MICROECONOMICS

NOTES

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Written by Alessandra Vitiello

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PRELIMINARIES OF MICROECONOMICS

- societies need to accomplish 3 tasks* → ① what to produce
  ② how to produce goods
  ③ who gets what

> * economics studies how societies manage to accomplish these three tasks

WHAT IS MICROECONOMICS? it is the branch of economics which concerns individual decision making and its collective effect on the allocation of a society's scarce resources (national economy concerns macroeconomics)

RESOURCES ALLOCATION

CAPITALIST ECONOMY →
- decentralized
- productions mostly owned and controlled by/for the benefit of private individuals
- allocation of resources governed by voluntary trading among businesses and consumers

vs

COMMUNIST ECONOMY →
- centralized
- the state owns and controls the means of production and distribution

> GDP = (gross domestic product) standard mesure of the value added created through the production of goods and services in a country during a certain period

- no economy is completely decentralized or centralized
- MARKETS =
  - most common form of economic decentralization
  - associated with a single group of closely related products that are offered for sale within particular geographic boundaries
  - economic institutions that provide people with opportunities and procedures for buying and selling goods and services
  - producs belonging to the same market are highly interchangeable
- price = the rate at which someone can swap money for a good (it governs trade)
- property rights = an enforceable claim on a good or resource → holding all property rights = owning
- property rights are transferable if the current owner of a good can reassign those rights to another consenting party (when they are not transferable markets can't operate)

> TYPES OF MARKETS
> - sellers = companies → buyers = individuals
> - sellers = companies → buyers = companies
> - sellers = individuals → buyers = companies
> - sellers = companies and individuals → buyers = companies and individuals

- nations having market economy = nations allocating sources mainly through markets —> in a free market system the government mostly allows markets to operate as they will with little regulation or other intervention

1 of the main objectives of micro = determine how well each method of allocating scarce resources performs

- ECONOMIC MOTIVES = microeconomics usually assume that people are motivated by material self-interest
- POSITIVE ECONOMIC ANALYSIS addresses positive questions (factual questions) usually concerning choices or market outcomes —>
  - what did happen = providing a factual account of the past
  - what will happen = forecasting the future
  - what would happen = describing the likely consequences of a course of action (cause-effect)

  —> economists must stick to objective facts
- NORMATIVE ECONOMIC ANALYSIS addresses normative questions (they involve value judgments) —> concerns what ought to happen (should)

  —> subjective (answers neither ✓ nor ✗) —> economists rely on the principle of individual sovereignty = each person knows whats better for them (with full knowledge of all consequences)

TOOLS OF MICROECONOMICS

SCIENTIFIC METHOD = general procedure used by scientists to learn about the characteristics, causes and effects of natural phenomena —>

1. initial observation
2. theorizing
3. identification of additional implications
4. further observation testing
5. refinement of the theory

MODELS OF MATHEMATICS

- theories are expressed through models = simplified representation of a phenomenon
- economists work with mathematical models because most economic choices are quantitative (they require precision)

- in an economic model ->
    - exogenous = variables taken as given
    - endogenous = variables determined by the model

  -> comparative statics = responses of endogenous variables to changes in exogenous variables
- equilibrium = a point of balance at which there is no tendency for a model's endogenous variables to change given fixed values of the exogenous variables
- models are simplified representations of the real world -> used by the economists to simplify complex social phenomena

DATA ANALYSIS

- records = companies usually keep track of detailed business records
- surveys = used to collect data
- experiments = to determine cause and effect using data economists use an approach called natural experiment ->
    - in it the circumstances of otherwise identical people differ entirely by chance
    - an economist attibutes differences in the average outcomes for those people to the differences in their circumstances
    - econometrics = application of statistical methods to empirical questions in the field of economics

THEMES OF MICROECONOMICS

DECISIONS

① trade-offs are unavoidable = good decision making requires recognizing trade-offs

② to choose well focus on the margin = think whether a marginal change (small adj. of a choice) will determine an improvement or not

③ people respond to incentives = weight the benefits and costs of a potentially desirable action

④ prices provide incentives = costs of buying and benefits of selling are determined by prices

MARKETS

⑤ trade can benefit everyone = occurs whenever people exchange valuable goods or services

⑥ the competitive market price reflects both value to costumers and cost to producers = goods competitive market price = cost of producing an extra unit

⑦ compared to other methods of resource allocation markets have advantages = market prices coordinate our activities

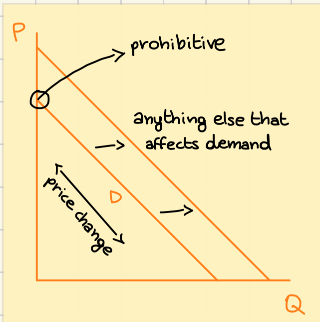
⑧ sometimes government policy can improve on free-market resource allocation

DEMAND

DEMAND CURVES

- it shows the quantity of goods buyers want to buy correspondingly to each possible price (holding fixed all other factors that affect demand
- relation between price and quantity demand (it moves along the curve)
- negative

- when income increases the demand for normal goods shifts right
- when income increases the demand for inferior goods shifts left



- DEMAND FUNCTION = it describes the amount of the product that is demanded for each possible combination of its price and other factors

- substitutes = (2 products all else equal) if one increases in the price it causes buyers to demand more of the other
- complements = (2 products all else equal) if one increases in the price it causes buyers to demand less of the other product

SUPPLY

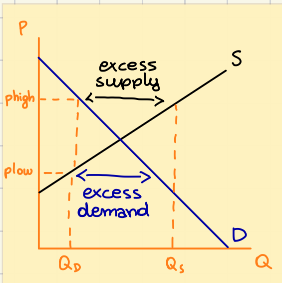
- it shows how much sellers of a product want to sell at each possible price (holding fixed all other factors that affect supply) → relation between price and quantity supplied (it moves along the curve)

if price changes the movement goes along the curve while when everything else that affects quantity supplied at a given price the curve shifts

- SUPPLY FUNCTION = describes the amount of the product that is supplied for each possible combination of its price and other factors

MARKET EQUILIBRIUM

- equilibrium price = price at which the amounts supplied and demanded are equal
- excess supply →
  - sellers lower their prices
  - Q_S decreases → Q_D increases
  - lower excess supply until it disappears
- excess demand →
  - buyers increase their bids
  - Q_S increases → Q_D decreases
  - lower excess demand until it disappears



THE SIZE OF CHANGES IN MARKET EQUILIBRIUM

- supply curve perfectly horizontal = an increase in the demand has no effect on the product's price but increases the amount bought and sold
- supply curve perfectly vertical = an increase in the demand has no effect on the amount bought and sold but increases the product's price
- steeper supply curve = larger increase in price + smaller increase in the amount bought and sold when demand increases
- steeper demand curve = larger increase in both price and amount bought and sold when demand increases

ELASTICITIES OF DEMAND AND SUPPLY

- elasticity = measures the percentage change in y per percentage change in x → $E^y_x = \frac{\%\text{ change in } y}{\%\text{ change in } x}$ (elasticities are unit-free measures while slopes depend on units)

PRICE ELASTICITY OF DEMAND

- (at price P, denoted E^D) equals the percentage change in the quantity demanded for each 1 percent increase in the price
- measures how responsive the quantity demanded is to changes in prices
  → $E^D = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price}} = \frac{100 \cdot \Delta Q^D / Q^D}{100 \cdot \Delta P / P} = \frac{\Delta Q^D / Q^D}{\Delta P / P}$

- we call demand = • elastic = its elasticity is less than -1
  • unit elastic = its elasticity equals -1
  • inelastic = its elasticity is between -1 and 0
- perfectly elastic = horizontal demand curve (elasticity $\to -\infty$)
- perfectly inelastic = vertical demand curve (elasticity = 0)
- constant elasticity demand curve = has the same elasticity at every price (= isoelastic)
- linear demand curve → • $E^D = \dfrac{\Delta Q/Q}{\Delta P/P} = \underbrace{\dfrac{\Delta Q}{\Delta P}}_{\text{negative constant } (-B)} \cdot \dfrac{P}{Q}$ *

the price elasticity of demand is ← negative constant (-B) different at every point on the curve

→ $E^D = -B \cdot \dfrac{P}{Q}$ *

PRICE ELASTICITY OF SUPPLY

- (at price P, denoted E^S) equals the percentage change in the quantity supplied for each 1 percent increase in the price
- measures how responsive the quantity supplied is to changes in prices

→ $E^S = \dfrac{\%\text{ change in quantity supplied}}{\%\text{ change in price}} = \dfrac{\Delta Q^S/Q^S}{\Delta P/P} = \dfrac{\Delta Q^S}{\Delta P} \cdot \dfrac{P}{Q^S}$

- supply is called = • perfectly elastic = $E^S_P \to \infty$
  • elastic = $E^S_P > 1$
  • unit elastic = $E^S_P = 1$
  • inelastic = $E^S_P < 1$
  • perfectly inelastic = $E^S_P = 0$

OTHER ELASTICITIES

- income elasticity of demand = measures how responsive demand is to changes in income → $E^D_I = \dfrac{\Delta Q^D/Q}{\Delta I/I}$ →
  • $E^D_I > 0$ → normal good
  • $E^D_I < 0$ → inferior good
- cross-price elasticity of demand = measures how responsive demand is to changes in the price of another good → $E^D_{P_O} = \dfrac{\Delta Q^D/Q}{\Delta P_O/P_O}$ →
  • $E^D_{P_O} > 0$ → substitutes
  • $E^D_{P_O} < 0$ → complements
  • $E^D_{P_O} = 0$ → independent goods

CONSUMER PREFERENCES

INTRODUCTION

- preferences tell us about a consumer likes and dislikes

RANKING PRINCIPLE = a costumer can rank in order of preference all potentially available alternatives ->
- indifferent consumer = (two alternatives) they like (or dislike) both of them equally
- consumer's preferences are ->
  - complete = if in comparing any two alternatives they either prefer one alternative to the other or are indifferent between them
  - transitive = if they prefer one alternative to the second and the second alternative to a third then they also prefer the first alternative to the third

RATIONAL CHOICE ASSUMPTION = among the available alternatives the consumer selects the one that he ranks the highest

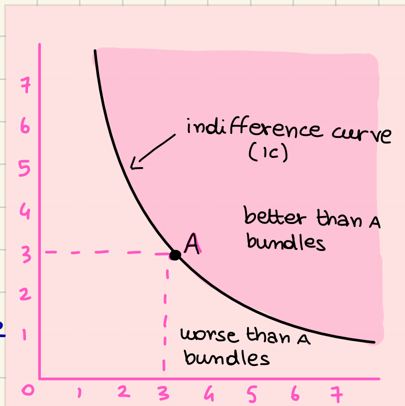
FEATURES OF CONSUMER PREFERENCES

- consumption bundle = collection of goods that an individual consumes over a given period (an hour, a day, a month, a year, a lifetime, etc.)

MORE-IS-BETTER PRINCIPLE = when one consumption bundle contains more of every good than a second bundle, a costumer prefers the first bundle to the second

INDIFFERENCE CURVES

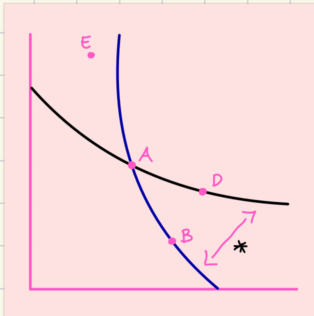
- shows all consumption bundles that a consumer likes equally well
- the IC that runs through consumption bundle A separates all the better than A bundles from the worse than A bundle
- starting with any alternative an indifference curve shows all the other alternatives that a consumer likes equally well



PROPERTIES OF INDIFFERENCE CURVES AND FAMILIES OF INDIFFERENCE CURVES

collection of indifference curves that represent one individual's preferences

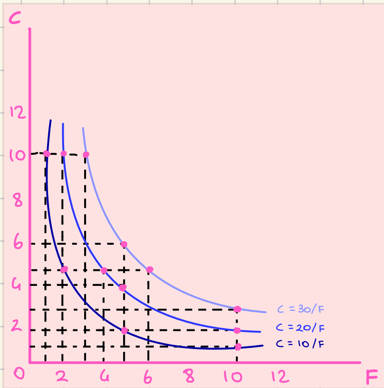
- IC are thin = B ≻ A (B "better" than A) due to MORE-IS-BETTER PRINCIPLE —> B and A cannot belong to the same IC
- IC do not slope upward = B ≻ A due to MORE-IS-BETTER PRINCIPLE —> B and A cannot belong to the same IC
- IC curves from the same family do not cross =
  - by being on the same indifference curve the consumer is indifferent between A and B
  - by the TRANSITIVE PROPERTY of the RANKING PRINCIPLE the consumer should be indifferent between B and D —> this is impossible since D ≻ B due to MORE-IS-BETTER PRINCIPLE *



- in comparing any two bundles the consumer prefers the one located on the IC that is furthest from the origin

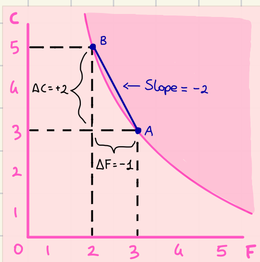
PLOTTING INDIFFERENCE CURVES

- suppose utility (U) is given by $U = C \cdot F$
- solve for good on vertical axis (C) —> $C = U/F$
- pick utility level (arbitrary) and plot
- higher the values of U lead to IC that are further from the origin
- the value of U for the IC that runs through any bundle provides a measure of the consumer's well-being (utility)



SUBSTITUTION BETWEEN GOODS

- a consumer can substitute goods at a rate that leaves them between bundles



- this consumer is indifferent between A and B
- moving A to B they lose 1 F and gain 2 C
- the rate at which the consumer is willing to substitute for F with C is 2 C per F

MARGINAL RATE OF SUBSTITUTION

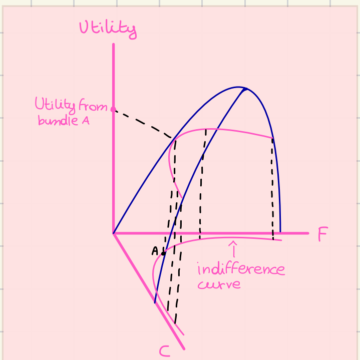
- the marginal rate of substitution for x with y (MRS_{xy}) is the rate at which a consumer must adjust y to maintain the same level of utility when x changes marginally → $MRS_{xy} = -\Delta y / \Delta x$
- in general MRS_{xy} depends on current levels of x and y
- the slope of a consumer's IC depends on her tastes
- an IC has a declining MRS if it becomes flatter as we move along the curve from the northwest to the southeast
- WHY ARE RATES OF SUBSTITUTION IMPORTANT? → mutually beneficial trade depends on trading partners' marginal rates of substitution

UTILITY

- it is a numeric value indicating the consumer's relative well-being
- higher utility indicates greater satisfaction than lower utility

UTILITY FUNCTION

- it assigns a utility value to each consumption bundle
- to create one we assign the same value to all points on a single IC → higher values for IC that correspond to higher levels of well-being (further from the origin)



→ the indifference curve passing through A consists of all the bundles for which the height of the utility function is the same

MARGINAL UTILITY

- it is the change in the consumer's utility resulting from a very small amount of some good devided by the amount added = the amount ΔU by which utility changes due to a small increase ΔX in the amount of a good consumed
- $MU_X = \Delta U / \Delta X$ →

- moving along the same IC utility is constant —> for small changes in x and y we have ΔU (due to Δx) = $-\Delta U$ (due to Δy)
- substituting ΔU yields (produces) $MU_x \cdot \Delta x = -MU_y \cdot \Delta y$
- by this definition —> $\underbrace{MRS_{xy} = -\Delta y / \Delta x}$

—> $MRS_{xy} = MU_x / MU_y$

- marginal rate of substitution = ratio of marginal utilities
- changing the units of utility function —> MRS still constant

COBB - DOUGLAS UTILITY FUNCTION

- $U(x,y) = x^a y^b$ —> a and be are constants (diff. from each consumer)
- indifference curves associated with Cobb-Douglas utility functions are strictly convex —> $y = U^{1/b} x^{-a/b}$
- marginal utility of x —> $MU_x = a x^{a-1} y^b$
- marginal utility of y —> $MU_y = b x^a y^{b-1}$

—> $MRS_{xy} = \frac{MU_x}{MU_y} = \left(\frac{a}{b}\right)\left(\frac{y}{x}\right)$

as x increases MRS_{xy} decreases $\left(\frac{\Delta MRS_{xy}}{\Delta x} < 0\right)$

- based on the work of mathematician Charles Cobb and economist and politician Paul Douglas

CONSTRAINTS, CHOICES AND DEMAND

INCOME, PRICES AND BUDGET CONSTRAINT

- income = the money a consumer receives during some fixed period of time → assume they can afford to purchase a consumption bundle if its price isn't higher than their income
- budget constraint = all the consumption bundles a consumer can afford over some period of time → price of consumption bundle ≤ income
- total cost of the bundle = $P_x x + P_y y$ (price x · units x + price y · units of y) $\leq M$ (income) → $\underbrace{y = \frac{M}{P_y} - \frac{P_x}{P_y}x}$

budget line = shows all the consumption bundles that just exhaust a consumer's income

CHANGES IN INCOME AND THE BUDGET LINE

- income increases = budget line shifts right (bundles become affordable)
- income decreases = budget line shifts left (bundles become unaffordable)

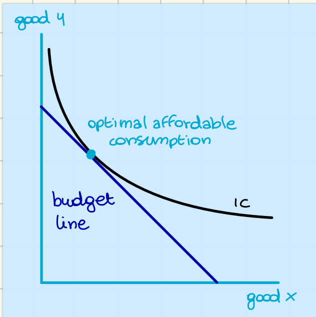
- price increases = budget line rotates towards the origin (bundles become unaffordable)
- price decreases = budget line rotates far from the origin (boundles become affordable)

PROPERTIES OF BUDGET LINES

- Budget lines separate affordable and unaffordable consumption bundles: Affordable bundles lie on and southwest of the budget line.
- The slope of the budget line is given by $-P_X/P_Y$, where X is the good on the horizontal axis.
- The budget line cuts the horizontal axis at M/P_X and the vertical axis at M/P_Y.
- An income change implies a parallel shift of the budget line .
- A price change rotates the budget line around the intersection with the axis of the good with the unchanged price (inward rotation for a price rise).
- Multiplying all prices by the same number has the same effect as dividing income by that number.

CONSUMER CHOICE

- graphically the budget line is tangent to the highest IC
- at the optimal affordable consumption bundle slopes are identical -> $MRS_{xy} = \frac{P_x}{P_y}$



PROPERTIES OF BEST CHOICE

- The consumer's best choice lies on the budget line.
- At the optimal consumption bundle, indifference curve and budget line are tangent, and hence $MRS_{XY} = \frac{P_X}{P_Y}$.
- The intersection of an indifference curve and the budget line cannot be optimal at an interior solution.
- For indifference curves with declining MRS (convex preferences), an interior choice that satisfies the tangency condition always is the best affordable choice.

UTILITY MAXIMISATION

- the optimal choice maximises the consumer's utility function subject to the budget constraint
- $\max_{x,y} U(x,y) \rightarrow P_x x + P_y y \leq M$

-> solution must lie on the budget line ($= M$) at the point where the marginal benefit of shifting resources to one good equals the marginal cost of shifting the same resources away from the other good ->

- One more euro spent on X will give the consumer $1/P_X$ more units of X.
- One more unit of X increases utility by $\approx MU_X$.

⇒ The marginal benefit of spending one more euro on X is MU_X/P_X.

- One less euro spend on Y means $1/P_Y$ fewer units of Y.
- One less unit of Y reduces utility by $\approx MU_Y$

⇒ The marginal cost of spending one less euro on Y is MU_Y/P_Y

-> further improvement is impossible when marginal benefit = marginal cost -> optimality = $\frac{MU_x}{P_x} = \frac{MU_y}{P_y}$ being on the budget line

$MRS_{xy} = \frac{P_x}{P_y}$ tangency

PRICES AND DEMAND

- price consumption curve = shows how the best affordable consumption bundle changes as the price of a good changes holding everything else fixed
- individual demand curve = describes the ralationship between the price of a good and the amount a particular consumer purcheses holding everything else fixed —> it derives from the price consumption curve with different axes
- the effect of the change in the price of one good on the demand for a second good will depend on whether they are —>
  - substitutes = a decrease in Px leads to a decrease (leftward shift) in the demand for y
  - complements = a decrease in Px leads to an increase (rightward shift) in the demand y

INCOME AND DEMAND

- income effect = the change in the consumption of a good that results from a change in income
- income - consumption curve = shows how the best affordable consumption bundle changes as income changes holding everything else fixed

NORMAL GOODS VS INFERIOR GOODS —> an increase in income reduces the amount consumed ($E^d_I < 0$)

↓

an increase in income raises the amount consumed ($E^d_I > 0$)

PROPERTIES

1. The income elasticity of demand is positive for normal goods and negative for inferior goods.
2. We can tell whether goods are normal or inferior by examining the slope of the income-consumption curve.
3. At least one good must be normal starting from any particular income level.
4. No good can be inferior at all levels of income.

ENGEL CURVE

- describes the relationship between income and the amount consumed holding everything else fixed
- for a normal good an increase in income shifts the demand curve to the right (whether the shift is proportional to income depends on other goods)

VOLUME SENSITIVE PRICING

- (in real life) the price paid for a good can depend on the volume purchased
- volume penality = when a good's price per unit rises with the amount purchased
- volume discount = when a good's price per unit falls with the amomt purchased
- rationed good = when the government or a supplier limits the amount that each consumer can purchase (similar to a very large volume penalty)

DETERMINE A CONSUMER'S PREFERENCES

- economists can either ask consumers to tell them what they like and dislike or use the REVEALED PREFERENCES APPROACH —>
  - = infer a consumer's preferences from their actual choices (works under rational choice assumption)
  - a consumption bundle is revealed preferred to another if the consumer chooses it when both are available

DEMAND AND WELFARE

- consumer welfare can be backed out via demand curves
- an increase in a good's price has two effects ->
  - income effect = depends only on the decrease in purchasing power
  - substitution effect = depends only on the change in relative price

MEASURING CHANGES IN CONSUMER WELFARE

- consumer surplus = net benefit a consumer receives from participating in the market for some good -> it is the compensating variation for losing access to the market
- compensating variation = amount of money that exactly compensates the consumer for a change in circumstances
- price increasing lowers consumer welfare for two reasons ->
  1. it reduces the net benefit of each unit consumed
  2. it reduces the number of units consumed

COMPENSATED PRICE CHANGE

- uncompensated price change = price change with no change in income (if a price raises, utility falls)
- compensated price change = price and income change that together leave the consumer well-being unaffected (if a price raises, keeping utility constant requires a rise in income)

SUBSTITUTION AND INCOME EFFECT

- when the price of a good increases two things happen ->
  1. substitution effect = the effect on consumption of a compensated price change -> consumers shift toward less expensive goods (especially to close substitutes)
  2. income effect = the effect on consemption of removing the compensation (consumers are poorer in real terms) -> consumers' purchasing power falls and they must adjust accordingly

DIRECTION OF

SUBSTITUTION EFFECT

- an increase in the price of a good always causes the consumer to buy less of that good
- consumers substitute away from the good as it becomes more expensive
- it is negative for a price increase and positive for a reduction

INCOME EFFECT

- an increase in the price of a good reduces consumers' purchasing power -> they buy less if the good is normal and more if it is inferior
- for a normal good the income effect works in the same direction as the substitute effect (for inferior goods in the opposite)
- normal good -> income effect is negative for a price increase and negative for a reduction (therefore it reinforces the substitution effect)
- inferior good -> income effect is positive for a price increase and negative for a reduction (therefore it opposes the substitution effect)

DOWNWARD SLOPING DEMAND CURVES

- Law of Demand = states that demand curves usually slope downward -> with it substitution effect is always consistent
- normal good -> income effect reinforces the substitution effect (normal goods always obey the Law of Demand)
- inferior good -> income effect opposes the substitution effect (usually is weaker than the latter)
- Giffen good = a product whose amount purchased increases as the price rises -> income effect is larger than the substitution effect for an inferior good (it violates the Law of Demand)

LABOUR SUPPLY

- for every "bad" there is a corresponding "good" (absence of bad)
- labour supply = sale of a consumer's time and effort to an employer -> demand for leisure (wage as its price)
- extensive margin of labour supply = work at all or not
- intensive margin of labour supply = how many hours (c) to work if working

- individual budget constraint = wage (w) + maximal available time ($\bar{L}$) + amount of leisure consumed ($N = \bar{L} - L$) —> $P_x X = R + WL$ or $P_x X + WN = R + W\bar{L}$ (slope = $-W/P_Y$)
- individual who chooses not to work at a given wage —>
  - fall in the wage rate = labour supply at 0 —> IC stays at the edge of the budget line
  - sufficiently large rise in the wage rate = positive labour supply may become worthwhile —> budget line tangent to a higher IC

INCOME AND SUBSTITUTION EFFECT

- rise in wages —>
  - welfare of an individual who works raises (moves to higher IC)
  - demand for both leisure and other goods raises (income effect)
  - demand for leisure reduces (substitution effect) —> leisure becomes more costly (the net effect on labour supply is ambiguous)
- leisure is not an inferior good —> the ambiguity results since it affects also the budget constraint

SAVING SUPPLY

- saving reduces and raises consumption in different given periods
- borrowing can raise consumption beyond a current period's budget constraint at the cost of future consumption
- firms can shift investment over time by borrowing and leading → consumers and firms face trade-off over time (interest rates are an important determinant)

FINANCE BASICS

- principal = amount borrowed when a person (or firm) lends money to another
- interest = amount of money a borrower is obliged to pay a lender over and above the principal
- interest rate = amount of interest paid on a loan during a particular period (usually a year) stated as a percentage of the principal
- compounding = payment of interest on loan balances that include interest earned in the past → causes the loan balance to grow faster as time passes
- $BT = D(1+R)^T$ →
  - BT = account balance
  - D = principal
  - R = rate of interest
  - T = time (in years)

PRESENT DISCOUNTED VALUE

- PDV = monetary value of a claim on future resources today →

$$\frac{\text{future value materializing in } T \text{ periods } (F)}{(1+R)^T}$$

→ amount one would have to put aside to accumulate F after T years

- at a positive interest €1 received in the future is valued at less than €1 today

WHY DO INTEREST RATES DIFFER?

- risk = it exists whenever the consequences of a decision are uncertain → the higher the risk of default (= failure to pay back borrowed money) the higher the interest payment demanded by lenders

- detail of agreements
- timing of repayment
- expected inflation

REAL INTEREST VS NOMINAL INTEREST → compensation received by the lender over and above the principal without adjusting for inflation

REAL INTEREST ↓ compensation measured in real dollars adjusted for inflation

INTER-TEMPORAL BUDGET CONSTRAINT

Consider a 2-period problem with
- today's price level P_0
- tomorrow's price level P_1
- consumption quantities C_0 and C_1 in the two periods
- incomes M_0 and M_1 in the two periods
- real interest rate R

A consumption bundle is affordable if, through borrowing and lending, the consumer can make all the required payments as they come due:

PDV of consumption stream = PDV of income stream

Hence, the **inter-temporal** budget constraint is

$$P_0C_0 + \frac{1}{1+R}P_1C_1 = M_0 + \frac{1}{1+R}M_1.$$

$$P_0C_0 + \frac{1}{1+R}P_1C_1 = M_0 + \frac{1}{1+R}M_1$$

If there is no inflation or deflation, so that prices are constant, $P_0 = P_1 = P$:

$$PC_0 + \frac{1}{1+R}PC_1 = M_0 + \frac{1}{1+R}M_1$$

or

$$C_1 = ((1+R)M_0 + M_1)/P - (1+R)C_0$$

Hence, $-(1+R)$ (or $-(1+R)P_0/P_1$ if prices vary) is the slope of a budget line relating today's to tomorrow's consumption.

SAVING, BORROWING AND THE INTEREST RATE

- interest rate increases →
  - substitution effect = saving becomes more rewarding and borrowing becomes more costly
  - income effect =

- a saver may decide to save less because more interest can be earned on each dollar saved -> future income target with less money put in savings
- a borrower becomes poorer so the income effect reduces consumption and borrowing

LIFE CYCLE HYPOTHESIS

- a typical person's adult life can be modeled with two main stages ->
  1. employed -> earning
  2. retired -> no earning
- people tend to prefer relatively stable consumption
- life cycle hypothesis = consumers will save and borrow to smooth consumption over time

TECHNOLOGY, PRODUCTION AND COSTS

- a firm's output and profit is constrained by the production technology it uses
- the simplest production function requires one input but we usually encounter two or more variable inputs
- firms decide on their optimal combination of inputs

as firms grow and increase the use of all inputs the effect on production may not be proportional = there may be returns to scale

PRODUCTION TECHNOLOGIES

- outputs = the physical products or services a firm produces
- inputs = the materials, labor, land, or equipment that firms use to produce their outputs
- efficiency = when there is no way for the firm to produce a larger amount of output using the same amounts of inputs
- production function = summerizes all possible combinations of inputs for production output using efficient methods → output = F (inputs)

PRODUCTION POSSIBILITY SET AND EFFICIENT PRODUCTION FRONTIER

PRODUCTION POSSIBILITY SET ↓ contains all combinations of inputs and outputs that are possible given the firm's technology

EFFICIENT PRODUCTION FRONTIER ↓ contains the combinations of inputs and outputs that the firm can achive using efficient production methods

AVERAGE AND MARGINAL PRODUCT

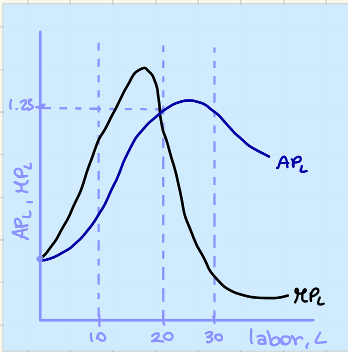
Firms must decide on the scale of production
- How much to produce?
  - Will require a certain number of workers.
  - Will depend on the cost of employing these workers
  - Will depend on the price of the firm's output
- For a **production function** $Q = F(L)$ that only uses labor L:
  - How much does a worker's produce on average?
  - By how much can an additional worker raise output?

- for a production function $Q = F(L)$ that only uses labour L →
  - average poduct of labour = amount of output divided by the number of workers employed → $AP_L = \frac{Q}{L} = \frac{F(L)}{L}$

- marginal product of labour = rate at which output produced increases due to an additional (marginal) unit ΔL of labor employed

$\rightarrow MP_L = \frac{\Delta Q}{\Delta L} = \frac{F(L+\Delta L) - F(L)}{\Delta L}$

- usually assumed that output increases in input amounts although AP_L and MP_L may not
- for many production processes there is a tendency for the marginal product of an input to eventually decline as its use is increased holding all other inputs fixed
- if the marginal worker is more productive than average the average product increases
- if the marginal worker is less productive than average the average product declines

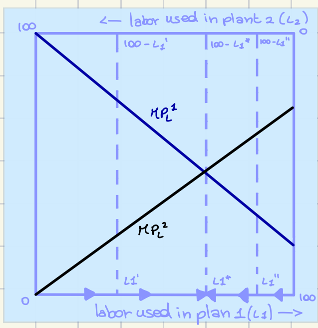


RETURNS TO SCALE

- constant returns to scale = when output rises at the same rate as input $\rightarrow$ AP_L stays constant as L increases
- increasing returns to scale ("economies of scale") = when output rises at a higher rate than input $\rightarrow$ AP_L rises as L increases
- decreasing returns to scale ("diseconomies of scale") = when output rises at a lower rate than input $\rightarrow$ AP_L falls as L increases

OPTIMAL ASSIGNMENT OF WORKERS BETWEEN TWO PLANTS

- two production plants within the same firm
- decreasing marginal product in each plant
- total of 100 workers who can work either in plant 1 or 2
- how to allocate them optimally? $\rightarrow$ equate the marginal products across plants
- most efficient allocation (that achieves the highest output) achieved when $\rightarrow$ $MP_L^1 = L_1^{-1/2}$ equals $MP_L^2 = 2L_2^{-1/2}$ $\rightarrow$ $4L_1 = L_2$



PRODUCTION IN THE SHORT RUN AND THE LONG RUN

- variable input = can be adjusted over the time period considered
- fixed input = cannot be adjusted over the time period considered
- short run = period of time over which one or more inputs is fixed
- long run = period of time over which all inputs are variable

PRODUCTION WITH TWO VARIABLE INPUTS

- PRODUCTIVE INPUTS PRINCIPLE = increasing the amounts of all principles strictly increases the amount of output the firm can produce (using efficient production methods)
- two inputs —> labor (L) and capital (K)
- production function —> $Q = F(L, K)$
- marginal product of labor —> $MP_L = \dfrac{F(L+\Delta L, K) - F(L, K)}{\Delta L}$ (hold other factors constant)
- we assume that $MP_x \geq 0$ for any factor x

ISOQUANTS

- = identifies all the input combinations a firm can use to efficiently produce a given amount of output
- family of isoquants = consists of the isoquants corresponding to all possible output levels as determined by a given production function

PROPERTIES OF ISOQUANTS

DECLINING MRTS ALONG AN ISOQUANT

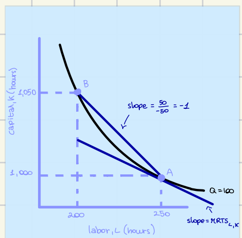
$\Delta Q = MP_L \cdot \Delta L + MP_K \cdot \Delta K = 0$ —>

$MRTS_{LK} \equiv -\dfrac{\Delta K}{\Delta L} = \dfrac{MP_L}{MP_K}$

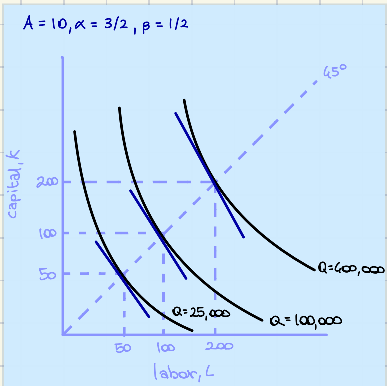
- are thin
- do not slope upward
- those for the same technology do not cross
- those of higher-level lie farther from the origin
- it is the boundary between input combinations that produce more than a given amount of output and those that produce less

SUBSTITUTION BETWEEN LABOR AND CAPITAL ALONG AN ISOQUANT AND THE MRTS

- marginal rate of technical substitution (MRTS) for input x with input y = the rate at which a firm must replace units of x with units of y to keep output unchanged starting at a given input



COBB-DOUGLAS PRODUCTION FUNCTION



- $F(L,K) = AL^{\alpha}K^{\beta}$
- $MP_L = \alpha AL^{\alpha-1}K^{\beta}$
- $MP_K = \beta AL^{\alpha}K^{\beta-1}$
- $MRTS_{LK} = \frac{\alpha}{\beta} \cdot \frac{K}{L}$ —> $K = L$ (45°)

RETURNS TO SCALE FOR MULTIPLE INPUTS

- constant returns to scale = all inputs all rise by the same proportion out —> output increases at this rate too
- increasing returns to scale = all inputs rise by the same proportion —> output increases at a higher rate
- decreasing returns to scale = all inputs rise by the same proportion —> output increases at a lower rate
- raising all inputs in a Cobb-Douglas production function $Q = F(L,K) = AL^{\alpha}K^{\beta}$ by an equal factor ϕ raises output by —> $F(\phi L, \phi K) = A(\phi L)^{\alpha}(\phi K)^{\beta} = A\phi^{\alpha+\beta}L^{\alpha}K^{\beta} = \phi^{\alpha+\beta}F(L,K)$
  - increasing returns to scale for $\alpha + \beta > 1$
  - constant returns to scale for $\alpha + \beta = 1$
  - decreasing returns to scale for $\alpha + \beta < 1$
- increasing returns to scale —> production is more efficient if there is a single large producer
- a single producer may not operate in a manner that would benefit consumers

TECHNOLOGICAL CHANGE

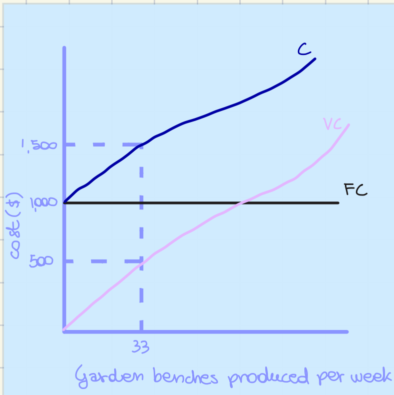
- higher productivity = when a firm can produce more output using the same amounts of inputs
- factor-neutral technical change = a productivity improvement that keeps the MRTS unchanged at every input combination —> an increase in A when $F(L,K) = AL^{\alpha}K^{\beta}$

REASONS FOR PRODUCTIVITY DIFFERENCES

- firms may have different levels of technical and organizational knowledge

- firms may lack the resources to invest in research and development
- firms may be subject to different regulations or market circumstances

TYPES OF PRODUCTION COSTS



- c(output) = FC + VC(output)
- variable cost VC(output) = costs of inputs that vary with the firm's output level
- fixed cost FC = costs of inputs whose use does not vary with the firm's output level →
  - avoidable = the firm does not incur the cost (or recoups it) if it produces no output
  - sunk = cost that is incurred even if the firm decides not to operate
- opportunity cost = the cost associated with foregoing the opportunity to employ a resource in its best alternative use

EXAMPLE OF ONE VARIABLE INPUT

Suppose the production function is $Q(L) = 5\sqrt{L}$.

$\Rightarrow L = Q^2/25$ units of labor required to produce Q units of output

- Labor is the only input factor

  $\Rightarrow VC(Q) = W \cdot L = W \cdot Q^2/25$
- If the wage rate is 15 Euro and the firm faces a fixed cost of 100 Euro, the cost function is

$$C(Q) = 100 + \frac{3}{5}Q^2 \; Euro.$$

AVERAGE COSTS AND MARGINAL COSTS

Average costs → the cost per unit of output produced averaged over all units

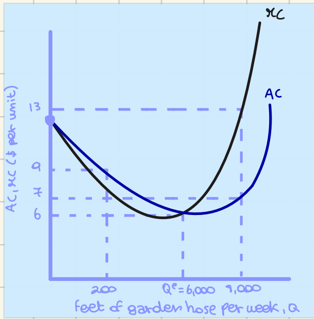
$$AC = \frac{C(Q)}{Q}$$

Marginal costs → the extra cost incurred per unit of output added

$$MC = \frac{\Delta C(Q)}{\Delta Q} = \frac{C(Q+\Delta Q) - C(Q)}{\Delta Q}$$

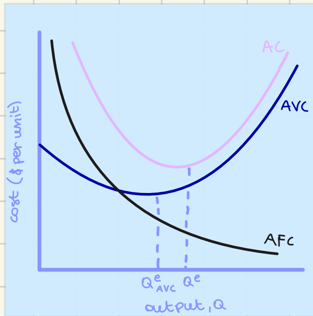
RELATIONSHIP BETWEEN AVERAGE COST AND MARGINAL COST

- when output is finely divisible the AC curve is upward sloping whenever MC > AC and downward sloping whenever MC < AC
- the AC curve has slope zero when MC = AC → the MC curve always crosses the AC curve at extremum



AVERAGE FIXED AND VARIABLE COSTS

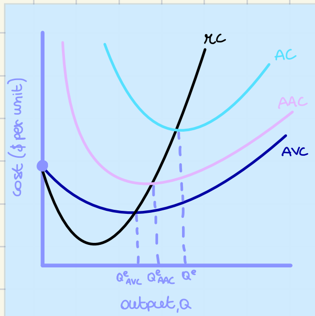
- average variable cost → $AVC = \frac{VC(Q)}{Q}$
- average fixed cost → $AFC = \frac{FC(Q)}{Q}$
- total average cost → $AC = \frac{VC(Q) + FC(Q)}{Q}$



AVERAGE AVOIDABLE COST

- average variable cost (always avoidable) → $AVC = \frac{VC(Q)}{Q}$
- total average avoidable cost → $AAC = \frac{VC(Q) + FCa(Q)}{Q}$
- total average cost → $AC = \frac{VC(Q) + FCa(Q) + FCs}{Q}$

(with avoidable fixed cost FCa and sunk fixed cost FCs)



DIFFERENT KINDS OF AVERAGE COST

Example: Suppose that $Q = \sqrt{L}$,
- $W = 20$,
- $FC_{sunk} = 15$ for R&D expenditure
- $FC_{avoidable} = 5$ for machines

Then variable costs are $VC(L) = 20Q^2$ for workers, and total costs are given by
$$C(Q) = FC_{sunk} + FC_{avoidable} + VC(Q).$$

$$C(Q) = FC_{sunk} + FC_{avoidable} + VC(Q) = 15 + 5 + 20Q^2$$

Hence:
$$AVC(Q) = 20Q \Rightarrow minimum:\ AVC(0) = 0$$
$$AAC(Q) = \frac{5}{Q} + 20Q \Rightarrow minimum:\ AAC\left(\frac{1}{2}\right) = 20$$
$$AC(Q) = \frac{20}{Q} + 20Q \Rightarrow minimum: AC(1) = 40$$

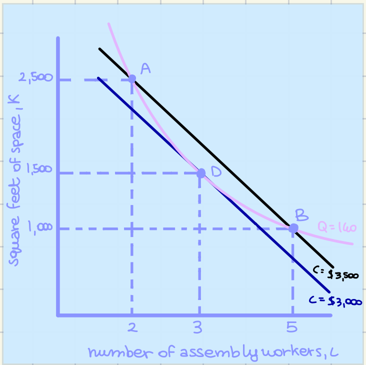
The marginal cost function $MC(Q) = 40Q$ cuts through all these minima!

ISOCOST LINES

- if there are more than one input factor isocost lines contain all the input combinations with the same cost
- isocost lines in combination with isoquants allow a firm to pick the least-cost combination of inputs to produce a certain level of output (or the largest possible output given a certain cost)
- along an isocost line for two input factors L and K the cost →
  $C = W \cdot L + R \cdot K$ where W is the cost for a unit of labor and R is the cost for a unit of capital
- rearranging gives → $K = \frac{C}{R} - \frac{W}{R}L$ (slope of the isocost line $= -W/R$)

LEAST-COST METHOD

the least-cost input combination for an output of 140 is the point on that isoquant that lies on the lowest isocost line (point D rather than points like A and B → there the isocost line is tangent to the isoquant for $Q = 140$



INTERIOR SOLUTIONS

substituting inputs along an isoquant (at a ratio $MRTS_{LK}$) leaves output unchanged →

- the marginal cost of raising the use of labor is the increased payment to labor W
- the marginal benefit of reducing capital at a rate that leaves output unchanged is the lower payment to capital $R \cdot MRTS_{LK}$
- at the best choice the marginal benefit of shifting resources across input factors equals the marginal cost of doing so
- at an interior solution the least-cost combination of inputs uses some of every input factor
- if there is an interior solution and the isoquant is smooth the isocost line is tangent to the isoquant at the least-cost combination of inputs → slope of the isoquant ($-MRTS_{LK}$) equals slope of the isocost line ($-W/R$)
- $MRTS_{LK} = W/R$ or $MP_L / MP_K = W/R$

EXAMPLE : COBB-DOUGLAS TECHNOLOGY

The Cobb-Douglas production function $Q(L,K) = AL^{\alpha}K^{\beta}$, has $MRTS_{L,K} = \frac{\alpha}{\beta}\frac{K}{L}$ (see previous lecture).

$\Rightarrow$ At the minimum-cost combination of L and K, $\frac{\alpha}{\beta}\frac{K}{L} = \frac{W}{R}$

To obtain the minimum cost function, plug into $Q(L,K)$ and solve for optimal factor input functions

$$L^* = Q^{\frac{1}{\alpha+\beta}}(W/\alpha)^{-\beta/(\alpha+\beta)}(R/\beta)^{\beta/(\alpha+\beta)}$$
$$K^* = Q^{\frac{1}{\alpha+\beta}}(W/\alpha)^{\alpha/(\alpha+\beta)}(R/\beta)^{-\alpha/(\alpha+\beta)}$$

These imply the minimum cost function:

$$C(Q,W,R) = WL^* + RK^* = (\alpha+\beta)Q^{\frac{1}{\alpha+\beta}}(W/\alpha)^{\alpha/(\alpha+\beta)}(R/\beta)^{\beta/(\alpha+\beta)}.$$

ECONOMIES OF SCALE

- economies of scale = average cost falls as firm produces more $\rightarrow$ $c(\lambda Q) < \lambda c(Q)$
- diseconomies of scale = average cost rises as firm produces more $\rightarrow$ $c(\lambda Q) > \lambda c(Q)$

ECONOMIES OF SCOPE

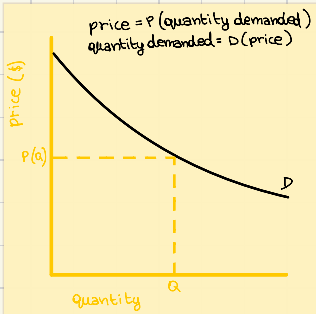
- economies of scope = a single firm can produce two (or more) products more cheaply than separate firms $\rightarrow$ $c(Q_1, Q_2) < c(Q_1, 0) + c(0, Q_2)$
- diseconomies of scope = producing two (or more) goods in a single firm is more expensive than producing them in separate firms $\rightarrow$ $c(Q_1, Q_2) > c(Q_1, 0) + c(0, Q_2)$

PROFIT MAXIMISATION

- firms managers usually set their prices (or sales quantities) to maximize profits -> how they do it depends on the market structure
- in competitive markets firms take the market price for their product as given and decide on profit-maximizing sales quantities
- optimal quantities can be found by comparing the marginal benefit of an increase in output to the marginal cost
- a firm wants to sell Q quantities of a good -> has to change a price P(Q) which is determined by consumer demand
- Firm's profit = sales revenue $P(Q) \cdot Q$ minus its cost $C(Q)$ -> $\pi = P(Q) \cdot Q - C(Q)$
- if the firm's aim is to maximize profit it will choose a Q that maximizes revenue less cost

CHOOSING PRICE VS CHOOSING QUANTITY

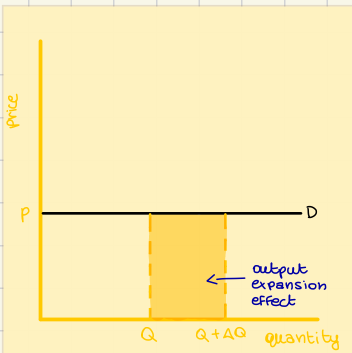
- inverse demand function = shows how much the firm can change to sell any given quantity of its product -> revenue = $P(Q) \cdot Q$



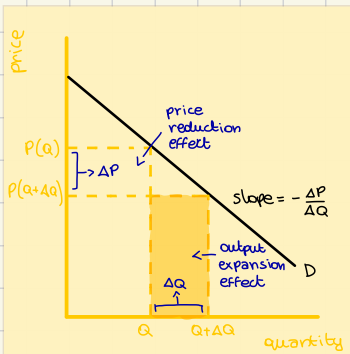
MARGINAL REVENUE

- increase in sales quantity from Q to $Q + \Delta Q$ changes revenue in two ways ->
  - output expansion effect = sell ΔQ additional units each at price of P(Q)
  - price reduction effect = increased sales quantity requires a reduction in price from P(Q) to $P(Q + \Delta Q)$

HORIZONTAL DEMAND CURVE



DOWNWARD SLOPING DEMAND CURVE



PROFIT MAXIMIZATION SALES QUANTITY

- to maximize profit $\pi = P(Q) \cdot Q - C(Q)$ a firm has to weigh the change in revenue against the change in cost when Q is changed
- marginal revenue = measures the rate at which revenue rises if the units sold increase by a small amount ΔQ →

$$MR(Q) = \frac{\Delta(P(Q)Q)}{\Delta Q} = \frac{\Delta P(Q) Q + P(Q)\,\Delta Q}{\Delta Q} = \frac{\Delta P(Q)}{\Delta Q} Q + P(Q)$$

- inframarginal units = units the firm sells other than the ΔQ marginal units

MARGINAL REVENUE AND DEMAND

$MR = \frac{\Delta P}{\Delta Q} Q + P$ → $MR = P$ for $\frac{\Delta P}{\Delta Q} = 0$ or $Q = 0$ → in all other cases $MR < P$

PROFIT-MAXIMISING SALES QUANTITY

- marginal revenue → $MR(Q) = \frac{\Delta P(Q)}{\Delta Q} Q + P(Q)$ →
  - equals $P(Q)$ for $Q = 0$
  - is below $P(Q)$ for $Q > 0$
- if $MR(Q) > MC(Q)$ → profit can be increased by raising Q
- if $MR(Q) < MC(Q)$ → profit can be increased by reducing Q
- profit maximization requires that $MR(Q) = MC(Q)$

PROFIT-MAXIMIZING SALES QUANTITY

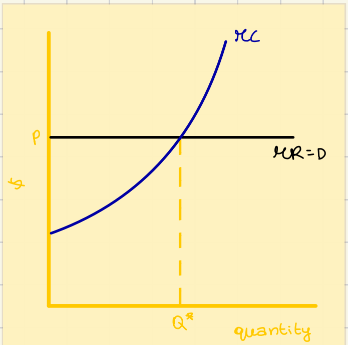
- to maximize profit raise output if the marginal benefit (marginal revenue) exceeds the marginal cost →
  1. quantity rule = identify positive sales quantities where $MR = MC$ → if this is satisfied by more than one positive sale quantity determine which produces the highest profit
  2. shut down rule = check whether the most profitable positive sale quantity results in greater profit than shutting down

PROFIT MAXIMIZATION FOR PRICE-TAKING FIRMS

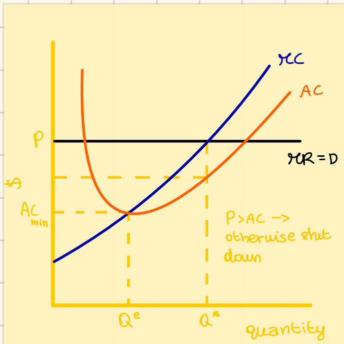
- in competitive markets firms are price takers → firms face horizontal demand curve so that $MR = P$ → to maximize profit →
  1. quantity rule = identify positive sales quantities where $P = MC$ → if this is satisfied by more than one positive sale quantity determine which produces the highest profit
  2. shut down rule = check whether the most profitable positive sale

quantity results in greater profit than shutting down

THE QUANTITY RULE



THE SHUT DOWN RULE



EXAMPLE : PROFIT MAXIMIZATION

Consider a firm with $C(Q) = 1 - 2Q + 4Q^2$, facing a price $P = 10$.

- Profit: $\pi(Q) = P \cdot Q - C(Q) = 10Q - 1 + 2Q - 4Q^2$
- Marginal revenue: $MR = P = 10$
- Marginal Cost: $MC(Q) = -2 + 8Q$
- Profits maximizing quantity at $P = MC(Q)$:

$$10 = -2 + 8Q$$
$$\Rightarrow Q^* = 3/2.$$

- Check whether profits are positive:

$$\pi(Q^*) = 10 \cdot 3/2 - 1 + 2 \cdot 3/2 - 4\left(\frac{3}{2}\right)^2 = 8 > 0.$$

- Profits are maximized at $Q^* = 3/2$ units of output.

SUPPLY FUNCTION OF A PRICE-TAKING FIRM

- the quantity a firm wants to supply at a given price $s(P)$ depends on the structure of avoidable fixed costs and variable costs ->
  1. no avoidable FC ->
     - produce as long as the price covers marginal cost incurred for each extra unit
     - supply curve equals MC curve
  2. with avoidable FC ->
     - produce as long as the price covers marginal cost and the price is higher than the average avoidable cost
     - supply curve equals MC curve only where MC > AAC and is at zero output otherwise

LAW OF SUPPLY

When the market price increases, the profit-maximizing sales quantity for a price-taking firm never decreases:
To see why, suppose $\bar{Q}$ and $\hat{Q}$ are the profit maximizing quantities at prices $\bar{P}$ and $\hat{P}$, with $\hat{P} > \bar{P}$.

$$\Rightarrow \hat{P}\hat{Q} - C(\hat{Q}) \geq \hat{P}\bar{Q} - C(\bar{Q}) \qquad (1)$$

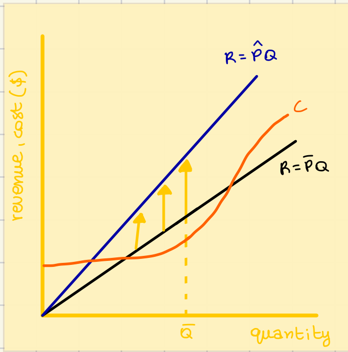
because $\hat{Q}$ is profit maximizing when $\hat{P}$, while $\bar{Q}$ is not,

$$\text{and } \bar{P}\hat{Q} - C(\hat{Q}) \leq \bar{P}\bar{Q} - C(\bar{Q}) \qquad (2)$$

by the same argument.
Subtract (2) from (1):

$$\Rightarrow (\hat{P} - \bar{P})\hat{Q} \geq (\hat{P} - \bar{P})\bar{Q}$$

$$\Rightarrow \hat{Q} \geq \bar{Q} \text{ (since } (\hat{P} - \bar{P}) > 0).$$



MARGINAL AND VARIABLE COST

- marginal costs equal the slope of the variable cost curve
- in turn variable costs equal the area under the marginal cost curve

PRODUCER SURPLUS

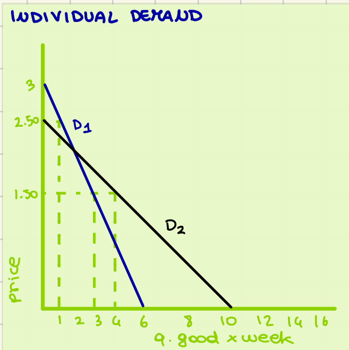
- producer surplus = revenue minus avoidable costs
- firm's profit = producer surplus minus sunk costs

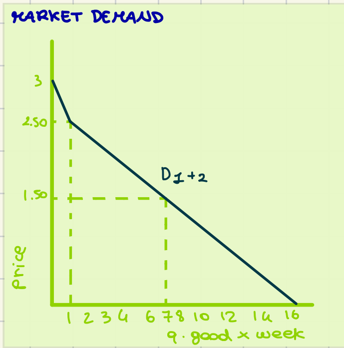
EQUILIBRIUM IN COMPETITIVE MARKETS

- individuals and firms are price takers (= they take the market price as given in deciding how much to buy or sell) if markets are competitive
- the equilibrium outcome in competitive markets is efficient -> maximization of aggregate surplus
- not competitive markets -> equilibrium outcomes may not be efficient + policy regulations can increase welfare
- market demand and supply are the sums of demands and supplies of all consumers and firms -> their curves are the horizontal sums of individual demand and supply curves

MARKET DEMAND

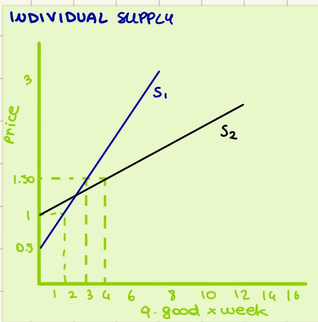
- = sum of the demands of all individual consumers -> $Q^d(p) = \sum_{i=1}^{I} Q_i^d(p)$ for individual consumers $i = 1, \dots, I$
- market demand curve = horizontal sum of individual demand curves

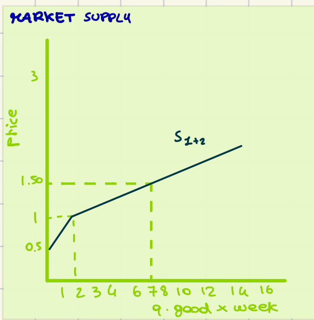




MARKET SUPPLY

- = sum of the supply of all individual consumers -> $Q^s(p) = \sum_{j=1}^{J} Q_j^s(p)$ for individual firms $j = 1, \dots, J$
- market demand curve = horizontal sum of individual supply curves

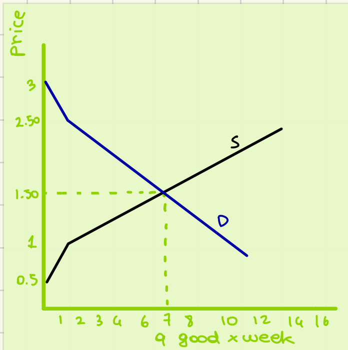




SHORT-RUN AND LONG-RUN

SHORT-RUN COMPETITIVE EQUILIBRIUM

- competitive equilibrium price = where the total quantity demanded equals the total quantity supplied -> $Q^d(P) = Q^s(P)$



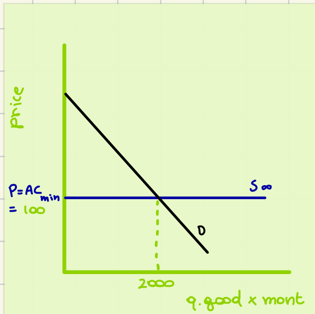
MARKET SUPPLY CURVES

- short-run supply = add up the short-run supply curves of all currently active firms
- long-run supply = add up the long-run supply curves of all potential suppliers

Free entry = technology is freely available to anyone who whishes to start a firm and entry is unrestricted (the number of potential firms is unlimited)

LONG-TIME COMPETITIVE EQUILIBRIUM WITH FREE ENTRY

- equilibrium price = AC_{min}
- firms earn 0 profit
- each active firm produces at its efficient scale of production



AGGREGATE SURPLUS

- it captures the net benefit created by the production and consumption of a good
- aggregate surplus = total benefit from consumption (tot. willingness to pay) − total avoidable cost of production or consumer surplus + producer surplus (of all firms and consumers)

PERFECT COMPETITION

IN A PERFECTLY COMPETITIVE MARKET

- buyers and sellers face no transaction costs
- products are homogeneous = identical in the eyes of the consumer
- no market power = there are many buyers and sellers each accounting for a small fraction of the overall demand or supply of the good
- buyers and sellers are price takers (prices are unaffected by them) in deciding how much to buy or sell
- no externalities = no one is not affected by the actions of others

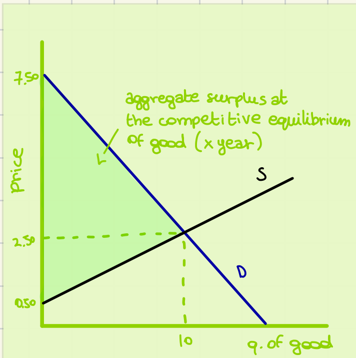
COMPETITIVE EQUILIBRIUM

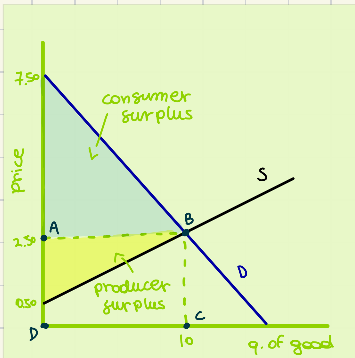
EFFICIENT WHEN the aggregate surplus achieved in a competitive equilibrium is higher than ->
- if the amount produced/consumed was changed
- if the distribution of output across firms was changed
- if the distribution of goods across consumers was changed

EFFECTS IN CHANGES
- in who consumes good
- in who produces good
- in goods produced and consumed

-> lowering aggregate surplus

DEMAND AND SUPPLY = MEASURES OF WILLINGNESS TO PAY AND AVOIDABLE COST





- units of good are consumed by those individuals with the highest willingness to pay for them -> consumers' total willingness to pay for the units they consume can be measured by the area under the market demand curve up to that quantity
- units of good are produced by the firms with the lowest avoidable cost of producing them -> firms' total avoidable cost for the units they produce can be measured by the area under the market supply curve up to that quantity

- consumer surplus = sum of consumers' total willingness to pay minus their total expenditure
- producer surplus = sum of firms' revenue minus their avoidable costs
- aggregate surplus = consumer surplus + producer surplus

EXAMPLE

consider a good with:

- market demand $Q^d = a - bP$
- market supply $Q^s = cP - d$

at a competitive equilibrium with price $P^* = \frac{a+d}{b+c}$ and quantity produced and consumed $Q^* = \frac{ac-bd}{b+c}$

aggregate welfare is given by the sum of:

- consumer surplus $CS = \left(\frac{a}{b} - \frac{a+d}{b+c}\right) \frac{ac-bd}{b+c} / 2$
- producer surplus $PC = \left(\frac{a+d}{b+c} - \frac{d}{c}\right) \frac{ac-bd}{b+c} / 2$

DEADWEIGHT LOSS

reduction in aggregate surplus below its maximum possible value

MARKET INTERVENTIONS

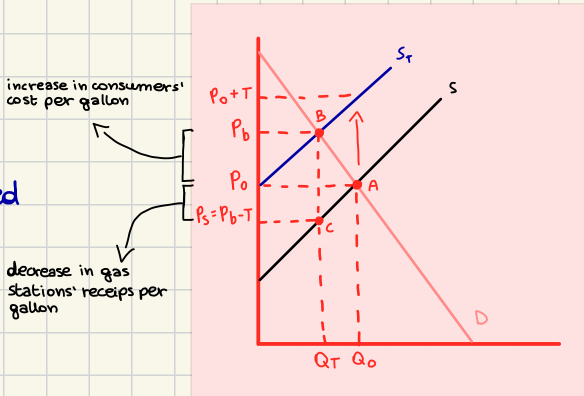
- government interventions alter market outcomes (ex. taxes, quantity regulations, etc.)
- some policies aim at revenue generation while others are implemented to re-direct market outcomes

TAXES

- governments tax goods mainly to raise the revenue needed to pay public expenditures
- types of taxes ->
  - specific tax = fixed dollar amount that must be paid on each unit bought or sold
  - ad valorem tax = stated as a percentage on the good's price

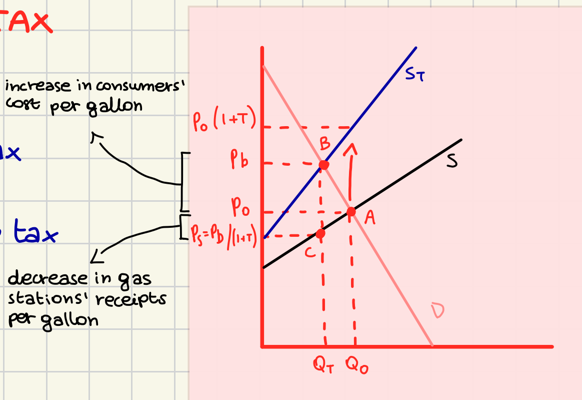
EFFECTS OF A SPECIFIC TAX

- point A = market equilibrium
- point B = increase in the price paid by consumers due to the tax
- point c = decrease in the price received by producers due to the tax



EFFECTS OF AN AD VALOREM TAX

- point A = market equilibrium
- point B = increase in the price paid by consumers due to the tax
- point c = decrease in the price received by producers due to the tax



INCIDENCE OF A TAX

- incidence = how much of the tax burden is borne by various market participants
- the incidence of a tax depends on the elasticity of a good's demand / supply
- the more inelastic one side of the market relative to the other is, the higher the share of the tax burden it has to bear

INCIDENCE OF A SPECIFIC TAX

- sellers bear the entire burden of the tax if →
  - demand is perfectly elastic
  - supply is perfectly inelastic
- buyers bear the entire burden of the tax if →
  - demand is perfectly inelastic
  - supply is perfectly elastic

for small taxes quantity traded is reduced by →

$$\frac{\Delta Q}{Q} = E^d \frac{\Delta P_b}{P_0} = E^s \frac{\Delta P_s}{P_0}$$

since

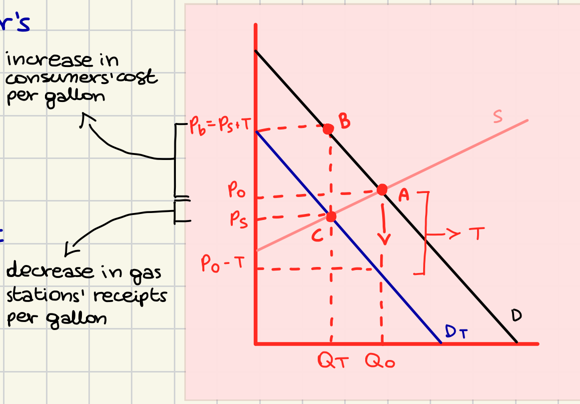
$$\Delta P_s = P_s - P_0 = P_b - T - P_0 = \Delta P_b - T$$

$$\rightarrow \Delta P_b = \frac{E_s}{E_s - E_d} T$$

the buyer's share of a specific tax T is $\frac{E_s}{E_s - E_d}$

A SPECIFIC TAX FROM A SELLER'S PERSPECTIVE : SHIFTING THE DEMAND CURVE

- point A = market equilibrium
- point B = increase in the consumer's cost due to the tax
- point C = decrease in the producer's profit due to the tax
- same incidence regardless of who is taxed by the government



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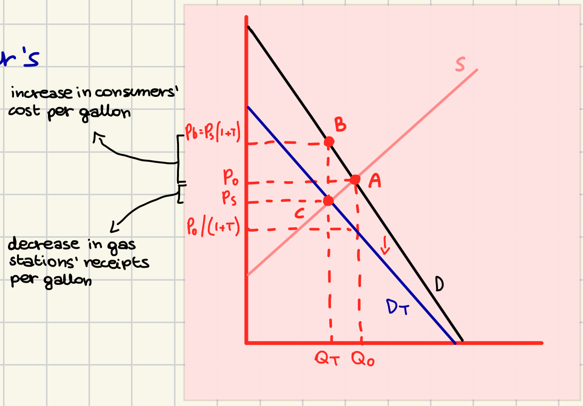
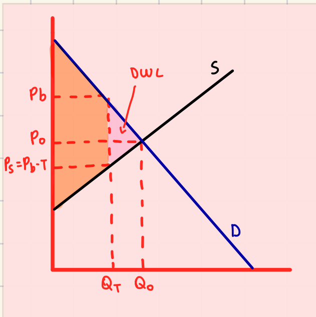
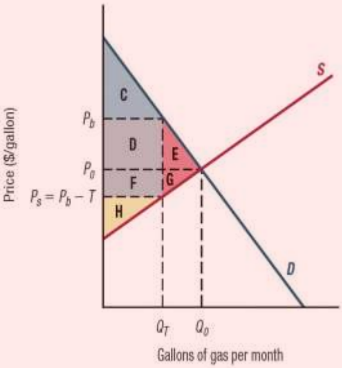


WELFARE EFFECT

DEADWEIGHT LOSS OF TAXATION

lost aggregate surplus that is the sum of →
loss in consumer surplus + loss in producer surplus



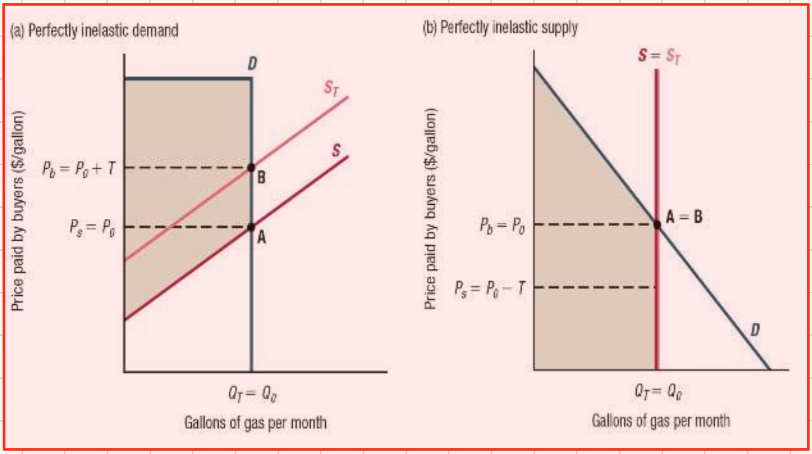


	Without tax	With tax	Gain/Loss with tax
Aggregate surplus	C + D + E + F + G + H	C + D + F + H	E + G
Consumer surplus	C + D + E	C	D + E
Producer surplus	F + G + H	H	F + G
Tax revenue	0	D + F	D + F

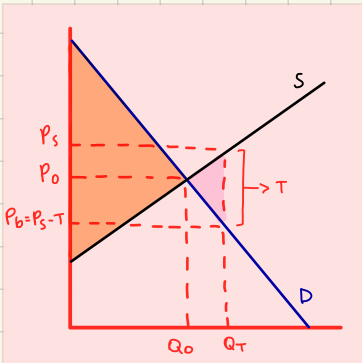
WHICH GOODS TO TAX?

- minimized loss in aggregate surplus = goods are taxed such that the deadweight loss of taxation will be low → either the demand or the supply curve is very inelastic
- caveat = demand often is inelastic for goods that are a necessity regardless of household income
- fairness considerations may conflict with aggregate surplus maximization

TAXATION WITH NO DEADWEIGHT LOSS



SUBSIDES



- subsidy = payment that reduces the amount that buyers pay for a good or increases the amount that sellers receive
- in competitive markets subsidies create deadweight loss because the cost $Q_T \times T$ to the government exceeds the gains in consumer and producer surplus

MONOPOLY

- some market structures allow firms to change a price above its marginal cost -> market power
- monopolies = only one supplier in a market (extreme structure)
- oligopoly = market with only a few sellers
- monopsony = market with a singular buyer
- governments regulate the price a monopolist can charge to prevent wellfare loss

BECOMING A MONOPOLIST

- when market competition is somehow prevented
- ownership of all of an essencial input is with one producer
- high entry costs and economies of scale create a "natural monopoly"
- other firms do not find the market profitable
- governments award long-term contracts to a single firm
- patents prevent othersellers from entering a market
- innovation and cost cutting deter market entry
- scale economies and monopoly -> it may be impossible for more than one firm to make a positive profit

MARGINAL REVENUE RECAP

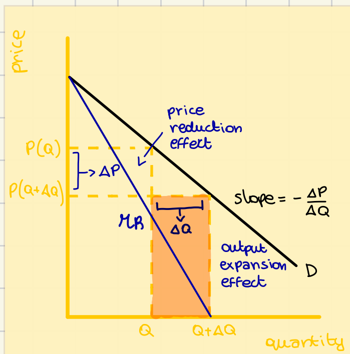
- measures the rate at which revenue rises if ΔQ additional units are sold ->

$$MR(Q) = \frac{\Delta(P(Q)Q)}{\Delta Q}$$

$$= \frac{\Delta P(Q)Q + P(Q)\Delta Q}{\Delta Q} \quad (\text{for small } \Delta Q)$$

$$= \frac{\Delta P(Q)}{\Delta Q} Q + P(Q)$$

DOWNWARD SLOPING DEMAND CURVE

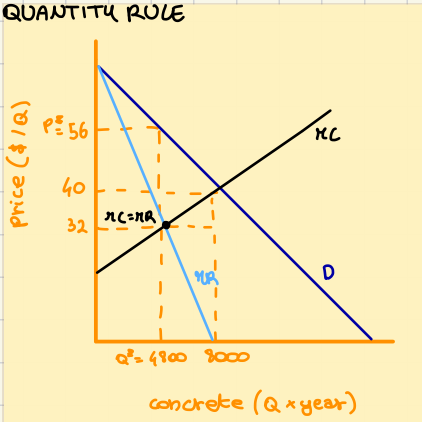


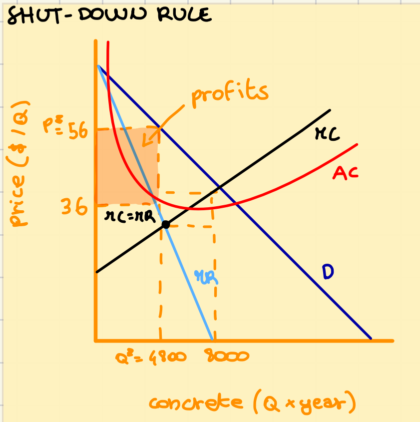
- $MR = P(Q)\left(1 + \frac{1}{E^d}\right)$ ->
  - the elasticity of demand E^d is a negative number = MR < price
  - the more elastic demand the closer marginal revenue is to the price

MONOPOLISTIC PROFIT MAXIMISATION → raise output if MR exceeds the MC

① quantity rule = identify positive sales quantities Q where $MR(Q) = MC(Q)$ → if this is satisfied by more than one positive sale quantity determine which produces the highest profit

② shut-down rule = check whether the most profitable sale quantity results in greater profit than shutting down





EXAMPLE

monopolist with →

- cost function $C(Q) = 2 + Q + \frac{1}{2}Q^2$
- facing demand $Q(P) = 10 - P$

setting $MR = MC$ →

- $MR = \dfrac{\Delta(P(Q)Q)}{\Delta Q} = \dfrac{\Delta((10-Q)Q)}{\Delta Q} = 10 - 2Q$

- $MC = \dfrac{\Delta C(Q)}{\Delta Q} = 1 + Q$

$$\Rightarrow 10 - 2Q = 1 + Q$$

$$\Rightarrow Q^* = 3 \quad P^* = 7$$

check profit → $\pi^* = P^*Q^* - C(Q^*) = 21 - 9.5 = 11.5 \geq 0$

MARKUP: A MEASURE OF MARKET POWER

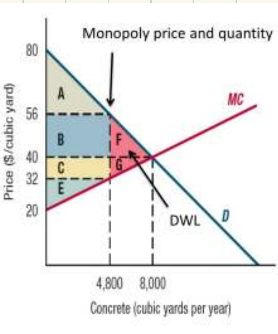
- level of market power depends on market demand
- at the profit maximizing price and quantity →

$$MR = P(Q)\left(1+\frac{1}{E^d}\right) = MC \Rightarrow \frac{P(Q)-MC}{P(Q)} = -\frac{1}{E^d}$$

→ the degree of a monopolist's market power (the extent to which its price exceeds its marginal cost)

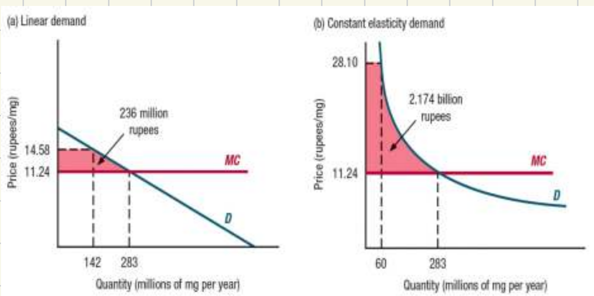
- ratio = markup/price-cost margin/Lerner index
- if $-\frac{1}{E^d} = \frac{P(Q)-MC}{P(Q)} < 1 \Rightarrow$ the profit maximising price always is at an elastic part of the demand curve ($E^d < -1$) because whenever $E^d = \frac{\Delta Q/Q}{\Delta P/P} > -1$ an increase in the price (reduction in quantity) raises profits since the gain $\Delta P \cdot Q$ is larger than the loss $-\Delta Q \cdot P$
- at inelastic parts of the demand curve a monopolist can always increase profits by raising the price

WELFARE EFFECTS OF MONOPOLY PRICING



	P = $40	P = $56
Consumer surplus	A + B + F	A
Producer surplus	C + E + G − Avoidable fixed cost	B + C + E − Avoidable fixed cost
Aggregate surplus	A + B + C + E + F + G − Avoidable fixed cost	A + B + C + E − Avoidable fixed cost
Deadweight loss	0	F + G
Area A = $57,600	Area E = $28,800	
Area B = $76,800	Area F = $25,600	
Area C = $38,400	Area G = $12,800	

WELFARE EFFECTS OF PATENT PROTECTION



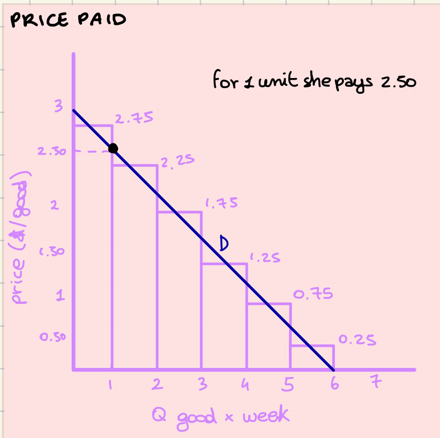
benefits of patent protection need to be weighed against welfare loss from monopolist and quantity choices

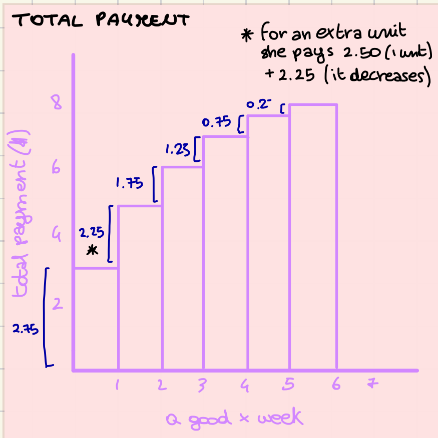
PRICING POLICIES

PRICE DISCRIMINATION

- firms can raise profits through price discrimination = when a firm charges different prices for different units of the same good
- a firm must have some market power
- consequences for consumer and aggregate welfare
- a monopolist can engage in perfect price discrimination if ->
  - a custumer's willingness to pay for each unit is known
  - the monopolist can charge a different price for each unit
- if consumers' willingness to pay is unknown (most cases it is not) firms can still discriminate based on observable characteristics

PERFECT PRICE DISCRIMINATION

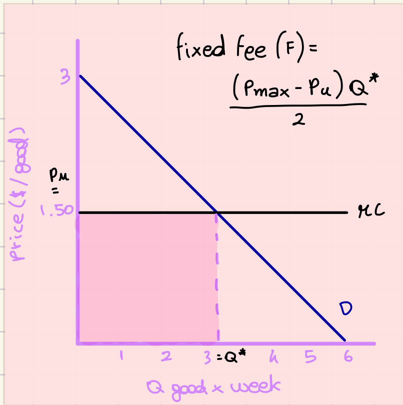




- the firm charges exactly the consumer's willingness to pay for each unit consumer surplus is reduced to zero
- producer surplus increases to the maximum amount -> aggregate surplus = aggregate surplus in a competitive market (though consumers lose out)
- marginal revenue curve = demand curve

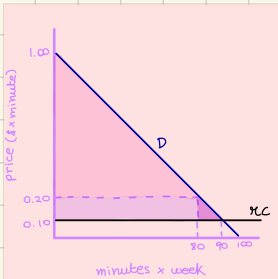
PERFECT PRICE DISCRIMINATION WITH 2 PART TARIFFS

- 2 part tariffs = consumers pay a fixed fee if they buy anything at all plus a separate per-unit price for each unit they buy
- EXAMPLE ->
  - with a per unit price of \$1.50 the demand will be 3 units
  - it leaves a consumer surplus of \$2.25
  - the consumer would be willing to pay a weekly fee of \$2.25 (and no more)



PROFIT WITH A 2 PART TARIFF AND IDENTICAL CONSUMERS

the firm can increase its profit to the maximum possible by ->
- lowering its per-minute charge from 20 to 10 cents (equal to MC)
- raising its fixed fee



OBSERVABLE CUSTOMER CHARACTERISTICS

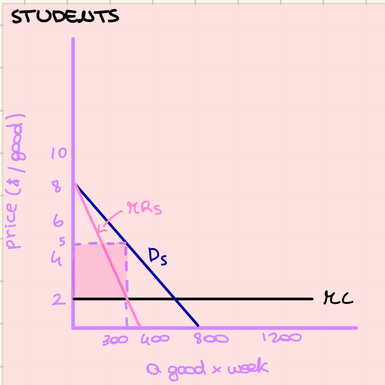
discrimination based on observable customer characteristics = when a firm can distinguish consumers with a high vs low willingness to pay

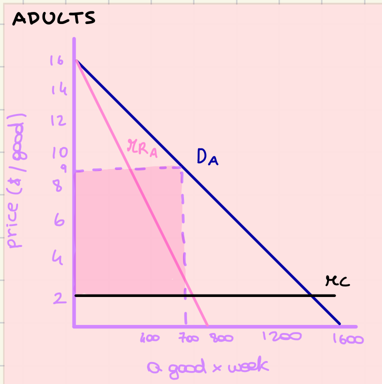
EXAMPLE (A = adults, S = students)

if $\underbrace{E_S^d < E_A^d}$ => $-\frac{1}{E_S^d} < -\frac{1}{E_A^d}$ $\underset{\text{profit max}}{=>}$ $\frac{P_S - MC}{P_S} < \frac{P_A - MC}{P_A}$ => $P_S < P_A$

students have lower income so if P↑ even a little they are likely to buy less

PROFIT MAXIMISING PRICES TO 2 GROUPS OF CONSUMERS





EXAMPLE

$P = a - bQ \Rightarrow$ revenue $= P \cdot Q = aQ - bQ^2 \Rightarrow MR = \frac{\Delta(P \cdot Q)}{\Delta Q} = a - 2bQ$

$Q_S = 800 - 100 P_S$

$Q_A = 1600 - 100 P_A$

monopolist producing with $c(Q) = 2Q \Rightarrow MC = 2$

$\Rightarrow$ inverse demand

$P_S = 8 \cdot 0.01 Q_S \rightarrow MR_S = 8 - (0.01 \cdot 2) Q_S \overset{!}{=} 2^{*} = MC$

$P_A = 16 \cdot 0.01 Q_A \rightarrow MR_A = 16 - (0.01 \cdot 2) Q_A \overset{!}{=} 2^{**} = MC$

$\Rightarrow$

$Q_S = 800 - \left(\frac{8+2}{0.02}\right)^{*} = 800 - 500 = 300 \rightarrow P_S = 5 \rightarrow \pi_S = 5 \cdot 300 - 2 \cdot 300 = 900$

$Q_A = 1600 - \left(\frac{16+2}{0.02}\right)^{**} = 1600 - 900 = 700 \rightarrow P_A = 9 \rightarrow \pi_A = 9 \cdot 700 - 2 \cdot 700 = 4900$

$\Rightarrow$ tot. profit with price discrimination on observables $\rightarrow \pi_S + \pi_A = 5800$

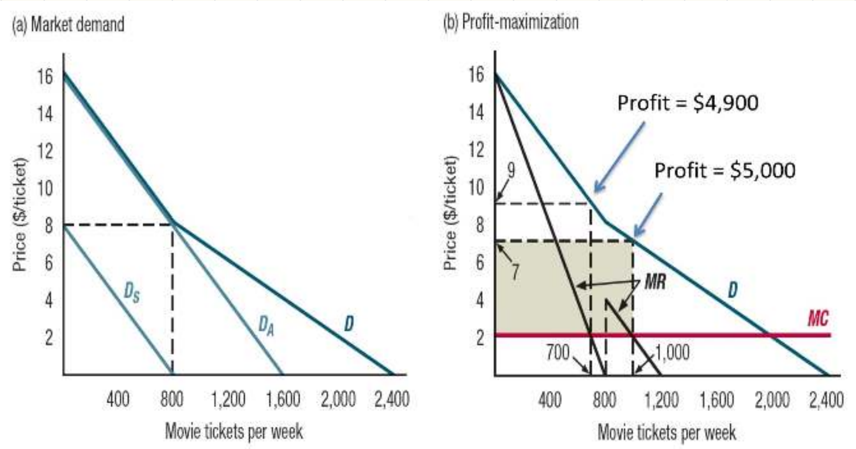
without price discrimination $\rightarrow$ market demand

$$Q = \begin{cases} 2400 - 200 \cdot P & \text{for } P \leq 8 \\ 1600 - 100 \cdot P & \text{for } P > 8 \end{cases}$$

$\Rightarrow$ inverse market demand

$$P = \begin{cases} 12 - 0.005 \cdot Q & \text{for } Q \geq 800 \\ 16 - 0.01 \cdot Q & \text{for } Q < 800 \end{cases}$$

PROFIT-MAXIMIZING PRICE WITHOUT DISCRIMINATION



GAME THEORY

- game = situation of strategic interaction –> situation in which a number of individuals make decisions and each cares both about their own choice and about others' choices (ex. negotiations)
- game theory = studies interactive decision-making where the outcome for each partecipant (or "player") depends on the actions of all –> make predictions
- economists use it to analyse strategic situations
- two types of games –>
  1. one-stage (static) game =
     - one set of decisions (each player moves only once)
     - players make choices without knowing the other players' choices (simultaneus moves)
  2. multiple stages (dynamic) game =
     - sequence of decisions
     - at least one player knows another player's choice before making their decision

NASH EQUILIBRIUM

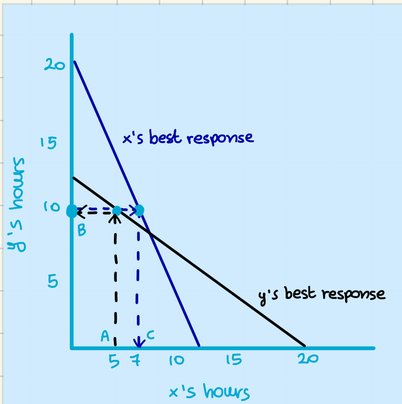
- concept by mathematician John Nash developed in 1950
- in a nash equilibrium the action played by each individual is a best response to the action played by everyone else
- combination of actions is stable

JUSTIFICATIONS FOR NASH EQUILIBRIUM

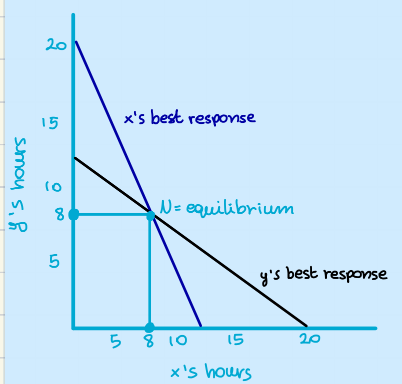
- if all players learn to make accurate guesses (through playing repeatedly) they will all play best responses to their opponents' actual decisions
- self-enforcing agreement = every party to the agreement has an incentive to abide by it (assuming others do the same)

BEST RESPONSES IN GAMES WITH FINELY DIVISIBLE CHOICES

BEST RESPONSE FUNCTION (REACTION FUNCTION) = shows the relationship between a player's best response and all other players' choices



NASH EQUILIBRIUM



EQUILIBRIUM IN THE PRISONER'S DILEMMA

- in a one-stage game actions have to be chosen before the actions of other players are observed
- each of them individually is better off squealing (even if both would be better off denying)
- both will sequeal in the equilibrium

OSKAR \ ROGER	deny	squeal
deny	-2 (Oskar), -2 (Roger)	-6 (Oskar), -1 (Roger)
squeal	-1 (Oskar), -6 (Roger)	-5 (Oskar), -5 (Roger)

roger's best responses

oskar's best responses

Nash equilibrium payoffs

STRATEGY CONCEPTS

BEST RESPONSE = an action that provides player with the highest possible payoff assuming other player behave in a hypothetical specified way

DOMINANT STRATEGY =

- a player's only best response regardless of other players' choices
- when a player has a dominant strategy they do not need to think about what other players will do

DOMINATED STRATEGIES

- = if there is some other strategy that yields a strictly higher payoff regardless of others' choices
- interative deletion of dominated strategies = the process of removing

the dominated strategies from a game ->

- remove the dominated strategies from a game
- inspect the simplified game to determine whether it contains any (new) dominated strategies -> if it does remove them
- repeat this process until there are no more dominated strategies left to remove

WEAKLY DOMINATED STRATEGIES
if there is some other strategy that yields a strictly higher payoff in some circumstances and that never yields a lower payoff regardless of others' choices

DESCRIBING A GAME

- one stage games ->
  - identify the players
  - identify the strategies available to each
  - identify each player's payoff for every possible combination of actions
- multi stage games -> same as one stage games but strategies refer to all possible plans of actions available

PERFECT INFORMATION = players make their choices one at a time and nothing is hidden from any player

BACKWARD INDUCTION = the process of solving a strategic problem by reasoning in reverse -> start at the end of the tree diagram that represents the game + work back to the beginning

OLIGOPOLY

- game theory is used to analyse what a firm's best actions are in oligopolies
- best strategies depend on the market structure
- best strategies differ the type of competition —>
  - Bertrand model = compete on prices
  - Cournot model = compete on quantities and set these simultaneously
  - Stackelberg model = compete on quantities and set these sequentially
- outcome of oligopolistic competition by applying game theory
- in a Nash equilibrium of an oligopoly market each firm is making a profit-maximising choice given the choices of its rivals

PROFITS

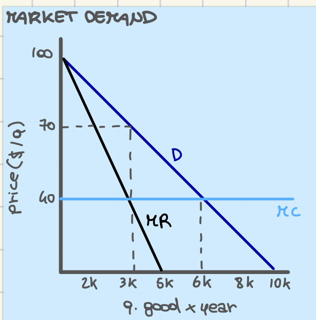
COKE \ PEPSI	high price	low price
high price	Coke 1500 / Pepsi 1500	Coke 500 / Pepsi 1700
low price	Coke 1700 / Pepsi 500	Coke 1000 / Pepsi 1000

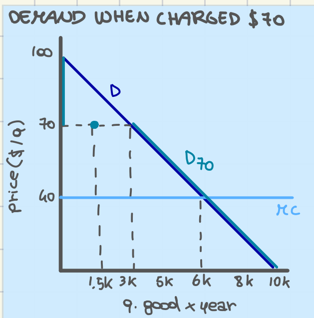
BEST RESPONSE + NASH EQ.

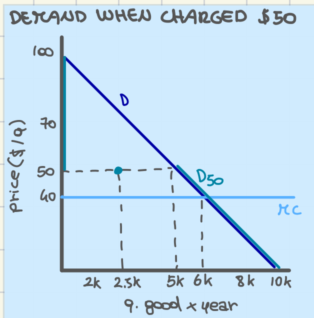
COKE \ PEPSI	high price	low price
high price	Coke 1500 / Pepsi 1500	Coke 500 / Pepsi 1700
low price	Coke 1700 / Pepsi 500	Coke 1000 / Pepsi 1000

BERTRAND MODEL

- duopoly = two sellers in the market (works the same for 2+ sellers)
- homogeneous goods = firms sell identical products
- price competition = firms choose prices (simultaneously)







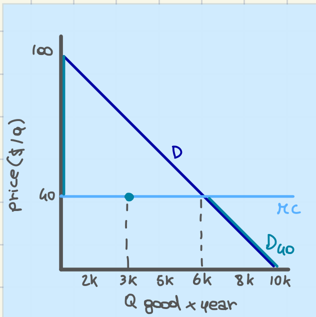
BEST RESPONSE

the best response for a firm with mc and P_{mono} for the respective market is →

- if $P_{comp} > P_{mono}$ ⇒ charge $P_{own} = P_{mono}$
- if $mc < P_{comp} \leq P_{mono}$ ⇒ charge $P_{own} = P_{comp} - \epsilon$
- if $P_{comp} \leq mc$ ⇒ charge $P_{own} = mc$

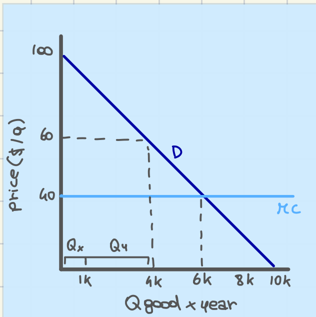
> • P_{own} = own price
> • P_{comp} = competitor's price
> • P_{mono} = monopolistic price

NASH EQUILIBRIUM



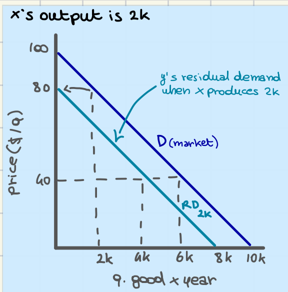
- in the Bertrand price competition model firms underbid eachother
- in equilibrium →
  - firms charge a price equal to their mc
  - firms make 0 profit
  - aggregate welfare is maximised

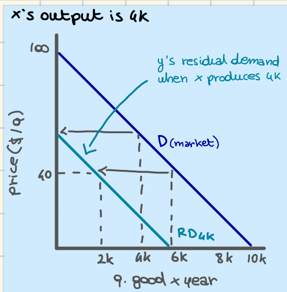
COURNOT MODEL



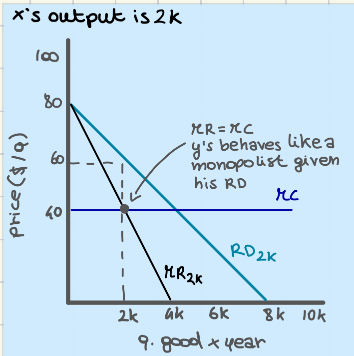
- firms simultaneously choose how much to produce
- the price clears the market given the total quantity produced

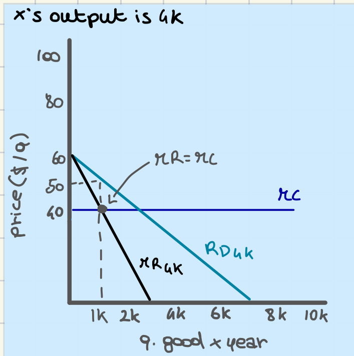
RESIDUAL DEMAND CURVE = shows the relationship between a firm's output and the market price given the outputs of the firm's rivals





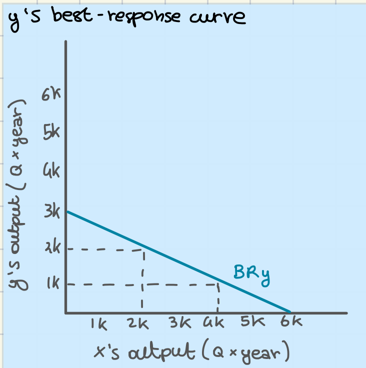
BEST RESPONSES IN THE COURNOT MODEL

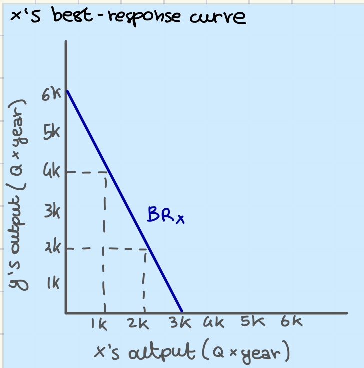


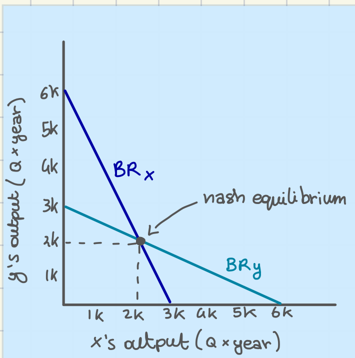


=> negative output between competitor's output and own best response

BEST-RESPONSE CURVES = show firms' best choice in response to each possible action by their rivals







NASH EQUILIBRIUM IN THE COURNOT MODEL

- each firm chooses its profit-maximising output level given its rival's output
- neither firm has an incentive to deviate from (2k, 2k)

EXAMPLE

two producers 1 and 2

unit cost c_1 and c_2

they compete on quantities in a market with $Q(P) = a - bP$

=>

- inverse market demand -> $P(Q_1 + Q_2) = \frac{a}{b} - \frac{Q_1 + Q_2}{b}$
- inverse firm demand -> $P(Q_i) = \left(\frac{a - Q_j}{b}\right) - \frac{Q_i}{b}$
- profit maximisation -> $MR_i = \frac{a - Q_j}{b} - \frac{2Q_i}{b} = c_i$
- best response -> $Q_i^*(Q_j) = (a - Q_j - bc_i)/2$
- equilibrium -> $Q_i = (a - (a - Q_i - bc_j)/2 - bc_i)/2$

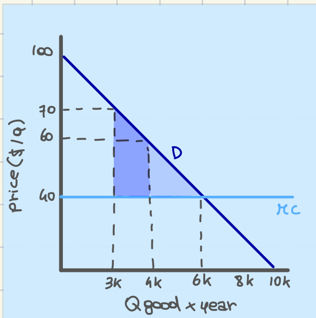
=> $Q_i^c = \frac{a + bc_j - 2bc_i}{3}$ for $i, j = 1, 2$ and $i \neq j$

equilibrium quantities -> $Q_i^c = \frac{a + bc_j - 2bc_i}{3}$, $i = 1, 2$ imply =>

- equilibrium price -> $P(Q_i^c + Q_j^c) =$
- equilibrium profits -> $\pi_i = \left(\frac{a + bc_i + bc_j}{3b} - c_i\right) \frac{a + bc_j - 2bc_i}{3} =$

$$\frac{(a + bc_j - 2bc_i)^2}{9b}$$

DEADWEIGHT LOSS



the deadweight loss in a monopoly is larger than in a duopoly because the monopoly quantity is lower and the monopoly price is higher above marginal cost than in a oligopolistic market

EQUILIBRIUM

- firms choose profit-maximising quantities given their competitors' output quantities and the resulting price is above their marginal cost
- firms can make positive profit

- aggregate welfare is lower than under price competition but higher than in a monopoly

MARKUPS

in a market with N identical firms each produces the same amount Q/N

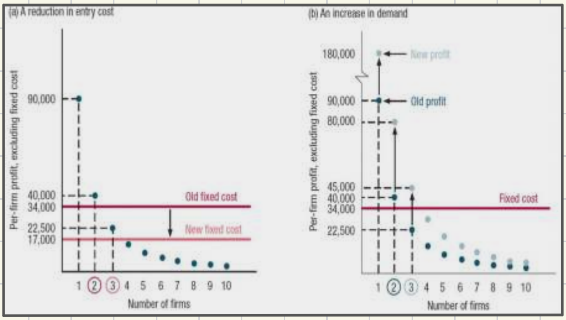
hence $MR = P + \frac{\Delta P}{\Delta Q}\frac{Q}{N}$

=> profit maximisation $MR = P + \frac{\Delta P}{\Delta Q}\frac{Q}{N} = MC$ implies a markup

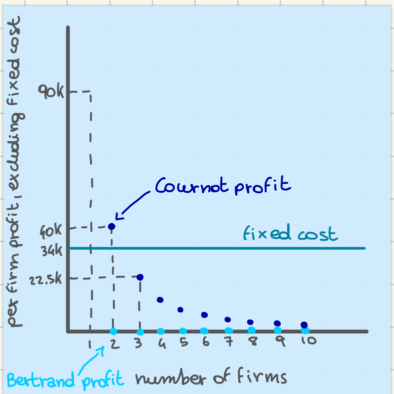
$$\frac{(P-MC)}{P} = -\frac{1}{NE^d}$$

=> the less elastic demand and the smaller the number of firms in the market, the greater the markup

FACTORS AFFECTING THE NUMBER OF FIRMS



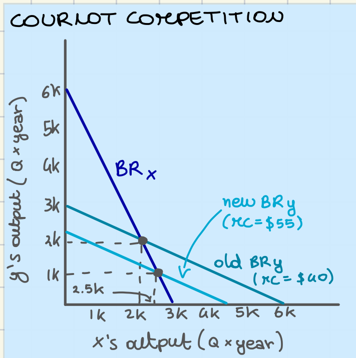
ENTRY IN THE BERTRAND VS COURNOT MARKETS



RAISING RIVALS' COSTS

own market share and profits can be increased by raising a rival's cost for example via →

- lobbying to impose regulations that favor own production technology
- lobbying to impose a tariff
- increasing the cost of a rival's inputs
- buying a lot of the supply of a critical input and not supplying it to rivals



STACKELBERG MODEL

- STRATEGIC PRE-COMMITMENT = a firm commits to certain actions before rivals take theirs with the aim of affecting rivals' later choices
- Stackelberg model of quantity competition = addresses this for a scenario where two firms choose their outputs sequentially

OUTPUT CHOICE BY A FIRST-MOVER

- sequential choices →
  1. quantity decision Q_1 by the first mover = leader
  2. quantity decision Q_2 by the second mover = follower
- find equilibrium quantities by SOLVING BACKWARD
  - step 1 = determine optimal Q_2 taking Q_1 as given: maximising $\pi_2(Q_1, Q_2) = P(Q_1, Q_2)Q_2 - C(Q_2)$ yields a best response (reaction) function $Q_2^*(Q_1)$
  - step 2 = determine optimal Q_1 anticipating $Q_2^*(Q_1)$: maximising $\pi_1(Q_1, Q_2^*(Q_1)) = P(Q_1, Q_2^*(Q_1))Q_1 - C(Q_1)$ yields an optimal Q_1^S from which $Q_2^S = Q_2^*(Q_1^S)$ can be deduced

EXAMPLE

suppose mover 1 and mover 2 with unit cost $c_1 = c_2 = c$ face market demand $Q(P) = 10 - P$

① maximise $\pi_2(Q_1, Q_2) = (P(Q_1, Q_2) - c)\, Q_2$ => profit maximisation yields best response $Q_2^*(Q_1) = (10 - Q_1 - c)/2$

② maximise $\pi_1(Q_1, Q_2^*(Q_1)) = (P(Q_1, Q_2^*(Q_1)) - c)\, Q_1$

$= \left(10 - Q_1 - \frac{10 - Q_1 - c}{2} - c\right) Q_1 = \frac{10 - Q_1 - c}{2} Q_1$ => profit maximisation yields equilibrium quantity $Q_1^S = \frac{10-c}{2}$ and thus

$Q_2^S = Q_2^*(Q_1^S) = \frac{10-c}{4}$

$Q_1^S = \frac{10-c}{2}$ and $Q_2^S = \frac{10-c}{4}$ imply ->

- equilibrium price $P^S = 10 - Q_1^* - Q_2^* = \frac{10+3c}{4}$ => lower than $P^{cournot} = \frac{10+2c}{3}$
- equilibrium profits $\pi_1^S = \left(\frac{10+3c}{4} - c\right) \frac{10-c}{4} = \frac{(10-c)^2}{16}$ => $\pi_1^S > \pi^{cournot} > \pi_2^S$

=> the leadear has a first-mover advantage

ENTRY DETERRENCE

- sufficiently expand one's output -> a firm may reduce the profit its rival foresees enough to deter them from entering the market
- the threat to increase output and cause loses to a potential entrant will only have an effect if the threat is credible

MONOPOLISTIC COMPETITION

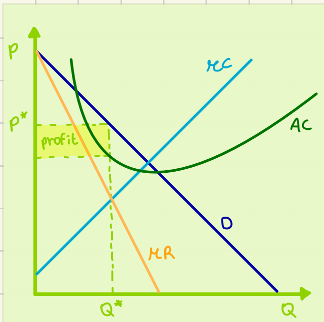
- many goods are strong substitutes yet different = differentiated goods
- if each variety of a such differentiated goods is produced by a single firm and there are many of them = monopolistic competition
- new firms and varieties may enter and exit
- ex. pasta and piadina are both good for lunch but they are not the same (not homogeneous)

MODEL OF MONOPOLISTIC COMPETITION (assumptions)

- many (small) firms = as in a perfectly competitive market
- differentiated goods = each firm sells one variety and in a monopolist for that variety
- monopolistic competition = firms choose prices or equivalently quantities (simultaneously)
- free firm entry = potentially positive profits in the short run and zero profits in the long run

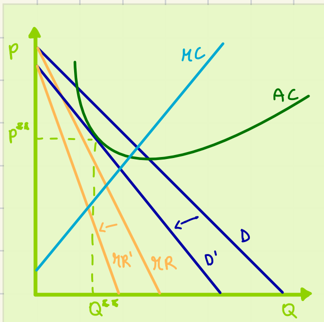
SHORT-RUN MONOPOLISTIC COMPETITION

each firm is a monopolist for its specific variety →
- firms have some market power
- firm demand curve is downward sloping in the short-run (flat in the long-run due to firm entry)
- short-run analysis the same as for a monopolist



LONG-RUN MONOPOLISTIC COMPETITION

positive profits attract new firms to the market →
- their output being substitutes shifts firm demand inwards
- lower optimal quantity and price
- profits declines and in the long-run falls to zero →
  - price = average cost
  - profit maximisation implies MC = MR



WELFARE IN MONOPOLISTIC COMPETITIONS

in the long-run equilibrium ->
- firms make zero profit
- price is above marginal cost
- units for which consumers' valuation exceeds the marginal cost of production are not produced
- there is welfare loss compared to a perfectly competitive market with homogeneous goods

EXAMPLE

suppose that
- a firm operating in a monopolistically competitive market is in a long-run equilibrium
- its inverse demand curve is $P = 50 - Q$
- its constant marginal cost is $MC = 10$
- if the firm produces an output $Q > 0$ the firm incurs (avoidable) fixed costs F

=> value of F of these fixed costs?

the firm is in a long-term equilibrium so ->
- marginal revenue must equal marginal cost so $50 - 2Q = 10$ or $Q^* = 20$
- price must be equal to the average cost at that quantity so $50 - Q = \frac{F}{Q} + 10$
- substituting $Q^* = 20$ we get $30 = \frac{F}{20} + 10$ or $F = 400$

CHOICES UNDER UNCERTAINTY AND INSURANCE

DESCRIBING RISK

- in reality many decision are taken under uncertainty with choices entailing different possible consequences
- consumers choose among risky options = lotteries ->
  - set of possible outcomes
  - probability that each outcome will be realised
  - the payoffs associated to each outcome
- outcome = possible consequence of a risky decision -> outcomes set = set of all possible outcomes
- payoff (value v) = monetary value associated to each outcome
- probability P = measure of the likelihood that a given outcome will be realised -> number between 0 and 1 (the sum of all probabilities always gives 1)
- probability distribution = measure of the likelihood that each possible outcome will be realised

LOTTERY

- = risky option
- set of outcomes each with an associated payoff and each happening with some probability
- degenerate lottery = lottery that puts probability 1 on one outcome (riskless bundle)
- expected value EV = weighted average of all possible payoffs using the probability of each payoff as its weight -> $EV = p_1 V_1 + p_2 V_2 + \dots + p_n V_n$

EXPECTED UTILITY

- when there is certainty agents choose the bundle with the highest utility
- when there is uncertainty we assume agents choose the bundle with the highest expected utility
- expected utility EU = weighted average of the utility of each consequence where the weights are the probabilities of each outcome -> $EU = \underbrace{p_1}_{\text{probability of outcome } i} \underbrace{U(V_1)}_{\text{utility that agent derives from the monetary value } V_i \text{ of outcome } i} + p_2 U(V_2) + \dots + p_n U(V_n)$

- if an agent maximises expected utility they are said to have "von Neumann-Morgenstern preferences"

EXAMPLE

if $U(x) = \sqrt{x}$ then

$EU(\text{investment}) = 0.1 \cdot \sqrt{0} + 0.7 \cdot \sqrt{10\,000} + 0.2 \cdot \sqrt{40\,000} = 110$

=>
- pays 0€ with p 0.1
- pays 10000 € with p 0.7
- pays 40000 € with p 0.2

$\Big\} \to EU(A) = 110$

to the same agent a riskless option B (degenerate lottery) paying the same expected value $EV(A) = 15\,000$ € would generate

=> $EU(B) = U(B) = \sqrt{15\,000} \approx 122.47 > EU(A)$

this agent prefers the safe option (dislikes risk)

CERTAINTY EQUIVALENT AND RISK PREMIUM

- with each lottery and an agent's utility function are associated ->
  - certainty equivalent CE = monetary payoff that if guaranteed with certainty would make the consumer as well off as with the lottery -> $U(CE) = EU(\text{lottery})$
  - risk premium (RP) = difference between its expected value and the consumer's certainty equivalent -> $RP = EV - CE$ (the amount by which a consumer is willing to reduce the expected value of a lottery to eliminate all risk

PREFERENCES TOWARD RISK

- agents have different preferences towards risk
- they can be classified according to their preferences

RISK AVERSE

- in comparing a riskless lottery to a risky lottery with the same expected value they strictly prefer the riskless one
- $U(\text{riskless lottery}) > EU(\text{lottery})$ -> for lotteries with $EV(\text{riskless lottery}) = EV(\text{lottery})$
- for a risk averse agent the CE of a lottery is always smaller than the expected value of the lottery
- the RP for a lottery is always positive
- the utility function is concave -> the greater the risk aversion

the greater the concavity

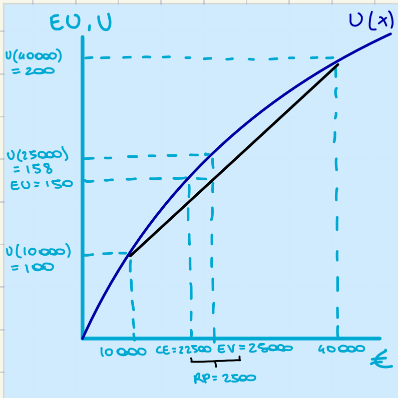
EXAMPLE

$U(x) = \sqrt{x}$ for two projects →

- risky investment option paying 10000 € with P 0.5 and 40000 € for P 0.5 ⇒ • EV(risky project) = 25000 €
  • EU (risky project) = 150
- riskless option paying V = 25000 € with certainty would yield utility ⇒ U(riskless project) = $\sqrt{25000} \approx 158$

an agent with this utility function is risk averse (prefers the riskless one = 25000 certainly > 25000 expected) →

- certainty equivalent =
  $U(CE) = \sqrt{CE} = EU = 150$ ⇒
  $CE = 22500 < EV = 25000$
- risk premium =
  $RP = 25000 - 22500 = 2500 > 0$



RISK LOVE

- in comparing a riskless lottery to a risky lottery with the same expected value they stricty prefer the risky one
- U(riskless lottery) < EU (lottery) → for lotteries with EV(riskless lottery) = EV (lottery)
- for a risk loving agent the CE of a lottery is always greater than the expected value of the lottery
- the RP for a lottery is always negative
- the utility function is convex → the greater the risk love the greater the convexity

EXAMPLE

$U(x) = (0.001x)^2$ for two jobs →

- a risky option paying 10000 € with P 0.5 and 40000 with P 0.5
  ⇒ • EV (risky job) = 25000 €
  • EU (risky job) = 850
- riskless option paying V = 25000 € with certainty would yield utility ⇒ U(riskless job) = $(0.001 \cdot 25000)^2 = 625$

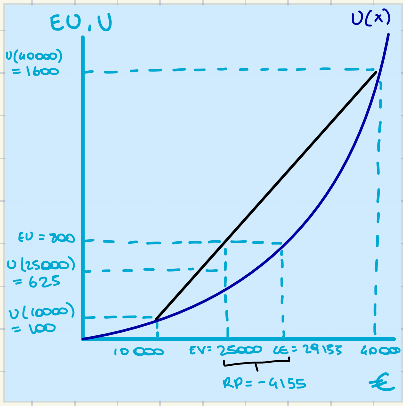
an agent with this utility function is risk loving (prefers the risky one = 25 000 expected > 25000 certainty) ->

- certainty equivalent =

  $u(CE) = (0.001 \cdot CE)^2 = EU = 850 \Rightarrow$

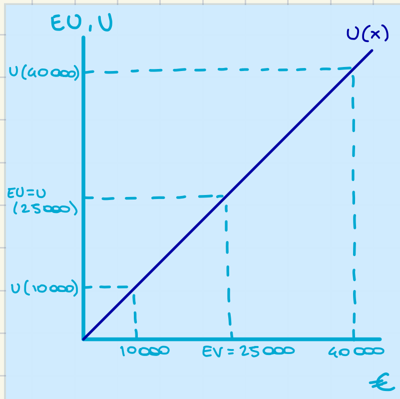
  $CE \approx 29\,155 > EV = 25\,000$
- risk premium =

  $RP \approx 25000 - 29155 = -4155 < 0$



RISK NEUTRALITY

- in comparing a riskless lottery to a risky lottery with the same expected value they are indifferent between the two options
- u(riskless lottery) = EU (lottery) -> for lotteries with EV (riskless lottery) = EV (lottery)
- for a risk neutral agent the CE of a lottery is always equal to the expected value of the lottery
- the RP of a lottery is always 0 -> utility function is linear



INSURANCE

- insurance policy = contract that at a price reduces the financial loss associated with a risky event ->
  - it specifies a benefit B (= amount the policyholder receives if the loss occurs) and a premium P (= price of the insurance)
  - full coverage if it covers the whole wealth (B = w)
- used so people can protect their wealth (w) against risky events (lotteries) by purchasing insurance policies
- assume for now that there are only two possible outcomes of a risky event -> a bad outcome (loss) with probability p and a good outcome (no loss) with probability (1-p)
- full insurance coverage turns a lottery into a riskless lottery

- having paid the premium ->
  - if a loss occures the policy holder receives the benefit for a net gain equal to the benefit minus the premium -> $B - P$
  - if a loss does not occur the consumer keeps the object and pays the premium -> value of the object $- P$
    (under full coverage the benefit equals the value of the object so the two net gains are equal)
  - agents under full insurance end up having with certainty a wealth lower than the initial w

EXAMPLE
- Daniel owns a car which he values at $W = 9000$ €
- the probability of the car being stolen is: $p = 0.1$
- this situation can be interpreted as a lottery ->
  - $p = 0.9$ => Daniel keeps the car and gets 9000 €
  - $p = 0.1$ => it is stolen and is left with 0 €
- if Daniel decides to fully insure the car and pays a premium P ->
  - in case of a robbery he has $9000 - P$ € (insurance pays)
  - in case of no robbery he has $9000 - P$ € (keeps the car)

=> the insurance turns the risky lottery into a riskless one

COMPANY SIDE: SIZE OF THE PREMIUM
- how much would an insurance company ask in order to insure an agent? -> a company decides to offer an insurance policy only if it makes non-negative expected profit (risk neutrality)
- the expected profits of an insurance company are given by =>

$$\underbrace{E\pi = P - pB - (1-p)0}$$

  - P = premium
  - p = probability of the bad outcome
  - B = benefit
- the expected profits of an insurance company are given by =>
  $E\pi = P - pB$ (the company will offer an insurance policy if $P \geq pB$
- if $P = pB$ the insurance is called actuarially fair and the premium is a fair premium
- if $P > pB$ the premium is called actuarially unfair

- under full insurance $B = w$ the value of the insured object

EXPECTED VALUE (AGENT'S PERSPECTIVE)

- expected value of the lottery with and without insurance ->
  - $EV(\text{no insurance}) = p \cdot 0.1 + (1-p) \cdot w$
  - $EV(\text{full insurance}) = w - P$
  - $EV(\text{fair full insurance}) = w - pw = (1-p)w$

=> under an actuarially fair insurance ($P = pw$) agents get for sure an amount equal to the expected value of the lottery under no insurance

- $EV(\text{unfair full insurance}) = w - P < w - pw = (1-p)w$

=> under a less than actuarially fair insurance ($P > pw$) agents get for sure an amount lower than the expected value under no insurance

AGENT'S SIDE

would an agent be willing to be insured for a premium $P \geq pB = pw$?

=> compare expected utilities with and without insurance ->

- $EU(\text{no insurance}) = p \cdot U(0) + (1-p) \cdot U(w)$
- $U(\text{insurance}) = U(w - P)$

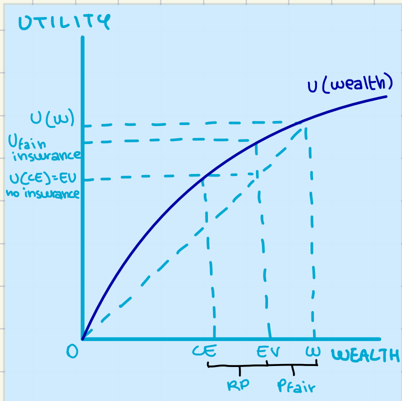
=> agent is willing to buy full coverage if $U(\text{insurance}) \geq EU(\text{no insurance})$

RISK LOVING AND RISK NEUTRAL AGENTS

- if a risk loving agent is offered an actuarially fair contract they will never choose the insurance -> $EV(\text{fair insurance}) = EV(\text{no insurance})$
  => $U(\text{fair insurance}) < EU(\text{no insurance})$
- if a risk neutral agent is offered an actuarially fair contract they are indifferent between insurance and no insurance ->
  $EV(\text{fair insurance}) = EV(\text{no insurance})$
  => $U(\text{fair insurance}) = EU(\text{no insurance})$
- neither risk loving nor risk neutral agents would buy the insurance if the premium is actuarially unfair ->
  $EV(\text{unfair insurance}) < EV(\text{no insurance})$
  => $U(\text{unfair insurance}) < EU(\text{no insurance})$

RISK AVERSE AGENTS

- if a risk averse agent is offered an actuarially fair contract they will choose full coverage →
  - the actuarially fair contract gives the expected wealth $(1-p)w$ for sure: $P = pW$
  - EV(fair insurance) = EV(no insurance) → U(fair insurance) > EU(no insurance)



- if a risk averse agent is offered an actuarially unfair contract the maximum premium they are willing to pay must leave them with the certainty equivalent of the lottery →
  - U(fair insurance) ≥ EU(no insurance) = U(CE)
  - insurance chosen if $W - P \geq CE$ → $P \leq W - CE$
  - if $P = W - CE$ then EU(no insurance) = U(unfair insurance)
  - $P \leq W - CE = pW + W - pW - CE$
    = fair premium + RP

PARTIAL LOSS

- in some cases a loss L does not amount to the full value w of an object but to loss so that $L < W$
- in that case EU(no insurance) $= p \cdot U(W-L) + (1-p) \cdot U(W)$

EXAMPLE

if with $p = 0.1$ an accident lowers the value of a car from $W = 40\,000$ to $W - L = 10\,000$ then with utility funtion $U(x) = \sqrt{x}$ expected utility becomes EU(no insurance) $= 0.1 \cdot 100 + 0.9 \cdot 200 = 190$

PARTIAL INSURANCE

- with partial insurance compensation B is less than the loss L so $B < L$
- in that case EU(no insurance) $= p \cdot U(W-L) + (1-p) \cdot U(W)$ compares to EU(insurance) $= p \cdot U(W - L + B - P) + (1-p) \cdot U(W - P)$

EXAMPLE

if in the previous example an insurance offers at a price of $P = 1975$ to pay $B = 16\,000$ in case of an accident

EU(insurance) $= 0.1 \cdot U(24\,025) + 0.9 \cdot U(38\,025) = 191$

ASYMMETRIC INFORMATION

- under perfect competition the equilibrium allocation is Pareto efficent
- perfect competition assumes perfect observability of all characteristics of goods traded
- if information is not equally available to all parties ->
  - Pareto efficiency can fail
  - market can break down
- argument not based on risk aversion (we can assume risk neutral agents)
- in reality asymmetric information between buyers and sellers is the rule rather than the exception
- examples ->
  - a company providing car insurance may know less than the driver does about the driver's skills
  - the buyer of a used car may know less than the seller does about the quality of the car
  - a bank financing an entrepreneur's project may know less about the project's profitability

EFFICIENCY LOSS

- inefficiency arises when trades that would generate surplus do not happen
- example = with too many low-ability workers around a firm may not be willing to pay an acceptable wage to workers of high unobserved ability -> even high-ability workers remain unemployed although their value to a firm exceeds the lowest wage they would be willing to accept
- inefficiency arises when trades that generate a negative surplus do happen
- example = with very few low quality cars around a buyer may be willing to pay a price that is acceptable to high-quality car owners despite not knowing -> even low-quality cars are bought although their value to the buyer is less than the price
- basic reason for market failure -> there are different goods (good of different quality) but only one price
- if all used cars look the same before they are bought this prevents

creation of two separate markets each with its own price
- no single price can simultaneously persuade high-quality sellers to trade at that price and dissuade low-quality sellers from doing so
- may lead to adverse selection with only low-quality goods being traded

EXAMPLE

1

Consider a used car market.

- Two types of cars: "lemons" and "peaches"
  - Lemon sellers accept \$1,000; buyers would pay \$1,300
  - Peach sellers accept \$2,000; buyers would pay \$2,300.
- If buyers can tell a peach from a lemon, lemons sell at \$1,000-\$1,300, peaches at \$2,000-\$2,300

  $\Rightarrow$ gains from trade are generated if buyers are well informed.

2

Let p be the fraction of peaches

$\Rightarrow$ expected value to a buyer of any car is

$$EV = 1300(1-p) + 2300p.$$

If $EV \geq 2000$, every seller can negotiate a price between \$2000 and EV (we assume risk neutral agents here)

$\Rightarrow$ all sellers gain from being in the market.

If $EV < 2000$, buyers are not willing to pay \$2000 and peach sellers exit the market

$\Rightarrow$ buyers know that only lemons are offered and pay at most \$1300.

3

Too many lemons **crowd out** peaches from the market - How many are too many?

(Risk neutral) buyers will pay \$2000 for a car only if

$$EV = 1300(1-p) + 2300p \geq 2000 \Rightarrow p \geq 0.7$$

If over 30% of all cars are lemons, the market for peaches breaks down and only lemons are traded.

4

What if there is more than two types of cars?

Suppose that

- car quality is uniformly distributed, with values to sellers between \$1,000 and \$2,000

  $\Rightarrow$ expected value to a seller is \$1,500
- any car a seller values at \$x is valued by buyers at \$(x+300).

5

- Expected value of a car to a seller is \$1500
- Expected value of any (unknown) car to a buyer is $\$(1500 + 300) = \$1800$

$\Rightarrow$ sellers who value their cars at more than \$1800 exit the market

$\Rightarrow$ expected value of remaining cars is \$1400.

6

Expected value to any remaining car to a buyer is $\$(1400 + 300) = \$1700$.

$\Rightarrow$ Sellers who value their cars at more than \$1700 exit the market...

This continues until the highest remaining car value V^H (to sellers) equals the expected value to buyers:

$$V^H = \frac{1}{2} \cdot 1000 + \frac{1}{2} \cdot V^H + 300 \Rightarrow V^H = 1600$$

$\Rightarrow$ Adverse selection drives out all cars valued by sellers at more than \$1.600.

CONTRACTING BETWEEN FIRM AND WORKER

- suppose that from a firm's point of view there are two types of workers
  → • type H = high ability
    • type L = low ability
- suppose that →
  - a worker's ability is a hidden characteristic (the worker knows it but the firm does not)
  - the firm knows that with probability $p \in (0,1)$ the worker is type H
- the worker's ability affects their productivity →
  - hiring = firm gets a revenue of 100 or 40 (depending on whether the worker is of type H or L)
    ⇒ if employing at wage w expected profits are
    $E[\pi] = p100 + (1-p)40 - w$
  - not hiring = the firm makes zero profits
    ⇒ the expected revenue of $p100 + (1-p)40$ is also the maximum wage the firm is willing to pay
- the worker's payoff from being employed is w
- if not employed they can earn 55 elsewhere
⇒ 55 is the worker's reservation wage
  the worker will not accept the job if being paid less than that
- we consider two cases → ① the worker proposes a wage to the firm which can then only accept or reject
  ② the firm proposes a wage to the worker who can then only accept or reject

WORKER'S ABILITY IS OBSERVABLE

- suppose the worker proposes a contract →
  - if the worker is of type H they will propose $w = 100$ and the firm will accept
  - if the worker is of type L any wage $w \geq 55$ will be rejected by the firm
  ⇒ type H is employed at $w = 100$, type L takes outside option with payoff 55, firm makes 0 profit
- suppose the firm proposes a contract →
  - to type H will propose $w = 55$ and $w = 40$ to type L workers
  - type H will accept while type L would reject
  ⇒ type H is employed at $w = 55$, type L takes outside option with payoff 55, firm makes profit of $\pi = 100 - 55 = 45$
- only type H will be employed

- only difference is the wage paid
- allocation is efficient in both cases → a worker is employed if and only if employment generates a positive surplus = the benefit exceeds the cost

WORKER'S ABILITY IS UNOBSERVABLE

- suppose $p = \frac{1}{2}$ = expected revenue from hiring is $p100 + (1-p)40 = 70$ →
  - any $w \geq 55$ attracts both types of workers
  - any $w < 70$ induces the firm to hire
- the worker will propose $w = 70$ while the firm will propose $w = 55$ →
  - both parties accept
  - both types are employed

  } → excessive hiring whenever $p100 + (1-p)40 > 55$ or $p > \frac{1}{4}$
- if profitability of type H is sufficiently high expected revenue is high enough for the firm to hire even though it knows that ability may turn out to be low
- inefficient because type L generates more social surplus (55 rather than 40) if working elsewhere
- consider $p < \frac{1}{4}$ = under-employment (no one is hired) →
  - suppose $p = \frac{1}{6}$ ⇒ expected revenue is $p100 + (1-p)40 = 50$ (firm is not willing to pay more than 50)
  - no $w \leq 55$ is acceptable to the worker → whichever party proposes the proposal will be rejected so neither type is employed
- if $p < \frac{1}{4}$ the probability of a hired worker being type H is too low
- the firm prefers not to hire even though its willingness to pay for a type H worker (100) exceeds the minimum acceptable wage to that worker (55)
- adverse selection problem = high-ability workers are inefficiently crowded out of the market because their opportunity cost of participating (55) is more than the firm's willingness to pay given the existing information asymmetries

⇒ ANALYSIS SO FAR

- type H payoff is 55 if firm proposes and $\max\{55; p100 + (1-p)40\}$ if worker proposes
- under perfect information a type H worker could earn up to 100 → type H worker would be better off if their type was known
- any wage acceptable for type H worker is also acceptable to type L worker (basic problem)

SIGNALING (type H worker can signal their ability)

- signals must be credible = sending it is convenient for type H but not for type L workers
- higher ability not only implies higher productivity (which firms are interested in) but also easier achievement of higher education levels
- case where worker proposes wage →
  - before proposal is made worker chooses whether to study hard for a good college degree
  - obtaining good grade entails a utility cost to the worker which is higher for type L ($c_L > c_H$)
  - suppose that studying hard does not affect productivity
- firm observes degree not ability (firm can condition hiring decision on worker's education outcome)
- if separation happens →
  - type H gets good degree but type L does not
  - firm infers ability from education outcome and pays up to 100 for good graduates (type H proposes 100 and firm accepts)
- separation happens when (assuming the worker proposes a wage) →
  - high grades must be preferable to type H
    ⇒ $100 - c_H > \max\{55; p100 + (1-p)40\}$
  - high grades are not preferable to type L
    ⇒ $100 - c_H < \max\{55; p100 + (1-p)40\}$

  → ex. if p is low so that $p100 + (1-p)40 < 55$ then separation occures if and only if $c_H < 45 < c_L$
- when signalling opportunities are available and separation happens a type H worker behaves differently from type L →
  - only type H chooses to study hard for a good degree
  - ability remains unobserved directly
  - firm can inderectly but perfectly infer the worker's ability by observing education outcomes in pre-contractual phase

  ⇒ the firm accepts a type H's proposal of 100

MORAL HAZARD

- tasks can be and often are delegated -> efficient when delegated to someone better able or in economies of scale (secialised people)
- principal (who delegates) cannot always full observe agent (to whom the task is delegated)'s chosen action -> diverging interests
- moral hazard is present when one party to a transation takes actions that a trading partner cannot observe ant that affect the benefits the partner receives from the trade

CONTRACTS

- suppose shareholders care about firm's profit manager cares about own work hours and salary
- contract tying manager's compensation to profit can incentivise manager to work hard toward high profit
- problem -> high profit doesn't only depends on manager's actions but also on external factors
  => manager's compensation is risky and if risk averse they will demand a risk premium (costly for the firm)

EXAMPLE OF MORAL HAZARD

- principal hires an agent to run a project which can either succeed and generate revenue of 100 or fail and generate revenue of 20
- agent can make high effort ($e=1$) or low effort ($e=0$) and suffers disutility (ψ) depending on e ->
  - success probability is 0.4 if $e=0$ and 0.8 if $e=1$
  - disutility is $\psi=0$ if $e=0$ and $\psi=2$ if $e=1$

  => moral hazard problem if principal observes revenue but not effort
- principal can offer contract that pays w_L if revenue is low and w_H if revenue is high ->
  - which values for $w=\{w_L, w_H\}$ maximise principal's profit $\pi(e,w)=$ revenue$(e)-w$? (principal is risk neutral meaning that profit is linear in w)
  - suppose agent's utility is $u(e,w)=\sqrt{w}-\psi(e)$ (agent is risk averse meaning that utility is concave in w)
  - suppose agent has a reservation utility of 2

- timing assumption ->
  - principal offers agent a contract $\omega = \{\omega_L, \omega_H\}$
  - agent accepts or turns down contract
  - if accepted agent decides on effort $e = \{0, 1\}$
  - revenue is realised and compensation is paid to agent

I BEST OUTCOME

- the principal can observe the agent's effort ->
  - risk averse agent = prefers fixed wage
  - risk neutral principal = indifferent between risky and fixed payments => efficient to pay fixed wage $\tilde{\omega} = \omega_L = \omega_H$
  - minimum level of $\tilde{\omega}$ for agent to exert $e = 1$ must yield $u = \sqrt{\tilde{\omega}} - 2 \geq 2$ (agent's participation constraint)
- suppose principal chooses $\tilde{\omega} = 16$ ->
  - expected profit $= 0.8 \cdot 100 + 0.2 \cdot 20 - 16 = 68$
  - maximum expected profit with $e = 0$ (requiring $u = \sqrt{\tilde{\omega}} - 0 \geq 2$ so principal chooses $\tilde{\omega} = 4$) is $0.4 \cdot 100 + 0.6 \cdot 20 - 4 = 48$ => if effort was observable principal would demand high effort and pay 16

II BEST OUTCOME

- (more realistic case) the principal cannot observe the agent's effort ->
  - at fixed compensation manager chooses $e = 0$
  - to induce agent to choose $e = 1$ requires outcome contingent contract
  - outcome partly stochastic => agent is not offered full insurance => agent must be offered a risk premium to accept contract
- agent's utility under different effort levels ->
  - $u(e=0) = 0.4\sqrt{\omega_H} + 0.6\sqrt{\omega_L} - 0$
  - $u(e=1) = 0.8\sqrt{\omega_H} + 0.2\sqrt{\omega_L} - 0$ => agent chooses high effort level if $0.8\sqrt{\omega_H} + 0.2\sqrt{\omega_L} - 2 \geq 0.4\sqrt{\omega_H} + 0.6\sqrt{\omega_L}$ or $\sqrt{\omega_H} - \sqrt{\omega_L} \geq 5$ (incentive compatibility constraint)
- optimal to minimise the variation in compensation -> choose $\sqrt{\omega_H} - \sqrt{\omega_L} = 5$ (binding constraint)
- for high effort contract must satisfy ->
  - the incentive compatibility constraint (to ensure agent's high effort if participating)

- the participation constraint under high effort $0.8\sqrt{w_H} + 0.2\sqrt{w_L} - 2 \geq 2$
  plugging in $\sqrt{w_H} = \sqrt{w_L} + 5$ yields $\sqrt{w_L} \geq 0$
  $\Rightarrow$ principal will choose $w_L = 0$ (minimising cost) and thus $w_H = 25$
  $\Rightarrow$ profit $= 0.8(100-25) + 0.2(20-0) = 64$

COMPARING I AND II BEST OUTCOMES

- profit under II best outcome is lower
- difference $(68 - 64 = 4)$ is equal to the risk premium the agent receives
- difference between $\rightarrow$ expected payment $(0.8 \cdot 25 + 0.2 \cdot 0)$ in II best case and certain payment (16) in I best case
- difference in profits is the cost of moral harzard to the principal

ASYMMETRIC INFORMATION ON CREDIT MARKET

- asymmetric information is often present in credit markets if lenders lack information about borrowers' ability to repay loans ->
  - borrowers' characteristics are unobservable to lenders = can lead to adverse selection
  - borrowers' actions are unobservable to lenders = can lead to moral hazard
- adverse selection in the credit market can lead to rationing of credit supply -> interest rate does not increase to level that equates demand and supply of credit
- credit crunch contributes to recessions -> reduction in credit that companies can obtain
- one explanation is bank's concerns about adverse selection and moral hazard

INVESTMENT EXAMPLE

- consider an entrepreneur who wants to finance a project ->
  - investment necessary is equal to 65
  - has no own money so must borrow the entire 65
  - has no other goods that could be used as collateral
  - project generates 100 if successful and 0 if it fails
- suppose contract says that ->
  - entrepreneur repays amount D to the bank
  - no more than what the project generates will be repaid (limited liability)
- suppose entrepreneur offers contract to the bank which can accept or refuse
- suppose opportunity cost of lending is exactly 65 to the bank -> it accepts the offer if expected profit is at least 65

HIDDEN CHARACTERISTICS

- suppose entrepreneur can be talented or untalented which affects success probability of project
- suppose lending bank does not observe entrepreneur's talent but knows the probability of high talent
- suppose the project is a success ->

- entrepreneur is talented = probability 0.8
- entrepreneur is not talented = probability 0.4

FIRST BEST SCENARIO

- bank observes entrepreneur type
- talented entrepreneur =>
  - would be financed as expected returns are $0.8 \cdot 100 + 0.2 \cdot 0 = 80 > 65$
  - can offer to repay $D = 81.25$ satisfying $0.8 \cdot D + 0.2 \cdot 0 = 65$
  - makes expected profit $0.8 \cdot (100 - 81.25) + 0.2 \cdot 0 = 15$ = overall expected profit of the project $(80-65)$
- untalented entrepreneur =>
  - would not be financed as expected returns are $0.4 \cdot 100 + 0.6 \cdot 0 = 40 < 65$
  - cannot offer to repay sufficiently
  - even if $D = 100$ this would in expectations not cover the loan amount of 65
- outcome = efficient ->
  - in expectations profitable entrepreneurs are financed
  - in expectations unprofitable entrepreneurs are not financed

ASYMMETRIC INFORMATION

- bank does not observe entrepreneur type
- suppose bank expects that 2/3 of entrepreneurs are of the talented type ->
  - bank expects a cash flow of $\frac{2(0.8 \cdot D + 0.2 \cdot 0)}{3} + \frac{1(0.4 \cdot 100 + 0.6 \cdot 0)}{3} = \frac{200}{3} > 65$
  - bank would approve loan to both types if offered a repayment of $D = 97.5$ in case of success satisfying $\frac{2(0.8 \cdot D + 0.2 \cdot 0)}{3} + \frac{1(0.4 \cdot 100 + 0.6 \cdot 0)}{3} = 65$
  - both types financed even though untalented type only repays $0.4 \cdot 97.5 = 39 < 65$ in expectations
  - loss compensated by talented type who now has to repay $0.8 \cdot 97.5 = 78$ in expectations
- crucial role for limited liability of the entrepreneur ->
  - project fails = they don't pay anything
  - project successful = make profit equal to $100 - 97.5 = 2.5$
- overinvestment compared to first-best scenario

MORAL HAZARD IN THE CREDIT MARKET

- arises if borrowers' actions cannot be fully observed by lenders
- can lead to riskier behaviour on side of borrowers than what lenders would like

- can lead to lower efforts on side of borrowers than what lenders would like

HIDDEN ACTIONS

- consider the same setup as before but that instead of different ability types entrepreneur can choose whether to exercise a high or low effort level —>
  - high effort = probability of success is 0.8 but effort cost to entrepreneur is 10 —> expected total payoff to (risk neutral) entrepreneur is given by expected cash flow minus effort cost that is by $80 - 10 = 70$
  - low effort = probability of success is 0.4 and effort cost to entrepreneur is 0 —> expected total payoff to (risk neutral) entrepreneur is given by expected cash flow minus effort cost that is by $40 - 0 = 40$
- condition on contract D for the entrepreneur to be induced to exert high effort is the incentive compatibility constraint => $0.8(100 - D) - 10 \geq 0.4(100 - D)$ implying $D \leq 75$
- condition on contract D for the bank to approve the loan is the participation constraint => $0.8D \geq 65$ implying $D \geq 81.25$
- incompatible so the entrepreneur will not be financed

EXTERNALITIES

- externality = when an action affects someone with whom the decision maker has not engaged in a related market transactions →
  - negative externality = when such an action harms someone else
  - positive externality = when such an action benefits someone else
- external cost = economic harm that a negative externality imposes on others
- external benefit = economic gain that a positive externality provides to others
- when externalities occur government policies can improve economic efficiency

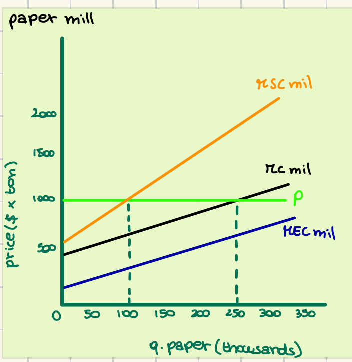
EXAMPLES

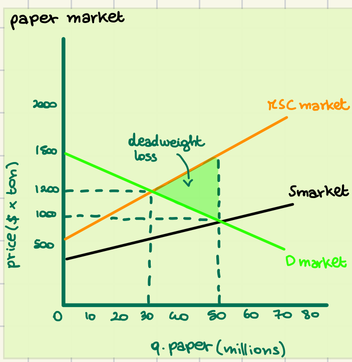
- negative externalities ⇒
  - cheap production at low environmental standards
  - plant closure that deprives supplying companies of demand for their goods and services
- positive externalities ⇒
  - vaccinations
  - training workers if skills are transferable

INEFFICIENCY IN COMPETITIVE MARKETS

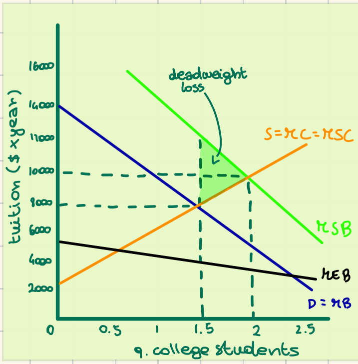
- when an externality is present the private costs and/or benefits of an activity to the party who performs it differ from the social costs and/or benefits of that activity
- consumption/production activity creates an externality → competitive markets allocate resources inefficiently (not all costs and/or benefits are taken into account by the decision maker)

COMPETITIVE EQUILIBRIUM WITH A NEGATIVE EXTERNALITY

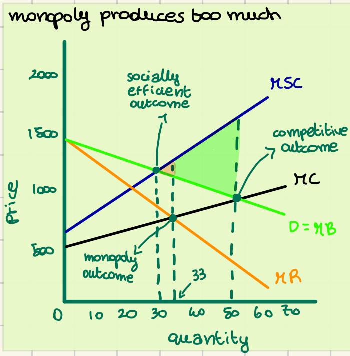


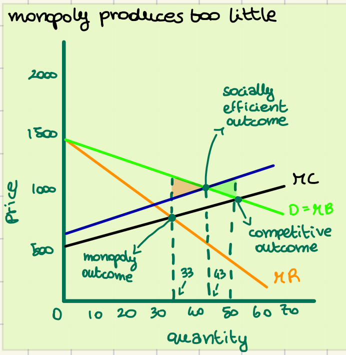


COMPETITIVE EQUILIBRIUM WITH A POSITIVE EXTERNALITY



MONOPOLY WITH A NEGATIVE EXTERNALITY





REMEDIES FOR EXTERNALITIES

- private sector → negotiation (though bargaining costs and initial allocation of property rights matters)
- public sector →
  - policies (internalise externalities)
  - taxes+fees+subsidies
  - quantity controls
  - liability rules

PROPERTY RIGHTS AND NEGOTIATION

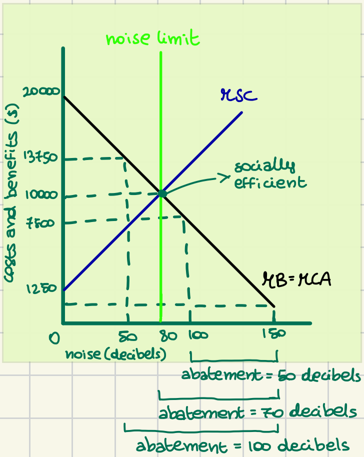
- Coase theorem = if bargaining was frictionless and property rights are fully assigned and enforced then voluntary agreements between private parties would remedy the market failures associated with externalities and restore economic efficiency

- bargaining is often not frictionless in reality
- bargaining can be impractical (substantial time and effort)
- assignment of property rights may be ambiguous
- parties may have limited information about each other's costs and benefits
- efficient contracts may be difficult to monitor and enforce

POLICES SUPPORTING MARKETS

- goverment policies can improve economic efficiency in those cases where private negotiations fail to remedy the market failures related to externalities
- governments can address externalities by helping the private sector create the necessary markets →
  - establish clear property rights (and pass laws that protect them)
  - enforce contracts
  - create and operate a market

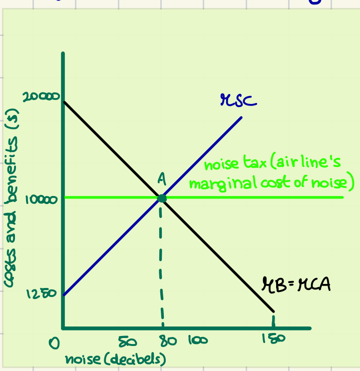
QUANTITY CONTROLS



emission standard = legal limit on the amout of noise or pollution that a person or company can produce when engaged in a particular activity

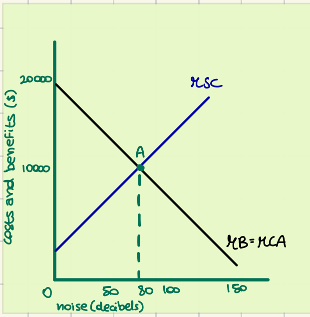
TAXES + FEES + SUBSIDIES

- pigouwian taxation = use of taxes or fees to remedy negative externalities
- pigouwian subsidisation = use of subsidies to support positive externalities
- outcome is the same as with a noise limit except that the tax generates revenues for the goverment



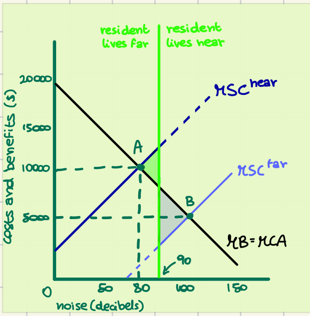
LIABILITY RULES

legal principal requiring a party who takes an action that harms others to compensate the affected parties for some or all of their losses



PITFALL FOR LIABILITY RULES AND PIGOUVIAN TAXES

efforts to correct private incentives may turn out to be inefficient if they induce the affected parties to engage in wasteful behaviours



For doubts or suggestions on the notes:

Alessandra Vitiello

+39 344 4916912

@alexxvitiello

For info about our Teaching Division:

PIETRO VILLA

+39 346 2100003

@pietro_villa__

CHIARA TUA

+39 347 9789059

@chiara_tua

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