# Microeconomics

-Explaining how the actions of all buyers and sellers determine prices and vice versa in a world of scarcity.


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Lecture 1 – Chapter 1+2

Statements:

**Positive statement:** a testable hypothesis about cause and effect (what will happen)

**Normative statement:** a value statement - a conclusion as to whether something is good or bad (what should happen)

Goods:

**Substitute good:** a good that can be consumed instead of the good in question. If the price of one good increases, then the demand for the other good increases

**Complementary good:** a good that can be consumed jointly with another good. If the price of one good increases, then the demand for the other decreases

Demand:

**Quantity demanded**: the amount of a good that consumers are willing to buy at a given price, holding other factors that affect purchase constant

**Demand curve:** the quantity demanded at each possible price, holding other factors that affect purchase constant. This is expressed through the demand function Q(p). In some cases I can be useful to instead look at the *inverse demand function*, where you isolate p to get a function of Q instead, p(Q). This will, however, not be used till much later in these notes.

**Law of demand:** consumers demand more of a product if the price is lower, thus demand curves slope downward (a good where a decrease in price causes quantity demanded to fall is called a Giffen good (see page 148 Microeconomics 7th edition for clarification))

**Slope of demand curve:** $\frac{\Delta p}{\Delta Q}$ , where p is price and Q is quantity

**Shift of the demand curve:** a change in any factor other that the price of the good, will move the entire demand curve (see page 37 Microeconomics 7th edition for clarification)

**Movements along the demand curve:** changes in quantity demanded in respond to changes in price of the good

**Summing demand curves:** $Q = Q_1 + Q_2$ , where Q is the total demand, $Q_1$ and $Q_2$ are respectively the demand function of customer 1 and 2 (customers face the same price) (horizontal summing)

Supply:

**Quantity supplied**: the amount of a good that suppliers want to supply at a given price, holding other factors that affect supply decisions constant

**Supply curve:** the quantity supplied at each possible price, holding other factors that affect supply decisions constant

**Slope of supply curve:** $\frac{\Delta p}{\Delta Q}$ , where p is price and Q is quantity

**Shift of the supply curve:** a change in any factor other that the price of the good, will move the entire supply curve (see page 42 in Microeconomics 7th edition for clarification)

**Movements along the supply curve:** changes in quantity supplied in respond to changes in price of the good

**Summing supply curves:** $Q = Q_1 + Q_2$ , where Q is the total supply, $Q_1$ and $Q_2$ are respectively the supply function of supplier 1 and 2 (suppliers face the same price)

Equilibrium:

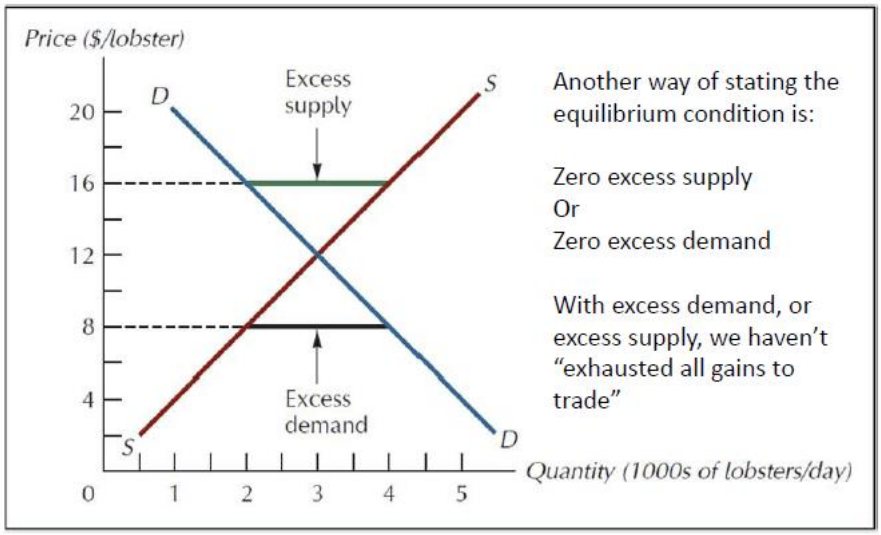
**Market equilibrium:** a state of rest, where neither supply or demand forces are acting for a change. This is true where the demand curve and the supply curve intersect, i.e. $Q_D = Q_S$ , where $Q_D$ is the demand function and $Q_S$ is the supply function.

**Equilibrium price:** the price at which the supply and demand curves intersect, p*

**Equilibrium quantity**: the quantity at which the supply and demand curves intersect, Q* ($=Q_D = Q_S$)

Excess supply and demand:

The difference in quantity that buyers are demanding and sellers are supplying at a certain price (which is zero at the market equilibrium)



Lecture 2 – Chapter 2+3

Shocking the equilibrium:
The market equilibrium changes if a shift of either the demand or the supply curve (or both) occurs, i.e. when one of the factors that were previously held constant changes e.g. through government interventions

Government interventions:
**Licenses:** limits the number of suppliers in the market

**Quotas:** limits the quantity supplied in the market

**Price ceiling:** a maximum price

**Price floor:** a minimum price

Tax:
**Ad valorem tax:** a percentage of the price of the a good (most common)

**Specific/unit tax:** an amount per unit

**Tax incidence:** the distribution of a tax burden among the participants in the market (sellers and buyers)

**Tax incidence of tax on consumers**: the share of the tax that falls on consumers (the percentage): $\Delta p / \Delta t = \frac{\eta}{\eta - \varepsilon}$, where p is the price share of the tax the consumers pay, t is the price of the tax, η is the supply elasticity, ε is the demand elasticity

Elasticity:
**Elasticity:** the shape of the demand and supply curve influence how much shifts in demand or supply affects the market equilibrium. To measure how extensive the change is elasticity is used. Elasticity is the percentage change in one variable in response to a given percentage change in another variable

**Price elasticity of demand:** the percentage change in quantity demanded in response to a given percentage change in price at a particular point on the demand curve:

$\varepsilon = \frac{percentage\ change\ in\ Q}{percentage\ change\ in\ p} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta p}{p}} = \frac{\Delta Q}{\Delta p}\frac{p}{Q}$, where Q is quantity demanded and p is price.

For a linear downward-sloping demand curve, Q = a - bp, elasticity is $\varepsilon = -b\frac{p}{Q}$.

A 1% increase in price leads to an ε% decrease in quantity demanded

**Price elasticity of supply:** the percentage change in quantity supplied in response to a given percentage change in price at a particular point on the supply curve:

$\eta = \frac{percentage\ change\ in\ Q}{percentage\ change\ in\ p} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta p}{p}} = \frac{\Delta Q}{\Delta p}\frac{p}{Q}$, where Q is quantity supplied and p is price.

For a linear supply curve, Q = g + hp, elasticity is $\eta = h\frac{p}{Q}$.

A 1% increase in price leads to an η% change in quantity supplied

**Income elasticity of demand:**

$\xi = \frac{percentage\ change\ in\ Q}{percentage\ change\ in\ Y} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta Y}{Y}} = \frac{\Delta Q}{\Delta Y}\frac{Y}{Q}$, where Q is quantity demanded and Y is income.

A 1% increase in income leads to an ξ % change in quantity demanded

It's a normal good if ξ > 0

Luxury good if ξ > 1

Necessity good if 1 > ξ > 0

It's an inferior good if ξ < 0

**Cross-price elasticity of demand:**

$\frac{percentage\ change\ in\ Q}{percentage\ change\ in\ p_o} = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta p_o}{p_o}} = \frac{\Delta Q}{\Delta p_o}\frac{Y}{p_o}$, where Q is quantity demanded and $p_o$ is the price of another good.

It's a substitute good if cross price elasticity > 0

The goods are complements if cross price elasticity < 0

**Perfectly inelastic**: ε = 0
(vertical curve)

**Inelastic**: 0 > ε > -1
(common for necessities)

**Unitary elasticity**: ε = -1

**Elastic**: ε < -1
(common for luxury goods. Often true for relatively expensive goods or goods with close substitutes)

**Perfectly elastic**: ε = ∞
(horizontal curve)

Lecture 3+4 – Chapter 4

Consumer preferences:

Consumer prefers a more than b: $a \succ b$

Consumer prefers a at least as much as b (maybe more): $a \succsim b$

Consumer prefers a as much as b: $a \sim b$

Properties/assumptions:

**Completeness:** consumers are able to rank goods so they fit under one of the above categories

**Transitivity**: consumers' rankings are logical. If $a \succsim b$ and $b \succsim c$, then $a \succsim c$

**Monotonicity (more is better)**: all else the same, more of a good is better than less of it

Consumer indifference:

**Indifference curve:** the set of all bundles of goods that a consumer views as being equally desirable (utility = constant)

**Indifference/preference map:** complete set of indifference curves that summarize a consumer's tastes. These maps must fulfill the following four properties:

1. Bundles on indifference curves farther from the origin are preferred to those on indifference curves closer to the origin
2. An indifference curve goes through every possible bundle
3. Indifference curves cannot cross
4. Indifference curves slope downward

**MRS – marginal rate of substitution:** The slope of an indifference curve, i.e. the amount of a good that a consumer will sacrifice (trade) to gain one more of another:

MRS = $\frac{\Delta q_2}{\Delta q_1}$ , where $q_1$ is the quantity of good 1 (depicted on the horizontal axis) and $q_2$ is the quantity of good 2 (depicted on the vertical axis)

MRS can also be described in relation to marginal utility:

MRS = $\frac{\Delta q_2}{\Delta q_1} = -\frac{MU_{q_1}}{MU_{q_2}}$

**Curvature of indifference curves:**

(see page 104 Microeconomics 7th edition for clarification)

-Convex: The entire curve is above any tangent drawn at any point of the graph (indifference curves are hard to imagine being anything but convex)

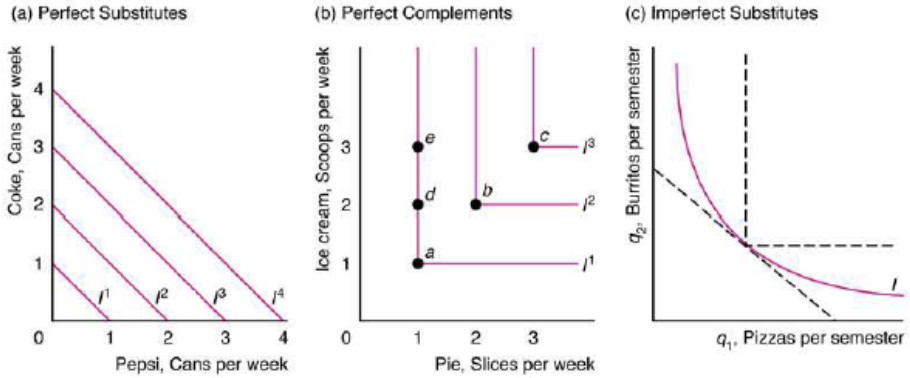
-Concave: The entire curve is below any tangent drawn at any point of the graph (not very likely in the case of indifference curves)

-Due to the convex nature of indifference curves, we have diminishing MRS, i.e. MRS approaches 0 as we move down the curve

-Perfect substitutes: goods that a consumer is completely indifferent as to which to consume (MRS = constant)

-Perfect complements: goods that a consumer is interested in consuming only in fixed proportions (e.g. only eating cookies with coffee and vice versa) (MRS = 0)

Examples of indifference curves:




Utility:

**Utility:** a value representing the ranking of a bundle of goods. The higher the value, the higher the ranking. This is an ordinal measure, i.e. we know the ranking of goods, but not how much one is better than another (which would be a cardinal measure)

**Utility function:** the relationship between utility measures and every possible bundle of goods e.g. $U(q_1,q_2) = \sqrt{q_1 q_2}$ , where $q_1$ is quantity of good 1 and $q_2$ is quantity of good 2
(this is just an example of a utility function!)

**MU - marginal utility:** the slope of the utility function, i.e. how much utility increases corresponding to an increase in one of the goods:
$MU_{q_1} = \frac{\Delta U}{\Delta q_1}$ , where U is utility and $q_1$ is quantity of good 1

Budget constraint:

**Budget constraint/budget line:** consumers face budget constraints and maximize their utility within this budget. We assume that consumers can't save or borrow money, so their budget is their income.
$Y = p_1q_1 + p_2q_2$ , where $p_1$ is price of good 1, $q_1$ is quantity of good 1, $p_2$ is price of good 2 and $q_2$ is quantity of good 2

**Opportunity set:** all the bundles a consumer can buy (all bundles below the budget line)

**MRT – marginal rate of transformation:** slope of the budget constraint:
$MRT = \frac{\Delta q_2}{\Delta q_1} = -\frac{p_1}{p_2}$ , where $q_1$ is the quantity of good 1 (depicted on the horizontal axis), $q_2$ is the quantity of good 2 (depicted on the vertical axis), $p_1$ is price of good 1 and $p_2$ is price of good 2

Maximizing utility:

**Maximizing utility:** utility is maximized when MRS = MRT. This is the consumer's optimal bundle, the consumer's optimum. If MRS < MRT, the consumer should consume less of $q_1$ and more of $q_2$ (and vice versa).

MRS = $-\frac{MU_{q_1}}{MU_{q_2}} = -\frac{p_1}{p_2}$ = MRT -> $\frac{MU_{q_1}}{p_1} = \frac{MU_{q_2}}{p_2}$

**Interior solution:** When the optimal bundles occurs at a point of tangency between the indifference curve and budget line (MRT = MRS)

**Corner solution:** when a consumer only wants one of the products, the solution is found a one of the corners of the budget line. If two goods are perfect substitutes and MRT ≠ MRS, the solution is found at one of the corners.

**Substitution method:**

1) budget constraint rewritten as a function of $p_1$: $Y = p_1q_1 + p_2q_2$ -> $q_1 = \frac{Y-p_2q_2}{p_1}$

2) substitute this into the utility function: $U(q_1, q_2) = U(\frac{Y-p_2q_2}{p_1}, q_2)$

3) we find $\max_{q_2} U(\frac{Y-p_2q_2}{p_1}, q_2)$ by setting $\frac{dU}{dq_2} = 0$

**Lagrangian method:**

To maximize utility given a budget constraint, $\bar{Y}$, we can also use the lagrangian method:

1) set up the lagrangian function: $\max_{q_1,q_2,\lambda} \mathcal{L} = U(q_1, q_2) + \lambda(\bar{Y} - p_1q_1 - p_2q_2)$

2) set up the first order conditions and set them equal to zero:

1. $\frac{d\mathcal{L}}{dq_1} = 0$
2. $\frac{d\mathcal{L}}{dq_2} = 0$
3. $\frac{d\mathcal{L}}{d\lambda} = 0$

3) isolate $\lambda$ in 1. and 2. and set these equal to each other, thus eliminating $\lambda$

4) isolate $q_1$ in the equation just set up and substitute this into 3., thus being able to find $q_2$

We can also use this method the other way around, i.e. to find the minimum budget needed to achieve a given utility, $\bar{U}$:

1) set up the lagrangian function: $\min_{q_1,q_2,\lambda} \mathcal{L} = Y(q_1, q_2) + \lambda(\bar{U} - U(q_1, q_2))$

2) set up the first order conditions and set them equal to zero (like in the above)

3) isolate $\lambda$ in the first and second "first order conditions", and set these equal to each other, thus eliminating $\lambda$

4) isolate $q_1$ in the equation just set up and substitute this into 3., thus being able to find $q_2$

Lecture 5 – Chapter 5

PCC - Price consumption curve:

a line through the optimal bundles at each price of one good when the price of the other good and the budget are held constant

Goods:

**Normal good:** An increase in income causes an increase in demand

**Inferior good:** An increase in income causes a decrease in demand

Effect of a budget increase on the demand curve:

The relation between change in income and new utility maximization choice can be depicted in three different ways

**Income-consumption curve (ICC):**

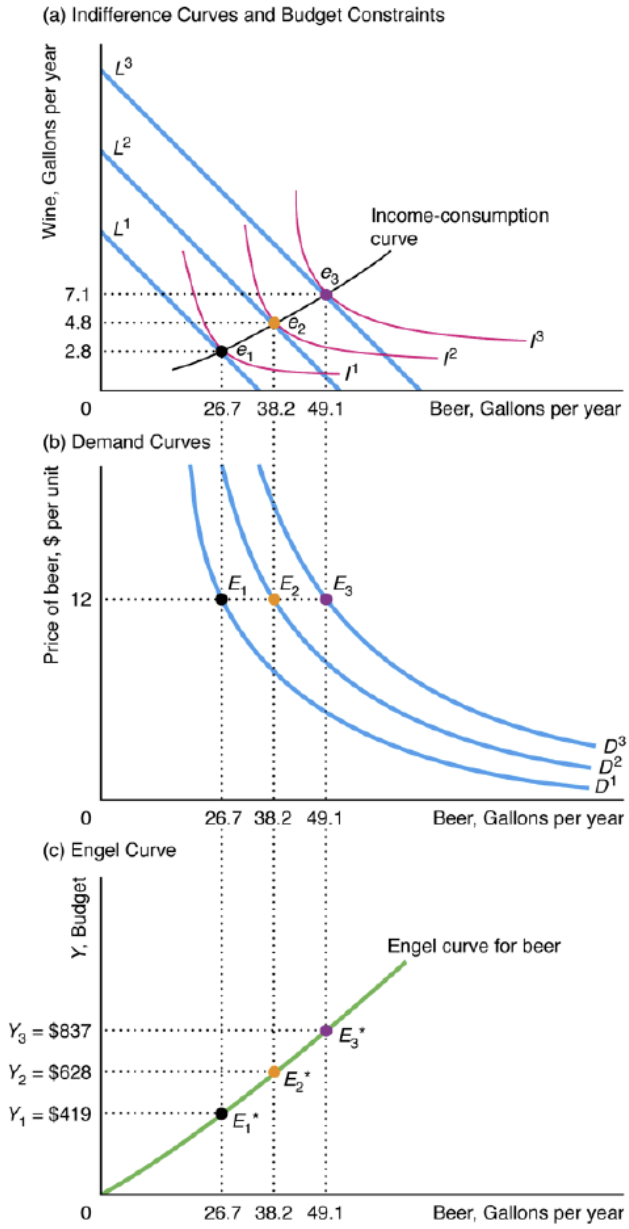
Connecting optimal consumption bundles

**Shifts in demand curve:**

Demand curves increase while price is constant

**Engel curve:**

Relationship between income and quantity demanded



Effects of a price increase:

**Substitution effect:** change in quantity demanded of a good when the good's price increases, holding other prices and utility constant (always negative)

**Income effect:** change in quantity of a good when income changes, holding prices constant (negative if it's a normal good. Positive if it's an inferior good. Depends on income elasticity). (Be attentive to the fact that by change in income we mean that the consumer effectively becomes poorer as prices increase because the consumer can afford less)

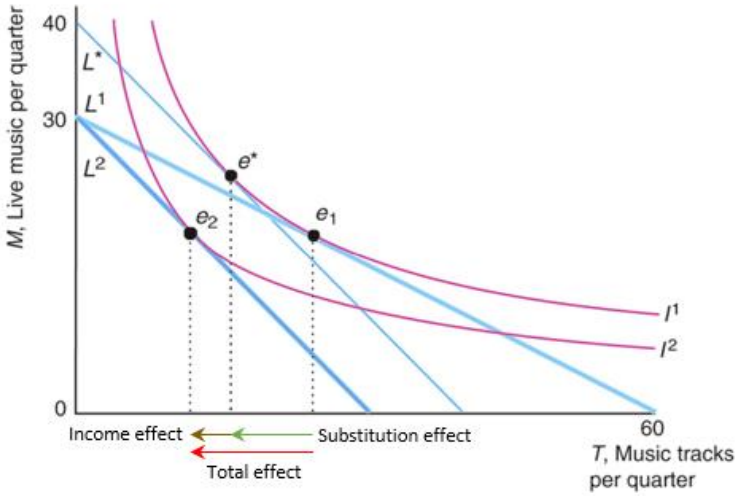
**Total change in quantity demanded:** the sum of the substitution and income effect

**Example:**
"Price of music tracks doubles"

From e1 to e*: substitution effect

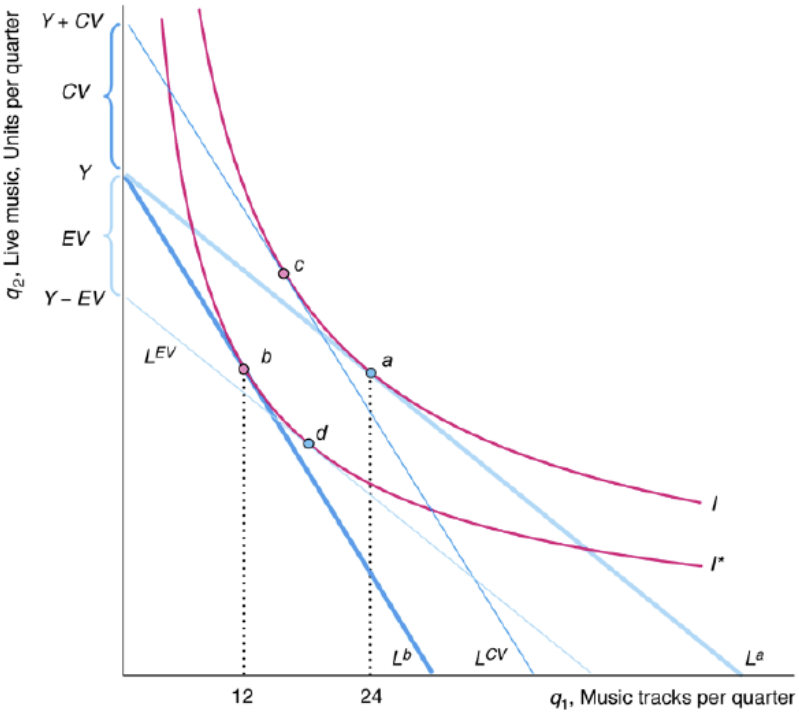
From e* to e2: income effect

From e1 to e2: total change




**Compensating variation (CV):**
the amount of money one would have to give a consumer to completely offset the harm from a price increase (to prevent movement from a to c)

**Equivalent variation (EV):**
the amount of money one would have to take from a consumer to harm the consumer by as much as the price increase (to achieve a movement from a to d)



Cost-of-living adjustments:

**Inflation:** the increase in the overall price level over time

**nominal price:** the actual price of a good

**real price:** the price of a good adjusted for inflation

**CPI – consumer price index:** the income it takes to buy a specific bundle at a specific point in time. This is used to calculate the real price of a good over time with inflation taken into account.

Real price in the past = $\frac{present\ CPI}{past\ CPI} * present\ price$

**Inflation rate:**

First year price of the bundle (CPI): $Y_1 = p_1^1 q_1 + p_2^1 q_2$

Second year price of the bundle (CPI): $Y_2 = p_1^2 q_1 + p_2^2 q_2$

Inflation rate: $\frac{Y_2}{Y_1} = \frac{p_1^2 q_1 + p_2^2 q_2}{p_1^1 q_1 + p_2^1 q_2}$

(see page 152 Microeconomics 7th edition for clarification)

$p_1^1$ is price of good 1 in year 1,
$p_2^1$ is price of good 2 in year 1
$q_1$ is quantity of good 1
$q_2$ is quantity of good 2
$p_1^2$ is price of good 1 in year 2
$p_2^2$ is price of good 2 in year 2

**Substitution bias:** To compensate for inflation rates, firms can choose to adjust the salary of their employees based on CPI so that the employee can still buy the same bundle next year. However, this kind of CPI adjustment suffers from substitution bias – it ignores that consumers may substitute toward the relatively inexpensive good when price change, thus causing the adjustment to be over compensating in the end (see page 154 Microeconomics 7th edition for clarification).

Labor supply curves:

**Income function:**

Y = wH + Y* , where Y is income, w is wage, H is work hours, and Y* is income unearned sources.

There is a time constraint on work hours: H = 24 – N, where N is leisure hours.

The price of leisure hours is N*w and can be defined as forgone earnings.

Thus utility is determined as as a function of income and leisure hours U = U(Y, N)

Lecture 6 – Chapter 6

Firms:

**Firm:** an organization that converts inputs such as labor, materials and capital into outputs. We assume that firms have efficient production, i.e. they do not waste resources and cannot produce their level of output with fever resources. The firm's goal is to maximize profits.

**Profit:** $\pi = R - C$ , where R is revenue and C is costs.

**Revenue**: R = p*q , where p is price and q is quantity/output

Production:

**Output:** a firms output can be described as a function of inputs, e.g.:
q = f(L,K) , where L is labor and K is capital

**Short run:** we define the short run as a period of time where at least one of the input factors cannot be varied/is constant (fixed input). In most cases we assume that capital is fixed in the short run and labor is the only variable input

**Long run:** we define the long run as a period of time where all inputs can be varied (variable input)

Short run production:

**$MP_L$ – marginal product of labor:** the additional output produced by an additional unit of labor, holding all other factors constant:
$MP_L = \frac{dq}{dL} = \frac{df(L,K)}{dL}$ , where q is output and L i labor

**$AP_L$ – average product of labor:** the ratio of output to the amount of labor employed
$AP_L = \frac{q}{L}$ , where q is output and L is labor

**Law of diminishing marginal returns:** If a firm keeps increasing an input, holding all other inputs and technology constant, the corresponding increases in output will eventually become smaller. This sets in at the point where $AP_L = MP_L$

Long run production:

**Isoquants:** Curves of combinations of inputs that all equal the same output: $\bar{q}$ = f(L, K). You can think of these curves as indifference curves (same properties), but instead of utility being **constant**, it's output (see page 184 Microeconomics 7th edition for clarification)

**MRTS – marginal rate of technical substitution:** the slope of isoquant curves:
$MRTS = \frac{dK}{dL} = -\frac{MP_L}{MP_K}$ , where K is kapital, L is labor, $MP_L$ is MP of labor and $MP_K$ is MP of capital.

If we have a "Cobb-Douglas" production function:
$Q = AL^{\alpha}K^{\beta}$ , where A, $\alpha$ and $\beta$ are constants, then MRTS = $-\frac{\alpha}{\beta}\frac{K}{L}$

**Returns to scale:** how much output changes if a firm increases all its inputs proportionally.
-Decreasing returns to scale:
If a percentage increase in inputs results in a smaller percentage increase in outputs
-Constant returns to scale:
If a percentage increase in inputs results in the same percentage increase in outputs
-Increasing returns to scale:
If a percentage increase in inputs results in a bigger percentage increase in outputs

Considering a "Cobb-Douglas" production function again: $Q = AL^{\alpha}K^{\beta}$
Returns to scale is decreasing if $\alpha+\beta < 1$, constant if $\alpha+\beta = 1$ and increasing if $\alpha+\beta > 1$

Technical change:
**Neutral technical change:** change that allows for more output using the same amount of input

**Non-neutral technical change:** altering the proportions of inputs in a way that allows for more output

Lecture 8 – Chapter 7

Categorizing cost/profit:

**Explicit costs:** direct costs/payments

**Implicit costs:** costs of foregone opportunities

**Opportunity/economic cost:** explicit + implicit costs

**Accounting profit:** revenue minus explicit cost

**Economic profit:** revenue minus opportunity cost

**Sunk costs:** the cost of past expenditures that cannot be recovered

Short run costs:

**FC – fixed costs:** costs that does not change with output

**VC – variable costs:** costs that changes with the level of output.
Because capital is fixed in the short run, then VC = wL , where w is wage and L is labor

**C – total costs:** fixed costs + variable costs

**MC – marginal costs:** slope of the cost curve: MC = $\frac{dC(q)}{dq}$

Because cost only change with VC and VC = wL, one could write: MC = $\frac{dVC(q)}{dq} = w\frac{dL}{dq} = \frac{w}{MP_L}$

**AFC – average fixed cost:** AFC = $\frac{FC}{q}$

**AVC – average variable cost:** AVC = $\frac{VC}{q}$

Because VC = wL, then AVC = $\frac{wL}{q} = \frac{w}{AP_L}$

**AC – average cost:** $AC = \frac{C}{q} = \frac{FC}{q} + \frac{VC}{q} = AFC + AVC$

Long run costs:

**Cost:** in the long run capital is not fixed, thus total costs can be expressed as
C = wL + rK , where w is wage, L is labor, K is capital and r is rental rate of said capital

**Isocost line:** holding total cost, wage and rental rate fixed, a graph can be drafted showing all combinations of labor and capital that results in the same costs, an isocost line:

$\bar{C} = wL + rK$

The slope of an isocost line is $\frac{dK}{dL} = -\frac{w}{r}$

You can think of an isocost line in terms of a budget constraint, but for firms instead of a consumer

Minimizing cost in the long run:

Before we maximized utility by finding out where the indifference curve touched the budget constraint, i.e. when the slope of the budget constraint (MRT) was equal to the slope of the indifference curve (MRS). This method is very much alike the following. To minimize cost, we need to find out where the isoquant curve touches the isocost line, i.e. where the slope of the isoquant line (MRTS) is equal to the slope of the isocost line (-w/r). Depending on the amount of information available, this can be done in three different ways:

**Lowest isocost rule:** If we only have graphs, we need to pick the bundle of inputs where the lowest isocost line touches the isoquant associated with the desired level of output

**Tangency rule:** If we have one of the quantities, we need pick the bundle of inputs where the desired isoquant is tangent to the budget line: MRTS = $-\frac{w}{r}$

**Last-dollar rule:** If we only have an output value, we need to calculate the bundle of inputs where the last dollar spent on one input yields as much additional output as the last dollar spent on any other input: $\frac{MP_L}{MP_K} = \frac{w}{r}$

To do this we again use the lagrangian method, holding output constant:

1) set up the lagrangian function: $\min_{\mathrm{L,K},\lambda} \mathcal{L} = wL + rK + \lambda(\bar{q} - f(L,K))$

2) set up the first order conditions and set them equal to zero:

1. $\frac{d\mathcal{L}}{dL} = 0$
2. $\frac{d\mathcal{L}}{dK} = 0$
3. $\frac{d\mathcal{L}}{d\lambda} = 0$

3) isolate $\lambda$ in 1. and 2. and set these equal to each other, thus eliminating $\lambda$

4) isolate K in the equation just set up and substitute this into 3., thus being able to find L

Maximizing production in the long run:

**Lagrangian method used to maximize output given a fixed cost**

1) set up the lagrangian function: $\max_{\mathrm{L,K},\lambda} \mathcal{L} = f(L,K) + \lambda(\bar{C} - \mathrm{wL} - \mathrm{rK})$

2) set up the first order conditions and set them equal to zero:

1. $\frac{d\mathcal{L}}{d\mathrm{L}} = 0$
2. $\frac{d\mathcal{L}}{d\mathrm{K}} = 0$
3. $\frac{d\mathcal{L}}{d\lambda} = 0$

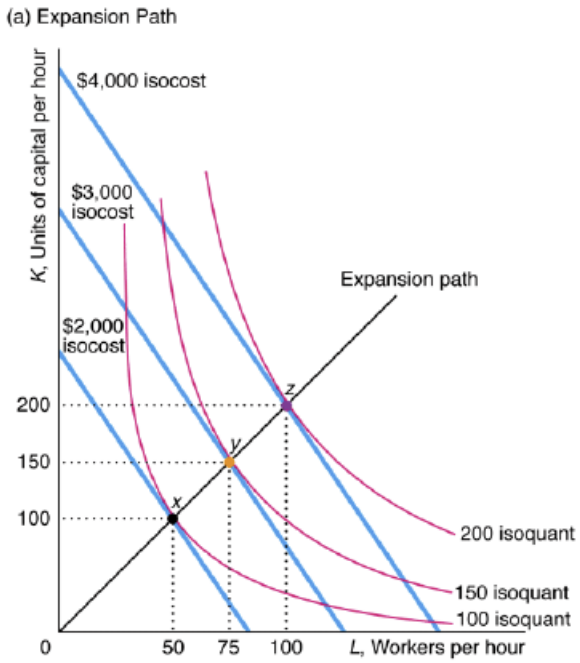
3) isolate $\lambda$ in 1. and 2. and set these equal to each other, thus eliminating $\lambda$

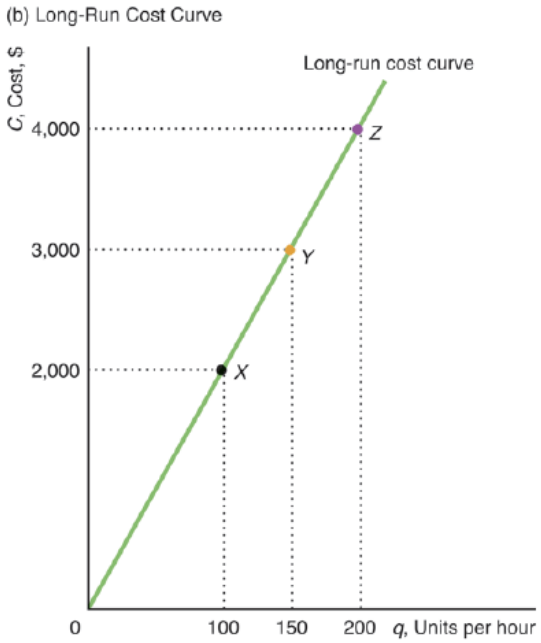
4) isolate K in the equation just set up and substitute this into 3., thus being able to find L

Long run cost graphs:

**Expansion path:**
The expansion path traces out the cost-minimizing combinations of inputs employed (not necessarily a straight line)

**Long-run cost curve:**
From the expansion path we can construct a long-run cost curve relating output and minimum cost for producing that output




**Long-run AC curve:**
Because the long-run cost curve does not have to be linear, the AC might just very well be U-shaped. A U-shaped AC cost curve can be split into two parts:
Economies of scale: the average cost of production falls as output increases
Diseconomies of scale: the average cost of production increases as output increases

Cost of producing multiple goods:

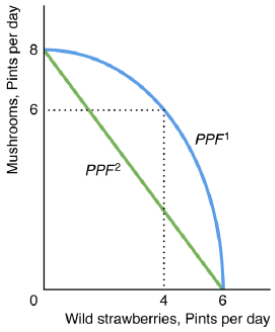
**Economies of scope:** when a firm produces two goods, it might be cheaper to produce them jointly. To measure this we use:

SC = $\frac{C(q_1,0)+C(0,q_2)-C(q_1,q_2)}{C(q_1,q_2)}$

If SC > 0 it is cheaper to produce the goods jointly

$C(q_1, 0)$ = cost of producing $q_1$ units of good 1 by itself
$C(0, q_2)$ = cost of producing $q_2$ units of good 2 by itself
$C(q_1, q_2)$ = cost of producing both goods together

**PPF - Production possibilities frontier:** We can set up a graph showing all possible combinations of producing the goods. The graph will bow away from the origin if there is economies of scope



Lecture 9 – Chapter 8

Firms in competitive markets:

**Residual demand curve:** the portion of the market demand that's not met by other sellers:
$D^r(p) = D(p) - S^o(p)$ , where D(p) is market demand and $S^o(p)$ is amount supplied by other firms

Marginal profit and revenue:

**MR - marginal revenue:** the slope of a revenue curve (R = pq):
MR = $\frac{dR}{dq} = p$

**Marginal profit:** $\frac{d\pi}{dq}$ = p – MC

Maximizing profit:

To maximize profit firms must do two things.
They must produce at the output level, q*, that maximizes profits/minimizes loss.
They must choose whether or not it's profitable to produce an output or shut down instead

**Choosing output level (q*):** a firm can use one of the following three rules to choose output level:
1. A firm sets its output where its profit is maximized
2. A firm sets its output where its marginal profit is zero (p – MC = 0)
   because MR = p in perfect competition, MR = MC
3. A firm sets its output where its marginal revenue equals its marginal cost (MR(q*) = MC(q*))

**Maximizing profit per unit:** profit per unit is maximized when the slope of the AC curve is zero:
$\frac{dAC}{dq} = 0$

**Short run shutdown decision:** a firm will choose to shut down in the short run if:
VC(q*) > R(q*) or AVC(q*) > p
If it produces its profit will be $\pi$ = R(q*) - VC(q*) – FC
If it shuts down its profit will be $\pi$ = -FC
Even if profit is negative a firm might still choose to produce if shutting down will result in a smaller profit

**Long run shutdown decision:** all costs are variable and thus avoidable in the long run, so a firm will only choose to shut down if it operates at a loss. Graphically it's the minimum of the long run AC curve.

Short run market competition:

In the short run the number of firms is fixed.

**Supply curve:** a single firm's supply curve in the short run is their MC, so long as MC > AVC

Long run market competition:
In the long run number of firms are not fixed.

**Supply curve:** because the number of firms in the long run is not fixed, the market supply curve is flat at the minimum of the long run AC curve, i.e. to find the equilibrium price we set dAC/dq = 0, isolate q, and use this in the AC function to isolate p. This can be used to calculate the market demand, and since we know how much one firm is willing to supply (q), we can figure out how many firms there are in the market. The market will supply as much as the market demands.

If the government was to restrict the number of firms, the long run market supply curve would start sloping upwards at the collective quantity supplied by the restricted number of firms.

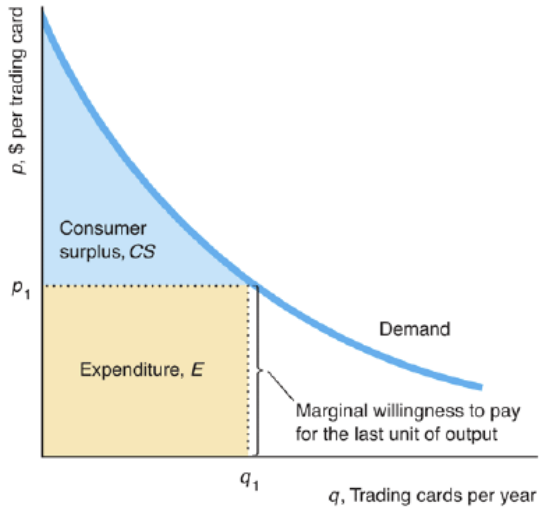
**Profit in the long run:**
Firms earn zero economic profit in the long run (R – C = 0). This is because they set price = MC = AC. They do however earn accounting profit. This just means that moving their resources into another industry will not make them better of, because this is already accounted for

Lecture 10 – Chapter 9+11

Consumer welfare:

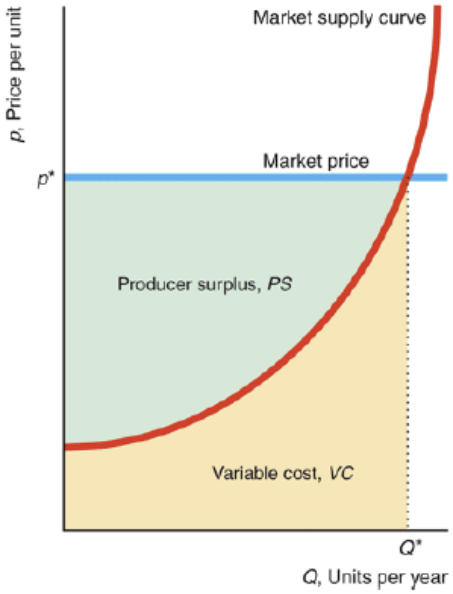
**Marginal willingness to pay:** the demand curve expresses how much a consumer is willing to give up to get an extra unit (the marginal value of the last unit bought)

**CS – consumer surplus:** the area below the demand curve, but above the price. To calculate this we use the formula to find the area of a triangle, (b*h)/2 , where b is base and h is height.
The total value of the good is CS + E (expenditure).




Producer welfare:

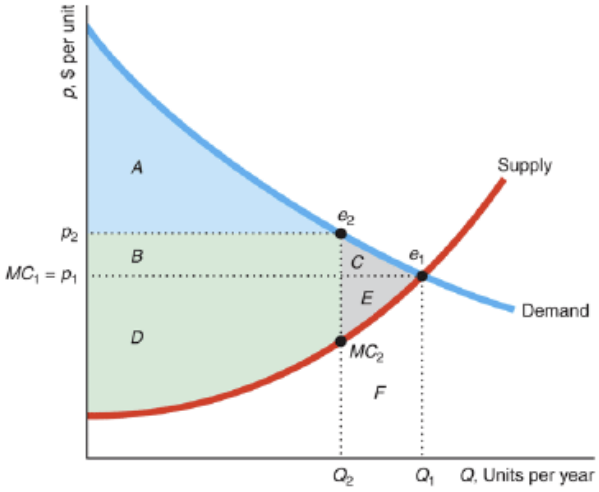
**PS – producer surplus:** the area above the supply curve, but below the price. To calculate this we use the formula to find the area of a triangle, (b*h)/2 , where b is base and h is height.
PS can also be calculated as PS = R - VC




Welfare:

**Welfare:** the welfare in society is the sum of consumer and producer surplus:
W = CS + PS

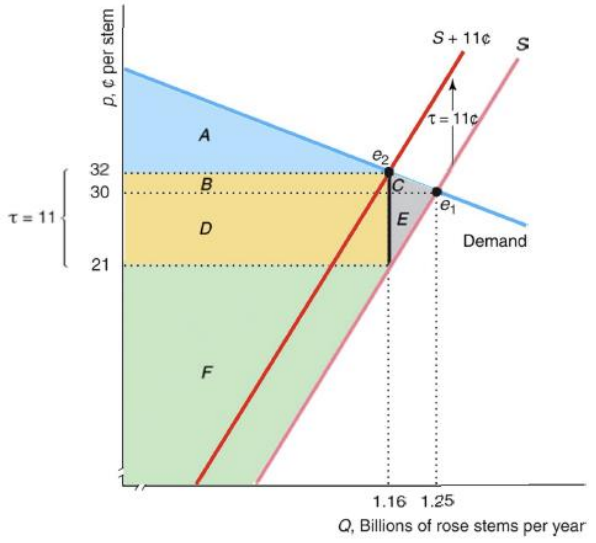
**DWL - deadweight loss:** if a change causes a reduction in overall welfare, the loss in welfare is called deadweight loss.
In the graph to the right the equilibrium price, $p_1$, created a PS of D+E and a CS of A+B+C, thus the total welfare was A+B+C+D+E.
The new price, $p_2$, creates a PS of B+D and a CS of A, thus the total welfare is A+B+D.
DWL in this case is C+E.



**Welfare effects of sales tax:**

We assume the government uses the tax for something useful, thus also adding to the welfare. With a tax the welfare is

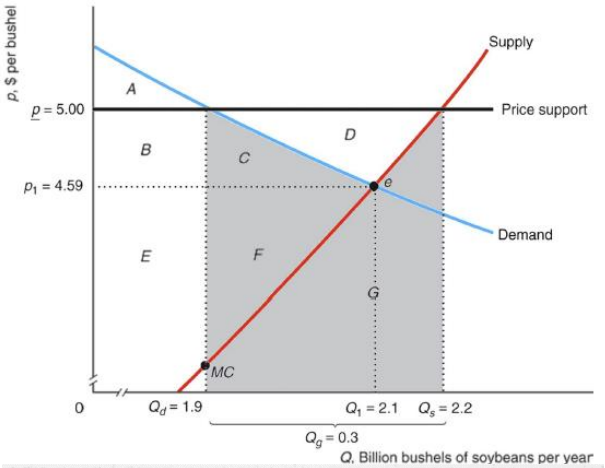
W = CS + PS + T.




| | No Tax | Specific Tax | Change ($ millions) |
|---|---|---|---|
| Consumer Surplus, *CS* | $A+B+C$ | $A$ | $-B-C=-24.1=\Delta CS$ |
| Producer Surplus, *PS* | $D+E+F$ | $F$ | $-D-E=-108.45=\Delta PS$ |
| Tax Revenue, $T=tQ$ | 0 | $B+D$ | $B+D=127.6=\Delta T$ |
| Welfare, $W=CS+PS+T$ | $A+B+C+D+E+F$ | $A+B+D+F$ | $-C-E=-4.95=DWL$ |

**Welfare effects of a price floor:**

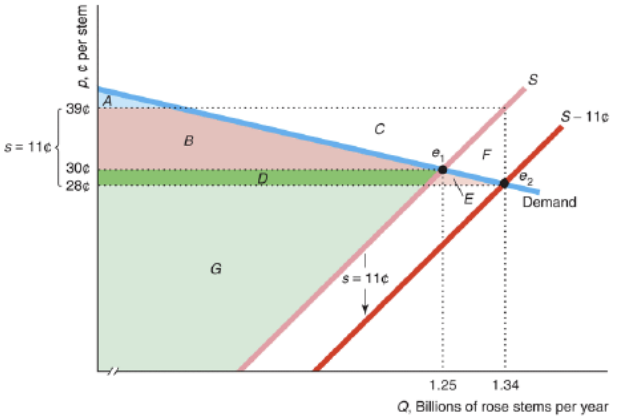
In the graph below, if the government sets a price floor of $5 there will be excess supply. The government will have to pay for all the excess supply, i.e. C, D, F and G. (see page 314 Microeconomics 7th edition for clarification)




| | No Price Support | Price Support | Change ($ millions) |
|---|---|---|---|
| Consumer Surplus, *CS* | $A+B+C$ | $A$ | $-B-C=-864=\Delta CS$ |
| Producer Surplus, *PS* | $E+F$ | $B+C+D+E+F$ | $B+C+D=921=\Delta PS$ |
| Government Expense, $-X$ | 0 | $-C-D-F-G$ | $-C-D-F-G=-1,283=\Delta X$ |
| Welfare, $W=CS+PS-X$ | $A+B+C+E+F$ | $A+B+E-G$ | $-C-F-G=-1,226=\Delta W=DWL$ |

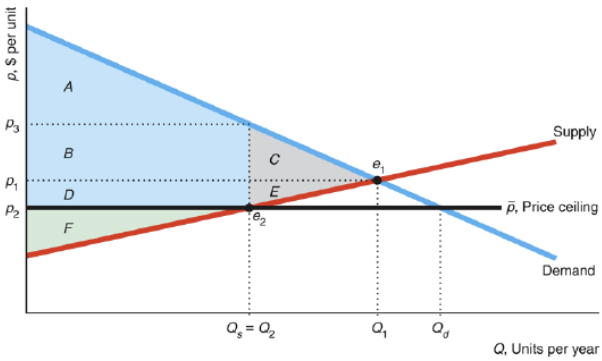
Government gains/pays tax/subsidy multiplied by the new equilibrium quantity

**Welfare effects of a subsidy:**




| | No Subsidy | Subsidy | Change ($ millions) |
|---|---|---|---|
| Consumer Surplus, *CS* | $A+B$ | $A+B+D+E$ | $D+E=116.55=\Delta CS$ |
| Producer Surplus, *PS* | $D+G$ | $B+C+D+G$ | $B+C=25.9=\Delta PS$ |
| Government Expense, *X* | 0 | $-B-C-D-E-F$ | $-B-C-D-E-F=-147.4=\Delta X$ |
| Welfare, $W=CS+PS-X$ | $A+B+D+G$ | $A+B+D+G-F$ | $-F=-4.95=DWL$ |

**Welfare effects of a price ceiling**




| | No Ceiling | Price Ceiling | Change |
|---|---|---|---|
| Consumer Surplus, *CS* | $A+B+C$ | $A+B+D$ | $D-C=\Delta CS$ |
| Producer Surplus, *PS* | $D+E+F$ | $F$ | $-D-E=\Delta PS$ |
| Welfare, $W=CS+PS$ | $A+B+C+D+E+F$ | $A+B+D+F$ | $-C-E=\Delta W=DWL$ |

Monopolies:

**Monopoly:** in a monopoly there is only one firm. This firm is not a price taker like in competitive markets, but can instead set the price according to the marked demand. This ultimately leads to DWL. Monopolies have less welfare than competitive markets, unless government intervenes

**Maximizing profit in a monopoly:** like in competitive markets, profit is still maximized when marginal revenue is equal to marginal cost (MR = MC), but monopolies can set price themselves and do this above MC to maximize profit, so $p \geq MR = MC$

**Finding the optimal price (p*) and quantity (Q*) in a monopoly:**

1) find TR (TR = p(Q)×Q) and calculate the derivative of this (dTR/dq = MR)
2) find TC (TC = VC + FC) and calculate the derivative of this (dTC/dq = MC)
3) set MR = MC and isolate Q*
4) plug Q* into p(Q) to find p*

**Market power:** the ability to charge a price above MC. Monopiles can do this, firm in competitive markets cannot. To evaluate the amount of market power a monopoly has we look at elasticity. The more elastic a demand curve is, the less can a monopoly change prices without loosing sales. Marginal revenue can be expressed in terms of elasticity:

MR = $p(1+\frac{1}{\varepsilon})$ = MC $\rightarrow$ $\frac{p}{MC} = \frac{1}{1+(1/\varepsilon)}$

**Lerner index (price markup):** Another way to examine elasticity in relation to MC is Lerner index: $\frac{p-MC}{p} = -\frac{1}{\varepsilon}$

The Lerner index ranges from 0 to 1. The higher the value, the higher the monopoly power.
In competitive markets Lerner index is 0

Lecture 11+12 – Chapter 13

Oligopoly:

**Oligopoly:** instead of having just one firm in the marked, we now have a limited small group of firms. When this group consists of only two firms, it's a *duopoly* (which we will mostly deal with)

**Cartel:** The group can coordinate their prices and quantities and act like a monopoly to increase their profits (collude) – in this case the group is called a cartel. Cartels maximize joint profits, i.e. to find Q in a cartel we set $\frac{d\pi}{dQ}$=0 and isolate Q

**Cournot oligopoly model:** firms simultaneously (and independently) choose output (q).
We assume, as mentioned before, that we are dealing with a duopoly. To find the Cournot equilibrium we execute the following steps:

1) find firm 1's residual demand: $q_1 = Q(p) - q_2$
2) find $MC_1$ of firm 1 (like we did in monopolies if it's not given)
3) find $MR_1$ of firm 1 by first isolating p in the residual demand (getting the inverse demand function), multiplying by $q_1$ to get revenue and deriving with respect to $q_1$ to get $MR_1$
4) set $MC_1 = MR_1$ and isolate $q_1$ to get the *best response function*. i.e. the optimal $q_1$ as a function of $q_2$
5) do step 1-4 for firm 2 to get firms 2's best response function
6) now that we have the best response function for firm 1 and 2, we can find out where they intersect (Nash-Cournot equilibrium) and thus find the optimal $q_1$ and $q_2$
7) the optimal quantities are finally put into the inverse demand function to find p

**Stackelberg oligopoly model:** A leader firm chooses its quantity, and then the follower firms (independently) chooses their output (q). We assume, as mentioned before, that we are dealing with a duopoly. To find the Stackelberg equilibrium we execute the following steps assuming that firm 1 is the leader firm and firm 2 is the follower:

1) find firm 2's residual demand: $q_2 = Q(p) - q_1$
2) find $MC_2$ of firm 2 (like we did in monopolies if it's not given)
3) find $MR_2$ of firm 2 by first isolating p in the residual demand (getting the inverse demand function), multiplying by $q_2$ to get revenue and deriving with respect to $q_2$ to get $MR_2$
4) set $MC_2 = MR_2$ and isolate $q_2$ to get the *best response function*. i.e. the optimal $q_2$ as a function of $q_1$ for the follower firm
5) insert the follower firm's best response function in the leaders (firm 1) residual demand function $q_1 = Q(p) - q_2$
6) now do step 2 and 3 for the leader firm
7) set $MC_1 = MR_1$ to find the leader's output, $q_1$
8) insert $q_1$ in the follower's best response function to find $q_2$
9) insert the total output ($q_1$+$q_2$) in the demand function to find the price

**Bertrand oligopoly model:** Firms simultaneously (and independently) choose price (p). This means that the equilibrium price will be set lower than the Cournot equilibrium price. We assume, as mentioned before, that we are dealing with a duopoly. To find the Bertrand equilibrium we execute the following steps:

1) find firm 1's profit as a function of the price of product 1 $p_1$:
$$\pi_1(p_1) = p_1 q_1 - AC_1 q_1 = (p_1 - AC_1) q_1$$
2) we have to find marginal profit ($\frac{d\pi_1}{dp_1}$). In the assignment you will have been given $q_1$ and MC=AC=constant. When we derive a function h(x)=f(x)g(x), then h'(x) = f'(x)g(x) + f(x)g'(x). Therefore $\frac{d\pi_1}{dp_1} = q_1 + (p_1 - AC_1) * \frac{dq_1}{dp_1}$
3) by substituting the $q_1$ function into this equation we can now find $p_1$ as a function of $p_2$, i.e. firm 1's best response function
4) repeat step 1-3 for firm 2 to find firm 2's best response function (remember to use $p_2$ and $q_2$ instead of $p_1$ and $q_1$)
5) insert firm 2's best response function in firm 1's best response function to find $p_1$ and afterwards also $p_2$

**Monopolistic competition:** there are no barriers to entry, so the market is like in perfect competition, except that in monopolistic competition the demand curve is downward sloping. This in turn also means that firms in this market will set prices p > MC (and p = AC because of zero economic profit). They still maximize at MC = MR

Lecture 13 – Chapter 14+18

Game theory:

**Game theory:** theory about which strategies players in the market will utilize at certain points

**A game:** a situation where players have to make strategic decisions (we will be looking at oligopolistic markets where we only have a few actors (usually two – a duopoly))

**Payoffs:** players' rewards from the game (profit)

**Rules of the game:** rules that determine the moves players can make (e.g. which output can they choose, and can they choose it simultaneously with other players)

**Action:** a move a player makes at some point of the game

**Strategy:** the battle plan of a player based on the information available

Static games:

**Static games:** players act only once, and they do it simultaneously. They have complete information (they know what options the other player has), but not perfect information (they don't know how the other player will act because they act simultaneously).

**Dominant strategy:** a strategy where the player gets a higher payoff than any other strategy no matter what the other player chooses

**Dominated strategy:** a strategy where the player gets a lower payoff than any other strategy no matter what the other player chooses (the opposite of a dominant strategy)

**Prisoners' dilemma:** a game where all players have a dominant strategy that leads to a lower payoff than what could be achieved through cooperation

**Nash equilibrium:** a situation where no player can obtain a higher payoff by choosing a different strategy

**Example:**

1.

Firm 2

| Firm 1 | $Q_2 = 25$ | 35 | 50 | 100 |
|---|---|---|---|---|
| $Q_1 = 25$ | 125, 125 | 100, 140 | 63, 125 | -63, -250 |
| 35 | 140, 100 | 105, 105 | 53, 75 | -123, -350 |
| 50 | 125, 63 | 75, 53 | 0, 0 | -250, -500 |
| 100 | -250, -63 | -350, -130 | -500,-250 | -900, -900 |

2.

Firm 2

| Firm 1 | $Q_2 = 25$ | 35 | 50 | 100 |
|---|---|---|---|---|
| $Q_1 = 25$ | 125, 125 | 100, 140 | 63, 125 | -63, -250 |
| 35 | 140, 100 | 105, 105 | 53, 75 | -123, -350 |
| 50 | 125, 63 | 75, 53 | 0, 0 | -250, -500 |
| 100 | -250, -63 | -350, -130 | -500, -250 | -900, -900 |

3.

Firm 2

| Firm 1 | $Q_2 = 25$ | 35 | 50 | 100 |
|---|---|---|---|---|
| $Q_1 = 25$ | 125, 125 | 100, 140 | 63, 125 | -63, -250 |
| 35 | 140, 100 | 105, 105 | 53, 75 | -123, -350 |
| 50 | 125, 63 | 75, 53 | 0, 0 | -250, -500 |
| 100 | -250, -63 | -350, -130 | -500, -250 | -900, -900 |

4.

Firm 2

| Firm 1 | $Q_2 = 25$ | 35 | 50 | 100 |
|---|---|---|---|---|
| $Q_1 = 25$ | 125, 125 | 100, 140 | 63, 125 | -63, -250 |
| 35 | 140, 100 | 105, 105 | 53, 75 | -123, -350 |
| 50 | 125, 63 | 75, 53 | 0, 0 | -250, -500 |
| 100 | -250, -63 | -350, -130 | -500, -250 | -900, -900 |

In the pictures above we see how to find the Nash equilibrium.
-*Picture 1* shows all combinations of payoff for the players, firm 1 and 2. They can each choose to produce either 25, 35, 50 or 100 units of output. If firm 1 chooses to produce 25, and firm 2 chooses to produce 50, firm 1 will get a payoff of 63, and firm 2 will get a payoff of 125.
-*Picture 2* shows firm 1's strategies. If firm 2 produces 25, firm 1 will choose to produce 35 to maximize its payoff. Similarly, if firm 2 chooses to produce 35, firm 1 will choose to produce 35 to maximize its payoff. If firm 2 chooses to produce 50 or 100, firm 1 will produce 25. There is no dominant strategy here, as not one output is always preferred. However, outputs 50 and 100 are dominated for firm 1, as firm 1 will never choose to produce at these levels.
-*Picture 3* shows the same, but for firm 2
-*Picture 4* shows the Nash equilibrium. This is where the strategies overlap, i.e. where firm 1 and 2 produces 35, and both gets a payoff of 105. (Be attentive to the fact that they do not always have to produce the same amount and get the same amount of payoff, and there can be more than one Nash equilibrium!)

<u>Mixed games:</u>
**Pure strategy:** in the example above we say that the firms have a *pure strategy*, i.e. they choose an action with certainty

**Mixed strategy:** we do not know for certain which strategy the players will utilize, but we can calculate the probability of each strategy based on the expected payoffs for each player (a best-response analysis).

**Example:**

| | | Firm 2 | |
|---|---|---|---|
| | | A | B |
| Firm 1 | A | 10, 0 | 5, 10 |
| | B | 0, 35 | 30, 30 |

Here there is no pure strategy Nash equilibrium. To calculate the mixed strategy Nash equilibrium, we expect firm 1 to have a $\theta_{1A}$ chance of choosing strategy A, such that firm 2 is indifferent between choosing strategy A and B (and vice versa, i.e. firm 2 to has a $\theta_{2A}$ chance of choosing strategy A, such that firm 1 is indifferent between choosing strategy A and B).
If the chance of firm 1 choosing strategy A is $\theta_{1A}$, then its chance of choosing strategy B is 1- $\theta_{1A}$.

To calculate $\theta_{1A}$ in practice, we say that firm 2 expects a payoff of the following when it chooses strategy A:

$$\theta_{1A} * 0 + (1 - \theta_{1A}) * 35$$

and expects a payoff of the following when it chooses strategy B:

$$\theta_{1A} * 10 + (1 - \theta_{1A}) * 30$$

At the mixed strategy Nash equilibrium these expected payoffs are equal:

$\theta_{1A} * 0 + (1 - \theta_{1A}) * 35 = \theta_{1A} * 10 + (1 - \theta_{1A}) * 30$
$\theta_{1A} = \frac{1}{3} \approx 33\%$
This means that firm 1 has a 33% chance of choosing strategy A (and a 66% chance of choosing B).

We do the same with firm 2. Firm 1 expects a payoff of the following when it chooses strategy A:

$\theta_{2A} * 10 + (1 - \theta_{2A}) * 5$

and expects a payoff of the following when it chooses strategy B:

$\theta_{2A} * 0 + (1 - \theta_{2A}) * 30$

At the mixed strategy Nash equilibrium these expected payoffs are equal:

$\theta_{2A} * 10 + (1 - \theta_{2A}) * 5 = \theta_{2A} * 0 + (1 - \theta_{2A}) * 30$
$\theta_{2A} = \frac{25}{35} \approx 71\%$
This means that firm 2 has a 71% chance of choosing strategy A (and a 29% chance of choosing B).

Externalities (chapter 18):
**Externalities:** when the actions of someone outside the market directly affects actors within the market. Positive externalities help the actors, while negative externalities harm the actors

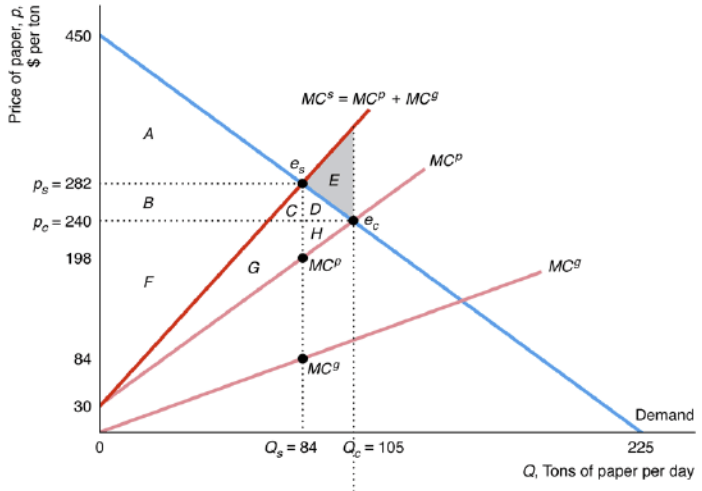
**Nonoptimal production:** the result of externalities. If a firm is producing negative externalities (e.g. pollution) and do not have to pay for it, it will produce too much. On the other hand, if a firm is causing positive externalities and is not rewarded, it will produce too little.
Example: A candy maker produces a benefit of 40. However, while he is producing, the noise from his machine makes the doctor next door unable to work. If the doctor were able to work, she would produce a benefit of 60. Its optimal for the candy maker to produce, but for the social optimal outcome he should actually not produce.

Socially-optimal equilibrium:
**Private cost:** the cost of production for a firm

**Social cost:** the private cost + the cost of the harms of production (negative externalities)

**Socially optimal equilibrium:** normally in competitive markets we find the equilibrium where private MC = market demand (and set p=private MC to maximize profits). The socially optimal equilibrium is where social MC = market demand (and we set p=social MC to maximize profits). Competitive firms set equilibrium price below the social optimal. Monopolies can set equilibrium price either above, below or at the social optimal.

In this graph we see how the competitive private MC causes an equilibrium at a price below the socially optimal equilibrium. In the graph $MC^p$ is the private marginal cost, $MC^g$ is the marginal cost of the pollution, and $MC^s$ is the total social marginal cost ($MC^p$+ $MC^g$)




| | Social Optimum | Private | Change |
|---|---|---|---|
| Consumer surplus, $CS$ | $A$ | $A + B + C + D$ | $B + C + D$ |
| Private producer surplus, $PS_p$ | $B + C + F + G$ | $F + G + H$ | $H - B - C$ |
| Externality cost, $C_g$ | $C + G$ | $C + D + E + G + H$ | $D + E + H$ |
| Social producer surplus, $PS_s = PS_p - C_g$ | $B + F$ | $F - C - D - E$ | $-B - C - D - E$ |
| Welfare, $W = CS + PS_s$ | $A + B + F$ | $A + B + F - E$ | $-E = DWL$ |

Rivalry and exclusion:

**Rival good:** a good that is used up as it is consumed

**Exclusion:** the ability to prevent others from using a good (excludable good)

**Open-access common property:** a resource that is nonexclusive and rival

**Club good:** a good that is nonrival, but excludable

**Public good:** a good that is nonrival and nonexcludable. Unlike private goods, where market demand is the horizontal sum of all demand curves, the social demand curve is the vertical sum of all individuals demand curves, $p(Q) = p(q_1) + p(q_2)$.

**Free riding:** benefiting from the actions of others without paying