac{p_R}{2} \text{ and } q_R = 85 - p_R + \frac{p_B}{2}$$

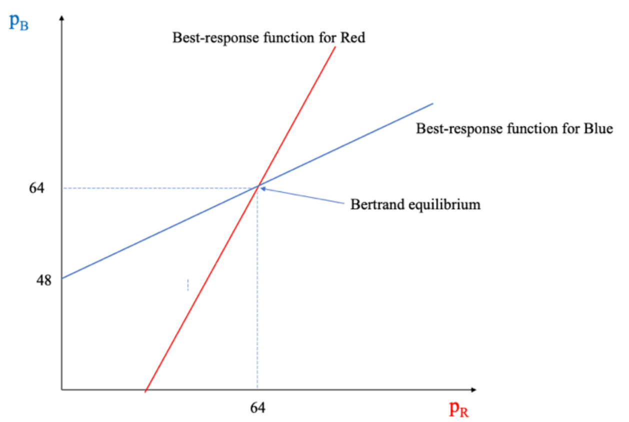
$$\max_{p_B}\left(85 - p_B + \frac{p_R}{2}\right)p_B - \left(85 - p_B + \frac{p_R}{2}\right)11 \text{ where 11 is marginal cost}$$

$$\max_{p_B}(85 - p_B + \frac{p_R}{2})(p_B - 11)$$

After differentiating with respect to p_B and p_R and rewriting it is:

$$p_R = \frac{96}{2} + \frac{p_B}{4} \rightarrow p_B = -96 \cdot 2 + p_R 4$$

Figure 10.8: Best-response Functions: Price Competition with Differentiated Products (Bertrand)



They both produce 64 bottles.

CHAPTER 11 – GAMES AND STRATEGIES

In a **GAME**, there are three basic ingredients:

- A set of **PLAYERS**,
- That each can take different **ACTIONS**,
- And **PAYOFFS** that depend both on each player's own action as well as the actions of the other players.

A **STATIC GAME** is when the players choose a strategy simultaneously, not knowing the actions taken by other players.

A **SEQUENTIAL GAME** is where one player gets to select strategy first after which others follow.

SIMULTANEOUS GAMES

(also called static or normal-form games) When two players move at the same time. The payoffs can be illustrated by a **PAYOFF MATRIX**:

Figure 11.1: A simultaneous game depicted in normal form

		Orange's Strategy	
		Cooperate	Play Aggressively
Black's Strategy	Cooperate	5 , 5	1 , 8
	Play Aggressively	8 , 1	2 , 2

The **BEST RESPONSE OF A PLAYER TO THE STRATEGIES OF THE OTHER PLAYERS** is the strategy that maximizes her own payoff given the strategies chosen by the other players.

A player has a **DOMINANT STRATEGY** is her best response is the same no matter what strategies are chosen by the other players.

A **DOMINANT STRATEGY EQUILIBRIUM** is a combination of strategies for each of the players such that the strategy for each player in the combination is a dominant strategy for her.

The two players always choose the highest payoff for themselves, and in this game, it would be as following:

Figure 11.2: A simultaneous game depicted in normal form where best responses have been underlined

		Orange's Strategy	
		Cooperate	Play Aggressively
Black's Strategy	Cooperate	5 , 5	1 , <u>8</u>
	Play Aggressively	<u>8</u> , 1	<u>2</u> , <u>2</u>

DOMINANT STRATEGIES is a strategy that is optimal no matter what the other player does. The **PREDICTED EQUILIBRIUM OUTCOME** is that both players play aggressively, and each receive a payoff of 2. If the two players could agree to cooperate, they could each get a payoff of 5 instead of 2. This means that the equilibrium set of strategies is such that both players could be better without.

NASH EQUILIBRIA

It is a set of strategies such that no player can achieve a higher payoff by unilaterally changing strategy.

It is a combination of strategies for each of the players such that each player's strategy is a best response to the strategies of the other players.

A **COORDINATION GAME** is when the players want to corporate.

In the game below, the **MAXIMIN STRATEGY** in the game is to play aggressively, because it is the strategy that maximizes the minimum payoff.

Figure 11.3: A simultaneous game with two Nash equilibria

		Orange's Strategy	
		Cooperate	Play Aggressively
Black's Strategy	Cooperate	10 , 10	1 , 8
	Play Aggressively	8 , 1	2 , 2

There is also a possibility, that pure strategies have no Nash equilibrium in it, because they always want to change their strategy, because there is no case, where both players can win.

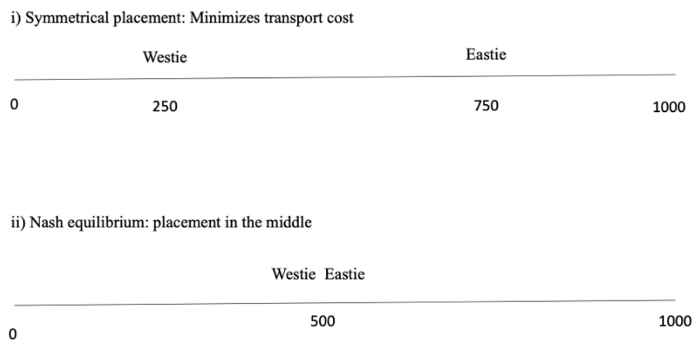
Figure 11.4: A simultaneous game with no Nash equilibria in pure strategies: rock, paper, scissors

		Red		
		Rock	Paper	Scissors
Blue	Rock	0,0	-1,1	1,-1
	Paper	1,-1	0,0	-1,1
	Scissors	-1,1	1,-1	0,0

A **MIXED STRATEGY** is where each player chooses probabilities to best respond to the probabilities chosen by the opponent. This can be e.g. where to take a penalty in football.

In the case below, none of the vendors want to change their location from the 500 meters, and therefore it is a Nash equilibrium.

Figure 11.5: A simultaneous game with continuous variables: The ice cream vendor problem



REPEATED GAMES

'Consider again the payoffs that we used to illustrate the prisoner's dilemma above but now instead think of Black and Orange as symbolizing two firms that each can choose to "cooperate" or to "defect", as illustrated in Figure 11.6. Cooperate means to abide to a cartel agreement – that could be explicit as in an international cartel such as that between oil producers within OPEC. It could also be a case of tacit collusion, where, for instance, based on mutual understanding, both firms set a high price, or avoid competitive advertising etc. If the game is only played once the dominant strategy for each firm is to defect.'

Figure 11.6: The payoffs in a one shot game: Can repeated play sustain cooperation?

		Orange's Strategy	
		Cooperate	Defect
Black's Strategy	Cooperate	5 , 5	1 , 8
	Defect	8 , 1	2 , 2

A firm's **DISCOUNT FACTOR** is how future profit is valued today. Seen from the perspective of today, profits in the future are worth less then profits today.

$$FutureValue = PresentValue \cdot (1 + r)$$

$$PresentValue = FutureValue \cdot \frac{1}{1+r} \text{ where } \frac{1}{(1+r)} \text{ is the discount factor.}$$

The present value of cooperating is given by:

$$V_{i,cooperate} = \pi_{i,cooperate} + \delta\pi_{i,cooperate} + \delta^2\pi_{i,cooperate} + \cdots = \frac{\pi_{i,cooperate}}{1-\delta}$$

The present value of defecting is given by:

$$V_{i,defect} = \pi_{i,defect} + \delta\pi_{i,nash} + \delta^2\pi_{i,nash} + \cdots = \pi_{i,defect} + \frac{\delta}{1-\delta}\pi_{i,nash}$$

The payoff from adhering to the collusive strategy to be at least as great as the payoff from defecting, the following must hold:

$$V_{i,cooperate} \geq V_{i,defect} \rightarrow \delta \geq \frac{\pi_{i,defect} - \pi_{i,col}}{\pi_{i,defect} - \pi_{i,nash}} = \delta_{min}$$

The collusion is sustainable only if sufficient weight is put on the future, if the discount factor is high enough. In the case above it is:

$$\delta \geq \frac{8-5}{8-2} = \frac{1}{2}$$

The framework also suggests:

- The greater $\pi_{i,defect}$ is, the greater δ_{min} is, and therefore the more difficult is it to sustain collusion.
- The greater $\pi_{i,col}$ is, the lower δ_{min} is, and the easier it is to sustain collusion. If the payoff form cooperating is high this clearly promotes cooperation.
- The greater $\pi_{i,nash}$ is the larger is δ_{min}, and the more difficult it is to sustain collusion. The greater the profits in the case of non-cooperation, the less of an incentive to cooperate is there, the less of a concern is it if cooperation breaks down.

SEQUENTIAL GAMES

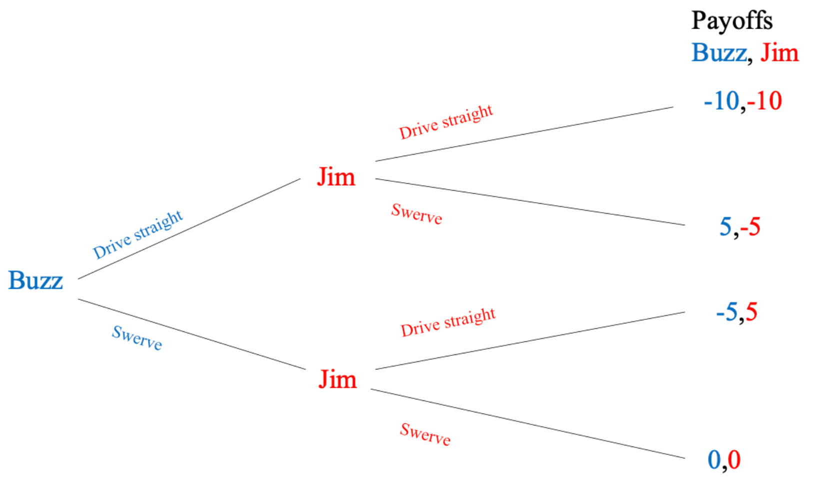
(also known as extensive-form games). One player chooses action first and then the other player chooses after having observed the first player's choice. The timing of the actions is important.

Figure 11.7: A game of chicken with best responses in the simultaneous game underlined

		Jim's Strategy	
		Drive Straight	Swerve
Buzz's Strategy	Drive Straight	-10 , -10	5 , -5
	Swerve	-5 , 5	0 , 0

A **GAME TREE** starts from the left with a node where all the different strategic choices that are possible for that player at that stage are illustrated by lines. Moving rightward we get to the nodes where the strategic choices for the second player are illustrated.

Figure 11.8: A sequential game of chicken depicted with a game tree



A **SUB-GAME PERFECT NASH EQUILIBRIUM** is when we go backwards and choose the strategy that maximizes his payoff, and then on to the second to last and so on. In this case the predicted set of equilibrium strategies is that buzz drives straight and Jim swerves.

Figure 11.9: A sequential game of chicken depicted with a game tree

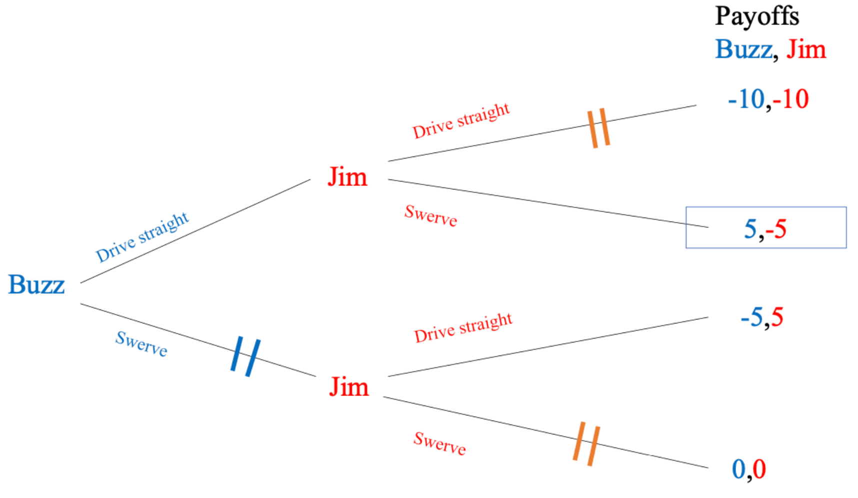
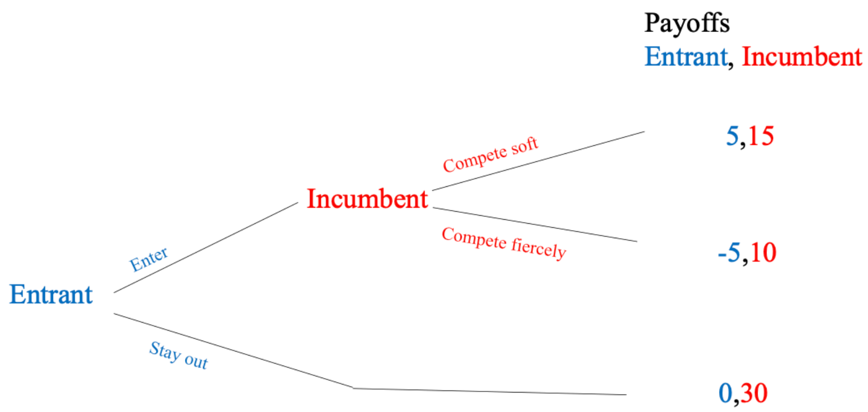
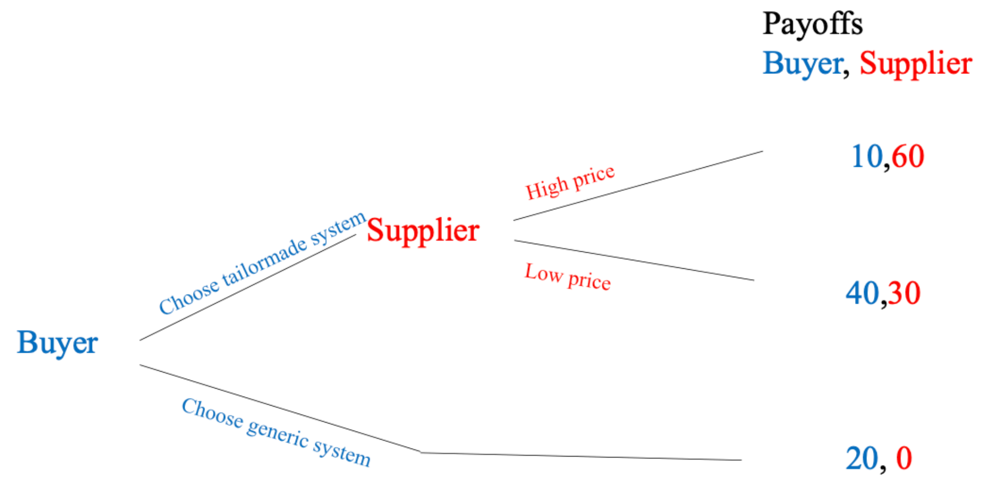


Figure 11.10: An entry game



HOLD-UP PROBLEMS concern cases where a party makes a relation-specific investment which puts them at risk of being taken advantage of ex post. A firm that chooses a specialized supplier rather than a more general technology may have given up outside options if the specialized supplier ex post wants to raise the price. This issue has a lack of trust in it.

Figure 11.12: A hold-up problem



CHAPTER 13 – EXTERNALITIES

EXTERNALITIES are actions taken by individuals and firms that affect others.

NEGATIVE EXTERNALISTIES have a negative welfare effect on others.

- Pollution
- Reckless behavior
- Noisy people in study space
- SUV

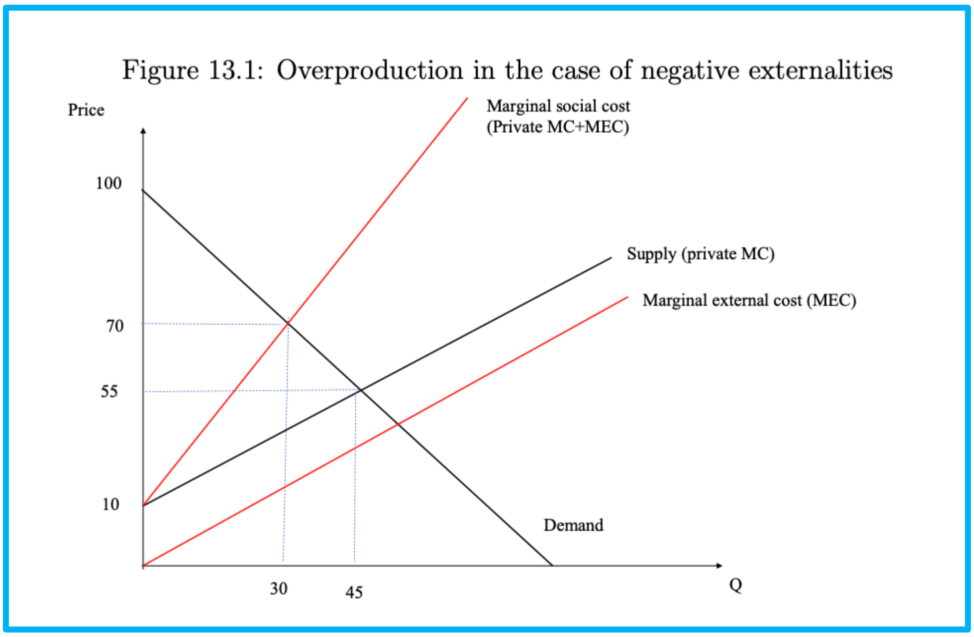
POSITIVE EXTERNALITIES have a positive welfare effect on others.

- Vaccines
- Education
- Healthy lifestyle

NETWORK EXTERNALITIES are another example of positive externalities. The more people, that use a particular social media site, the greater benefit is to others.

When there are **NEGATIVE EXTERNALITIES** then competitive markets **PRODUCE TOO MUCH**.

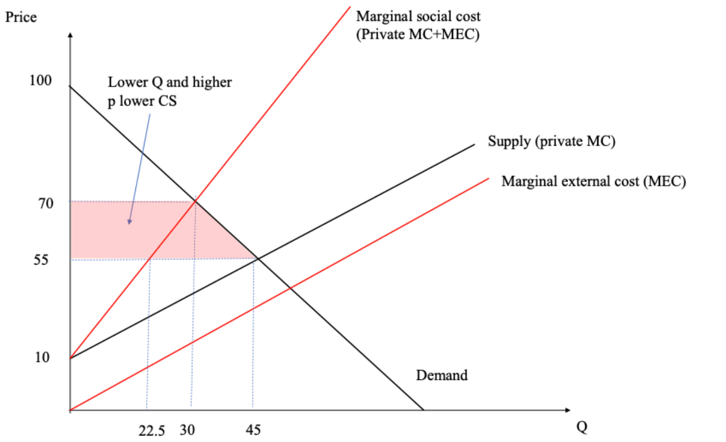
Example: demand function $p = 100 - Q^D$ and supply, given by the marginal cost curves of firms, $p = 10 + Q^S$. This marginal cost curve reflects the **PRIVATE COSTS**. Assume, that the marginal external cost equals Q. The private solution is highlighting only the producers' own costs, which is their private costs. Therefore: $100 - Q = 10 + Q \rightarrow 45$. This gives a price of 55. The **MARGINAL SOCIAL COST** is given by the sum of the private and external marginal costs: $10 + Q + Q$. This gives a new quantity of: $100 - Q = 10 + 1Q \rightarrow 30$. Then the price is 70.



The quantity of paper is lower, and the price is higher in the social optimum. This lowers the consumer surplus.

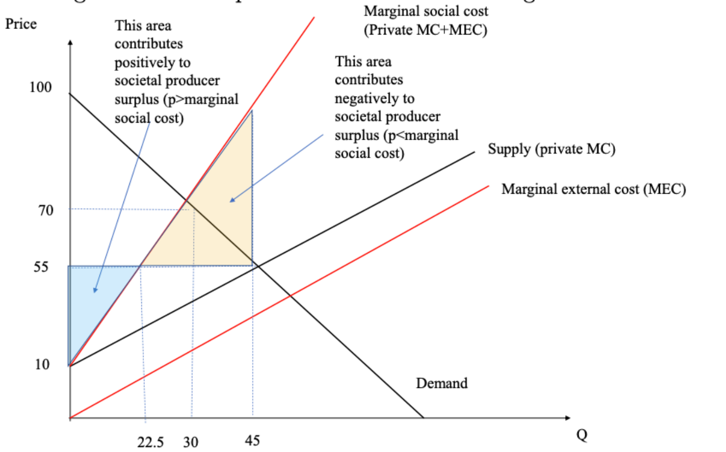
The **SOCIETAL PRODUCER SURPLUS** is the area between price and marginal cost curve, but takes account of the full social marginal costs, rather than just the private marginal cost. For low levels of production, price is greater than the social marginal cost and production on balance makes a contribution to society. At quantities above 22.5 $(10 + 2Q = 55)$. However, the marginal cost to society is greater than the price and each additional unit produces lowers the societal producer surplus. To some extent this loss is balances by the higher consumer surplus.

Figure 13.2: Overproduction in the case of negative externalities



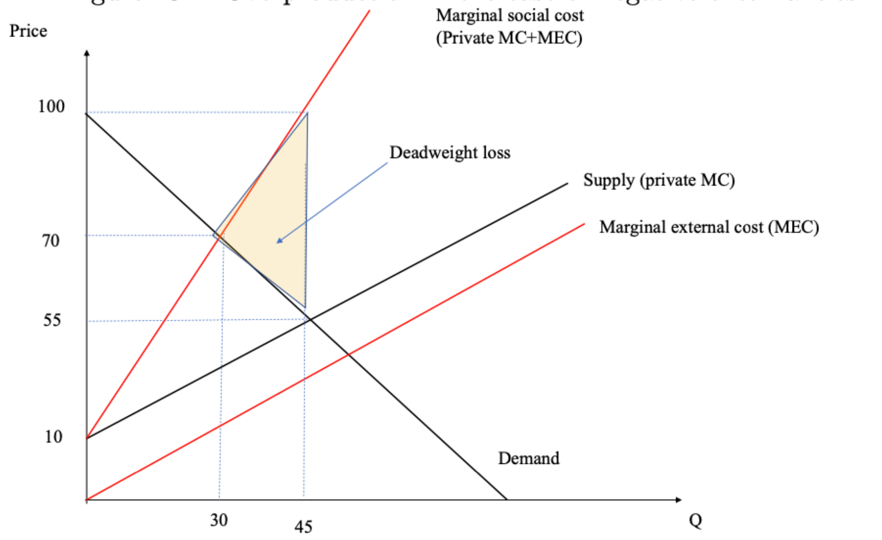
Video link for figures 13.1-13.4: https://youtu.be/apDS8R9RCjc.

Figure 13.3: Overproduction in the case of negative externalities



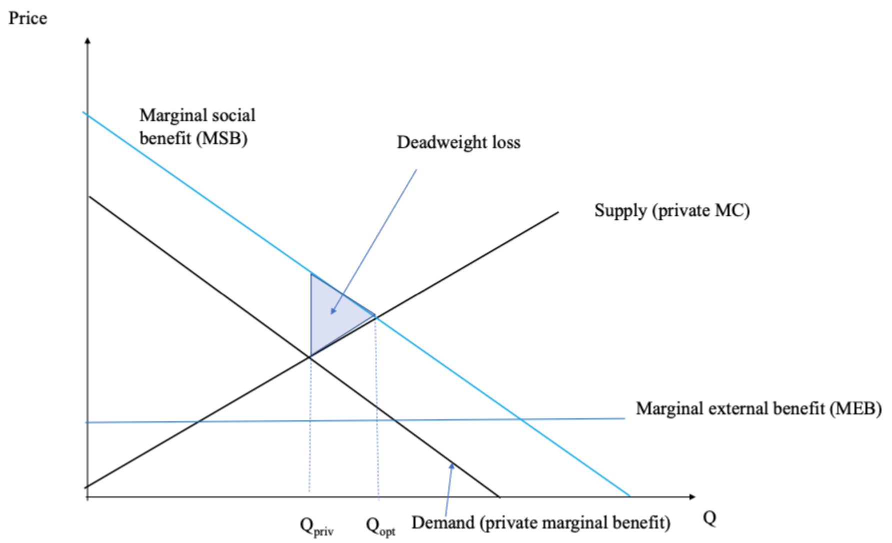
These are units where the increase in costs is greater than the valuation of additional units of paper. At $Q = 40$ for instance consumers’ valuation of additional units of paper I 60 euros (given by $100 - 40$) whereas the increase in costs to society is 90 euros (given by $10 + 2 \cdot 20$). The loss is greater than the gain. This is because the increase in costs is greater than the valuation of additional units of paper.

Figure 13.4: Overproduction in the case of negative externalities



When there are **POSITIVE EXTERNALITIES** then competitive markets **PRODUCES TOO LITTLE**. Provision of education is often given as an example of a service that is positive. There is a deadweight loss, because additional education is values higher for society than its cost in the private solution.

Figure 13.5: Underproduction in the case of positive externalities



The **COASE THEOREM** is that if property rights are well defined and there are no bargaining costs (costs of negotiating and writing binding contracts) then the efficient solution will be realized.

Table 13.1: Coasian example: Payoffs when no bargaining

Quantity of Rentals	Payoff White Water Co.	Payoff Landowner	Social Surplus
None	0	12	12
$Q_{Moderate}$	10	10	20
Q_{High}	14	2	16

Table 13.2: Coasian example: Example of payoffs when landowner has property right

Quantity of Rentals	Payoff White Water Co.	Payoff Landowner
None	0	12
$Q_{Moderate}$	1 (10-9)	19 (10+9)
Q_{High}	0 (14-14)	16 (2+14)

Table 13.3: Coasian example: Example of payoffs when White Water Co. has property right

Quantity of Rentals	Payoff White Water Co.	Payoff Landowner
None	0	12
$Q_{Moderate}$	17 (10+7)	3 (10-7)
Q_{High}	14	2

BARGAINING COSTS can be actual costs of time and involving legal experts to formulate difficulties in coordinating action between these.

If property rights are well assigned, the bargaining takes care of many externalities, and we do not need to rely on states to use taxes, quotas, and so forth.

DIFFERENT TYPES OF GOOD

Goods are **RIVAL** in consumption if one person's consumption means that another person cannot consume that same good.

NON-RIVAL goods are when one's consumption of the good does not hinder another from consuming the good: it could be radio and be protected by the same national defense.

A good is **EXCLUDABLE** if people can be excluded from consumption. If I own the apple, I can say no to others taking it instead.

A good is **NON-EXCLUDABLE** if people cannot be barred from consumption. A light house warns everyone

Table 13.4: Different types of goods

	Excludable	Non-excludable
Rival in consumption	Private goods	Common resource
Non-rival in consumption	Club goods	Public good

PRIVATE GOODS

...are goods and services that we would naturally think of when we purchase something: an apple, a shirt, a haircut, a meal at a restaurant.

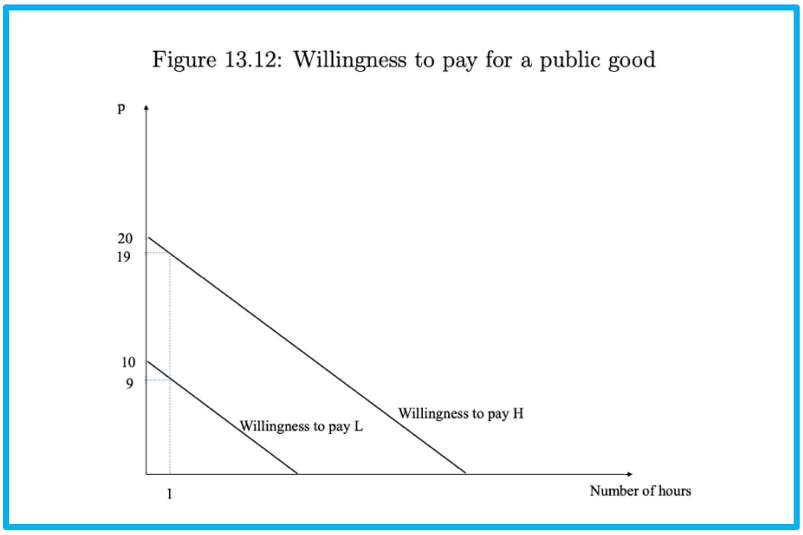
PUBLIC GOODS

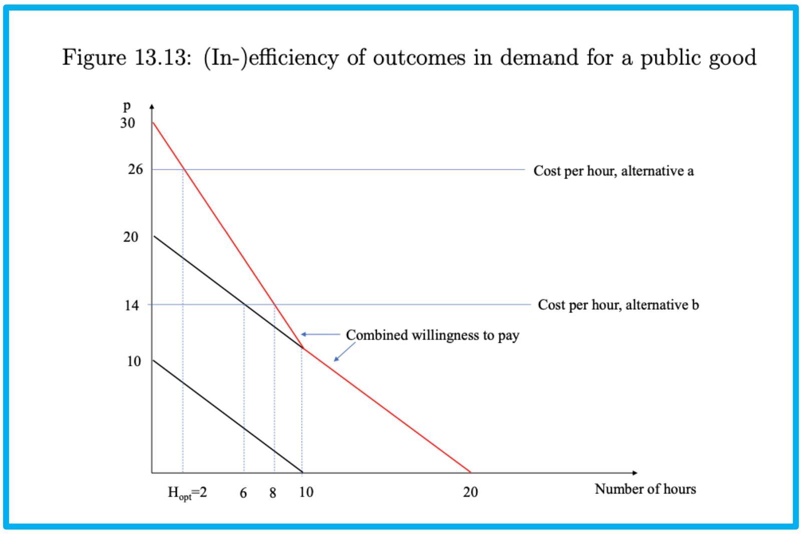
...are non-rival in consumption and non-excludable. National defense is an example. Positive externalities are at the core of public goods. There comes a **FREE-RIDER PROBLEM**. The opportunity to gain the benefits without contributing created a temptation to free ride on the efforts of others.

EXAMPLE: two apple tree farms. They want to have a guard to watch for thieves. The willingness to pay for guard services, the marginal benefit of an extra hour is $p_L = 10 - h$ for L and $p_H = 20 - h$ for H. At 1 hour of guarding, L's willingness to pay for this is 9 euros and H's willingness to pay is 19 euros. They are together willing to pay 28 euros.

The willingness to pay is:

$$p(h) = \begin{cases} 20 - h & \text{if } h > 10 \text{ and } h \leq 20 \\ 30 - 2h & \text{if } h \leq 10 \end{cases}$$





SOLUTIONS TO PUBLIC GOOD PROVISION

- **TAXATION**
- **QUANTITY MECHANISMS**
- **LOCAL RULES AND SOCIAL NORMS**

CLUB GOODS

...are non-rival in consumption, but excludable. Broadcast media that are protected by login details are an example

COMMON RESOURCES

COMMON RESOURCES are rival in consumption but non-excludable. Many natural resources, such as ocean fishing are of this type. Common resource problems is **TRAGEDY OF THE COMMONS** (in old days a commons was an area commonly owned by a village where villagers could let their livestock graze). The key underlying mechanism creating difficulties of common resources is that there is a negative externality - when someone uses a common resource, they lower the payoff for other users.

EXAMPLE: Fishing in a lake where there are a number of fishermen around the lake. First consider the case where they maximize surplus jointly (or alternatively think of it as the case where one fisherman has the property right).

$F(b)$ denotes the amount of fish caugt, which depends on the number of boats b used to catch fish and the cost of running a boat, c. The **MAXIMIZATION PROBLEM** first order condition is:

$$\frac{dF(b)}{db} = c$$

There will be additional fishing as long as:

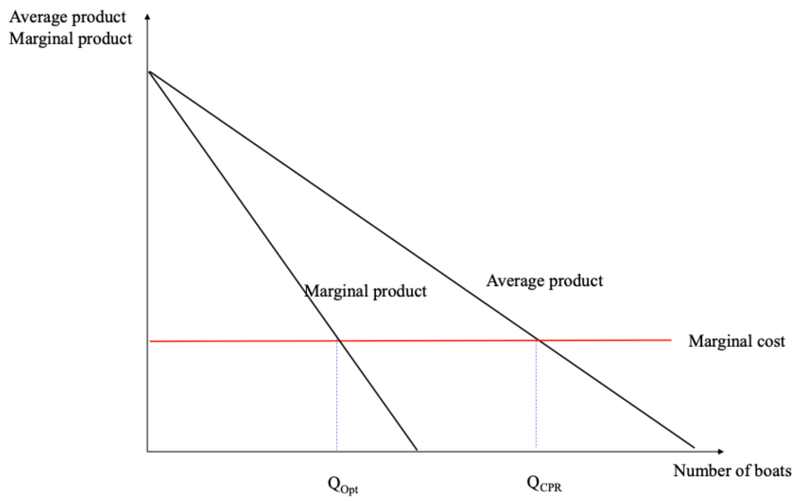
$$F(b) - cb \geq c$$

At the point where the equability holds with equality we have:

$$\frac{F(b)}{b} = c$$

There will be entry until the average product is equal to the cost. The logic for the common resource without cooperation is #if I don't take it, someone else will".

Figure 13.11: Overuse of a common resource



SOLUTIONS TO COMMON RESOURCES PROBLEMS

QUANTITY RESTRICTIONS

- Fishing quotas
- Maximum of number fished
- Time restrictions of the year

RAISING COSTS

- Raising costs of the common resource
- Restrictions on the type of tools allowed to be used

PROPERTY RIGHTS

- The bargaining costs are too high in many cases involving externalities for Coasean bargaining to solve the issues.

LOCAL RULES AND SOCIAL NORMS

- Common property resource can be seen as applying more to a group of people that jointly manage a common resource rather than the free-for-all that would come in a situation where literally there is no possibility to exclude.

CHAPTER 14 – ASYMMETRIC INFORMARTION

ASSYMMETRIC INFORMATION is where parties involved in a transaction differ in their knowledge of the good or service being sold.

ADVERSE SELECTION is the situation where there are potential customers with different probabilities of payout of the insurance. People with higher probability of failing are more likely to want to buy an insurance, where they get their money back, if they fail. Adverse selection is where different goods, services or people have different levels of quality (or risk) and one party knows much more than the other. **HIDDEN INFORMATION** is used as a synonym.

MORAL HAZARD is when the insured can act in different ways which the less informed party (the insurance company in this case) can't observe. **HIDDEN ACTION** is sometimes used as a synonym - reflecting that it is the actions of one party that is partly hidden from other parties.

ADVERSE SELECTION

SYMMETRIC INFORMATION WITH OBSERVABLE QUALITY is when the quality is known for both the buyers and the sellers.

SYMMETRIC INFORMATION WITH UNOBSERVABLE QUALITY neither party knows the quality. Both parties calculate that there is 50% probability of a given car being high quality, and 50% of low quality. A risk-neutral buyer would value a car $0.5 \cdot 150 + 0.5 \cdot 50 = 100$ euros. (A high quality car is valued at 150 euros by the buyer and the low quality at 50). The higher the probability that the product is of low quality, the lower the willingness to pay is.

ASYMMETRIC INFORMATION: SELLERS KNOW QUALITY BUT BUYER'S DON'T: the buyers require at least 130 euros to sell a car of high quality, but the buyers do not know the quality and their WTP is therefore too low. At the end only low-quality cars would be sold. Asymmetric information can shut down a market.

OVERVIEW

Equilibrium

- **MARKET EQUILIBRIUM** is for competitive markets.

- **EQUILIBRIUM IN DOMINANT STRATEGIES** for simultaneous move games is when the best response of each player is independent of the strategies chosen by the other players.

- **NASH EQUILIBRIUM** for simultaneous games is a combination of strategies such that each player is best responding to the other players' strategies. **COURNOT** is simultaneous choice of outputs. **BERTRAND** is choice of prices.

- **SUBGAME PERFECT NASH EQUILIBRIUM** is in sequential games.

Elasticities

- Remember, that it is always negative because of the **LAW OF DEMAND**.

- Usually **CHANGES** along the demand curve.

Marginal

- When **MARGINAL** is used, then it is a **SMALL** change in something else. It is a slope of a function at a particular point.

Consumer theory

- **MRS** is marginal rate of substitution. It is the slope of the indifference curve. To maximize the welfare, choose the point where the budget constraint is tangent to the indifference line. The slope of the budget constraint is $\mathbf{MRS} = -\frac{p_x}{p_y} \rightarrow \frac{MU_x}{p_x} = \frac{MU_y}{p_y}$.

- **MRT** is marginal rate of transformation. It is the slope of the production possibility frontier.

$$MRT = \frac{MC_F}{MC_D}$$

- **INDIFFERENCE CURVE** is a curve, where all combinations will give the same utility.

- **INDIFFERENCE MAP** is a list of all the indifference curves.

- If x is the solution to the consumer problem and it is bigger than 0, then:

$$\frac{MU_i(x)}{p_i} = \frac{MU_j(x)}{p_j}$$

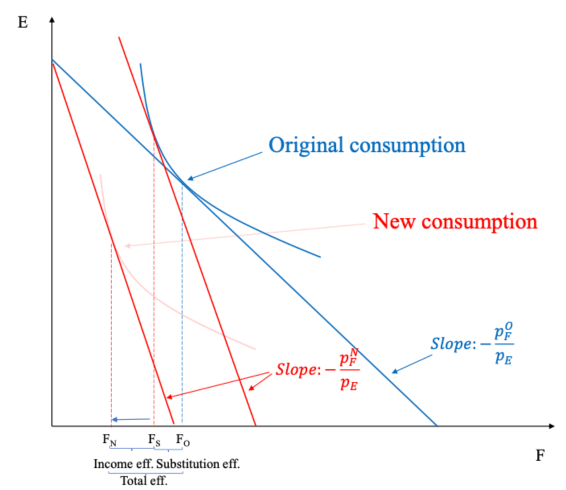
- **INTERIOR SOULTION** is a combination of inputs that maximizes profit.

- Non-interior solution is a **CORNER SOLUTION**, where one of the goods have a consumption of 0 in the maximization problem.

- If higher income is associated with higher quantities demanded, it is a **NORMAL GOODS**, and if higher income is associated with lower quantities demanded, it is **INFERIOR GOODS**.

- **SUBSTITUTION AND INCOME EFFECTS** is as described on the picture below:

Figure 6.13: The income effect for a normal good



- **COMPENSATING VARIATION** - price change (price increase) by how much should the income be increased to be at the same utility level as before?

Producer theory

- Firms **MAXIMIZE PROFIT** and then **MINIMIZE COST**.

$$\frac{MP_i}{p_i} = \frac{MP_j}{p_j}$$

- In **SHORT-RUN** not all inputs are variable, some costs are fixed/sunk.

- In the **LONG-RUN** all inputs are variable.

- **PRODUCTION FUNCTION** tells you the maximum output given inputs.

- When different combinations of inputs (e.g. capital and labor) give the same output, it is **ISOQUANT**.

- **MRTS** is the marginal rate of technical substitution. It is the slope of the isoquant, and it reflects how easy it is to substitute one input for another.

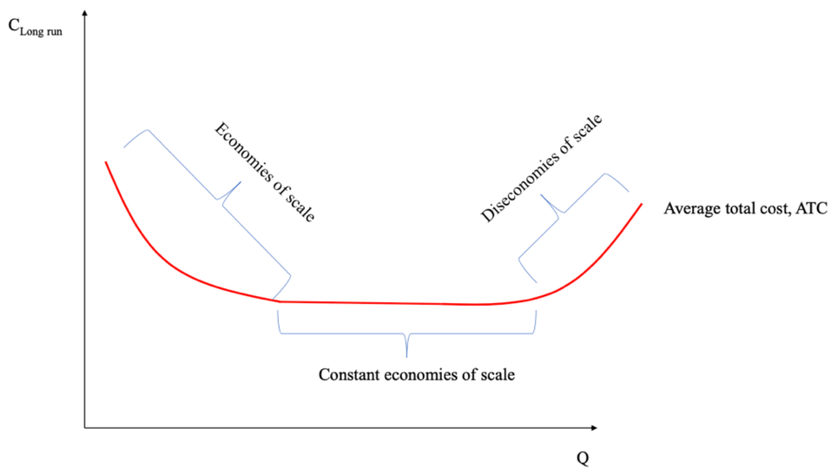
$$MRTS = slope\ of\ isoquant = \frac{MP_L}{MP_K}$$

The MRTS should be equal to $-\frac{w}{r}$ at an interior solution.

- **RETURNS TO SCALE** refers to the production function (refers only to input and output - NOT cost function) - what happens to **QUANTITY PRODUCED** if the amount of inputs used change in the same proportion. If the number of inputs used and output both doubles, the technology has constant returns to scale.

  If the amount of input doubles and the output more than doubles, then the technology has **INCREASING RETURNS TO SCALE**. An if output less than doubles, the technology has **DECREASING RETURNS TO SCALE**.

Figure 3.22: Economies of scale



Different combinations of L and K that give the same cost are said to be on the same **ISOCOST**.

- **ISOCOST LINE** is all the combinations (K, L) such that the total expenditure on those inputs $wL + rK$ is constant at a certain level.

$$C = wL + rK$$

- **COST FUNCTION:**

$$C(q) = \text{the cost of producing } q \text{ optimally}$$

- **AVERAGE COST FUNCTION:**

$$AC(q) = \frac{C(q)}{q}$$

If q is the output that minimizes **AVERAGE COST**, then:

$$AC(q) = MC(q)$$

And the MC curve intersects the AC curve from below.

- **AVERAGE VARIABLE COST FUNCTION:**

$$AVC(q) = \frac{VC(q)}{q}$$

If q is the output that minimizes **AVERAGE VARIBALE COST**, then:

$$AVC(q) = MC(q)$$

And the MC curve intersects the AVC curve from below.

- **MARGINAL COST**

$$MC(q) = \frac{dC(q)}{dq}$$

In the short run, there will be some fixed costs. In the long run there are no fixed costs.

- **ECONOMIES OF SCALE**: what happen to average cost, when the production is increased?

If the long-run average total cost curve is decreasing this implies that a producer of larger volumes will have lower average costs. This is **ECONOMIES OF SCALE.** If the long-run average total cost is roughly flat, we say that there are **CONSTANT ECONOMIES OF SCALE**. **DISECONOMIES OF SCALE** refer to the case where the average total costs are increasing when quantities produced increase.

Markets

- Consumers buy until the last unit where marginal benefit of buying exceed or equal the price they pay.

$$MWTP > p$$

- Firms produce/price to maximize profit:

$$\pi = R - C$$

- Consumers have a **WILLINGNESS TO PAY** and **MARGINAL WILLINGNESS TO PAY**. The willingness to pay is the total amount willingness to pay for unit 1, unit 2 and so on. Marginal willingness to pay is for only the 5th unit e.g.

- **WELFARE** is the sum of consumer and producer surplus in the market. If tac is generated, then it is also a part of welfare.

- **CONSUMER SURPLUS** is the difference between WTP of a consumer for quantity q of the good purchased and what she pays in total for q.

- **PRODUCER SURPLUS** is the difference between the payment for quantity q received by a seller and the cost of producing the q units.

- If the level of output is not efficient, there is a **DEAD-WEIGHT LOSS**.

- If marginal cost is greater than marginal willingness to pay, then the efficient output is 0.

- If marginal cost is smaller than marginal willingness to pay at some level, efficiency requires that the output is increased until marginal willingness to pay is equal to marginal cost (or just above).

Market structures

Type of market	Number of firms	Freedom of entry	Nature of product	Examples	Implications for demand curve faced by firm
Perfect competition	Very many	Unrestricted	Homogeneous (undifferentiated)	Cabbages, carrots (approximately)	Horizontal: firm is a price taker
Monopolistic competition	Many / several	Unrestricted	Differentiated	Builders, restaurants	Downward sloping, but relatively elastic
Oligopoly	Few	Restricted	Undifferentiated or differentiated	Cement cars, electrical appliances	Downward sloping. Relatively inelastic (shape depends on reactions of rivals)
Monopoly	One	Restricted or completely blocked	Unique	Local water company, train operators (over particular routes)	Downward sloping: more inelastic than oligopoly. Firm has considerable control over price

- **PERFECTLY COMPETITIVE MARKETS**

  Price-taking consumers and firms

  MARGINAL REVENUE is **CONSTANT**

$$MR = p$$

  Need to know how to find consumer surplus, producer surplus, and dead-weight loss. Also, how government policies affect welfare, and short-run and long-run equilibrium.

KNOW HOW TO AGGREGATE DEMAND CURVES! SUPPLY CURVES AND MARGINAL COST CURVES!

- **MONOPOLY**

Monopoly firms are price setters.

MARGINAL REVENUE is **NOT CONSTANT,** because they want to sell more, usually must lower price.

Monopoly is optimal when price is greater than marginal costs.

There will be a dead-weight loss in monopoly.

- **OLIGOPOLY**

Firms may behave like a monopoly

COURNOT is simultaneous output choice

BERTRAND is simultaneous price choice.

Remember to ask yourself, if it is different costs, differentiated products, sequential output choice, and sequential price choice.

- **OUTPUT COMPETITION AND UNDIFFERENTIATED PRODUCTS:**

Two firms, firm 1 and firm 2, facing a linear demand:

$$P(q) = a - bQ$$

The payoff/profit are:

$$\pi_1 = (q_1, q_2) = q_1[a - b(q_1 + q_2)] - q_1 m_1 - F_1$$
$$\pi_2 = (q_1, q_2) = q_2[a - b(q_2 + q_1)] - q_2 m_2 - F_1$$

Best responses will be:

$$q_1 = \frac{a - m_1}{2b} - \frac{q_2}{2}, \qquad q_2 = \frac{a - m_2}{2b} - \frac{q_1}{2}$$

Cournot NE (simultaneous moves):

$$q_1 = \frac{a - 2m_1 + m_2}{3b}, \qquad q_2 = \frac{a - 2m_2 + m_1}{3b},$$

Stackelberg SPNE (firm 1 moves first):

$$q_1 = \frac{a - 2m_1 + m_2}{2b}, \qquad q_2 = \frac{a - m_2}{2b} - \frac{q_1}{2}$$

- **PRICE COMPETITION AND UNDIFFERENTIATED PRODUCTS:**
  If the price is greater than marginal costs, you should price under your competitor. If they have marginal cost of 2, and you have of 1, then you should set the price at just under 2.

- There is market power when one or more of the following assumptions fails:
  1. Price competition
  2. Equal costs, no capacity constraints
  3. Product is undifferentiated
  4. Lots of transparency. Buyers/sellers are aware of each seller's price.

Game theory

- A best response for a player specifies the best strategy for a player in response to given strategies for other players.

- Nash equilibrium (NE): a combination of strategies for each of the players, such that each player is best responding to the strategies of the other players.

- Subgame perfect Nash equilibrium: if it is possible to find a subgame within a dynamic game, specify that the Nash equilibrium should also be a Nash equilibrium when applied to the subgame.

Market failures

- Inefficient production level where the equilibrium production levels do not maximize welfare (too high or too low):

- It can be caused by:
  - Market power
  - Externalities
  - Public goods
  - Asymmetric information

- **EXTERNALITIES**