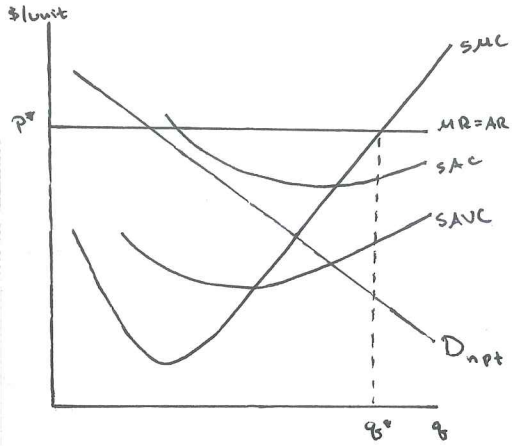
Lecture 16

Monopoly

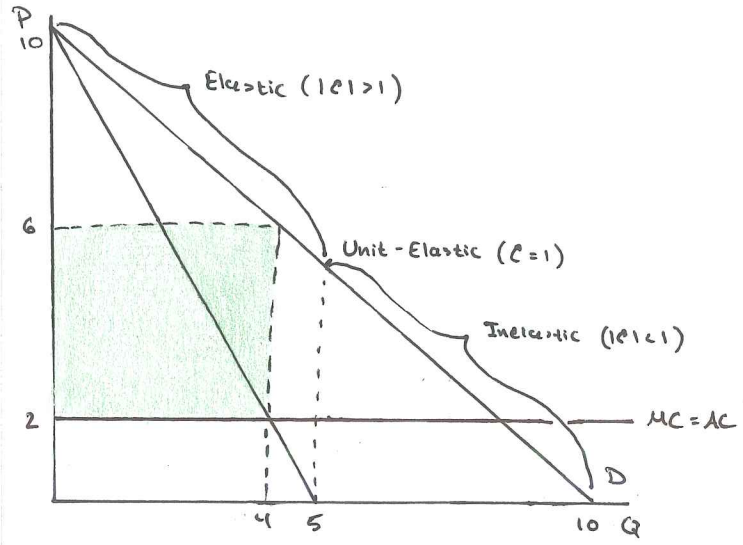
Characteristics of firms with market power:

- Are usually bigger
- Have some technical advantage over competitors
- Have a differentiable product
- Industry has legislative barriers to entry



- Price-taking firms face a perfectly elastic demand curve. They must accept the given price and will sell at the quantity where MR = MC.
- Non-price-taking firms can influence the price at which they sell goods, but because of this, they face a downward sloping demand curve. So, in order to sell more, they must lower the price.

Linear Demand Curves



Example: $D_p = 10 - P$

$Q_D = 10 - P$ $\quad P = 10 - Q$

$MR = 10 - 2Q$ (twice the slope of the demand curve)

MR = 0 at the point of unit elasticity

Maximize Profit

$MR = MC$

$MR = 10 - 2Q \quad MC = 2$

$10 - 2Q = 2$

$8 = 2Q$

$Q = 4$

Demand at $Q = 4$

$P = 10 - (4)$

$P = 6$

Revenue Maximization

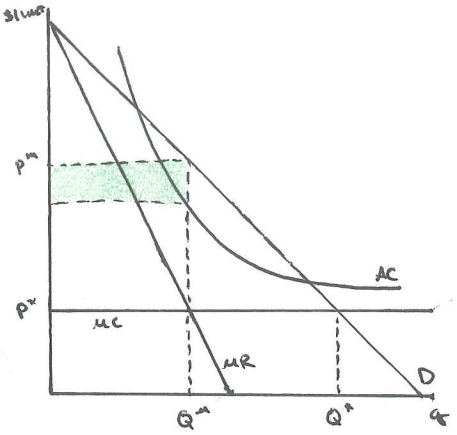
Revenue is maximized at the quantity at which MR = 0, which is the point of unit-elasticity.

Monopoly

A monopoly is a situation in which there is only a single seller of a good. These markets are unstable because of constant entrance and exits of firms. Existence requires sufficient barriers to entry.

- Technical barriers to entry include large startup costs or large and increasing returns to scale
- Sometimes, governments may create natural monopolies so that an important good is available (directly through creating a public agency and then privatizing it or indirectly through licensing a single supplier)

Natural Monopoly Example

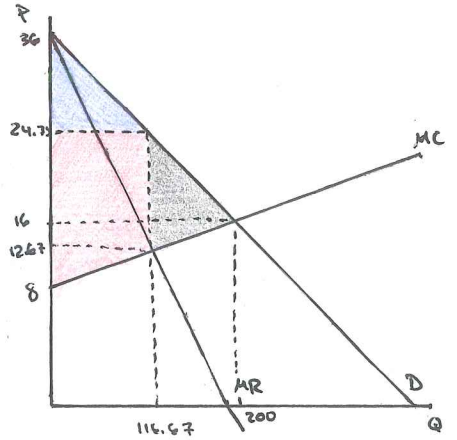


- AC is constantly declining because of massive returns to scale (which is why small firms can't compete... they make a loss at market equilibrium)
- P^*, Q^* is Competitive Equilibrium
  P^m, Q^m is Monopoly Equilibrium (where $P = MR = MC$)
- Monopoly Equilibrium price is higher and quantity is lower

- Legal Barriers to Entry: used to encourage research, innovation, and creativity. Can be in the form of licensing, patents, and trademarks, copyrights
- Ownership of a rare resource (example: De Beers Group)
- Non-Competitive Behavior: firms can collude by essentially forming one firm to maximize profits, predatory pricing by dropping price such that a firm drops out, dumping by flooding market to decrease price, rent-seeking by purchasing legislation or exploiting regulation for permission

- Downside of Monopoly:
  - Less of the good is sold at a higher price
  - Economy suffers because of lost efficiency

Surplus and Monopoly



- Note that monopolists have no supply curve because quantity supplied is a function of marginal revenue at a given price, which is based on the demand curve

Example: $MC = Q^S = 25P - 200 \rightarrow P = \frac{Q^S}{25} + 8$

$Q^D = 360 - 10P$

$MR = 36 - \frac{Q^D}{5}$

$MR = MC$

$36 - \frac{Q^D}{5} = \frac{Q}{25} + 8$

$28 = \frac{6Q}{25}$ $\quad Q = 116.67$

$P(116.67) = 24.33$

Market Equilibrium: $P = 16$ and $Q = 200$ $\quad$ MR & MC @ $Q = 116.67$ $= 12.67$

CS: $(\frac{1}{2})(116.67)(36 - 24.33) = \$680.56$

PS: $(\frac{1}{2})(116.67)(12.67 - 8) + (24.33 - 12.67)(116.67) = \$1633.33$

TS = $2313.89

DWL = 2800 - 2313.89 = $486.11

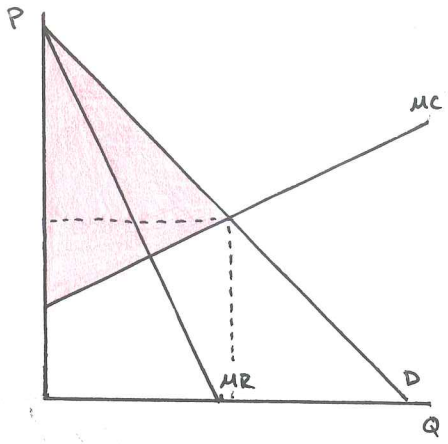
In perfect competition....

CS = $2000 and PS = $800

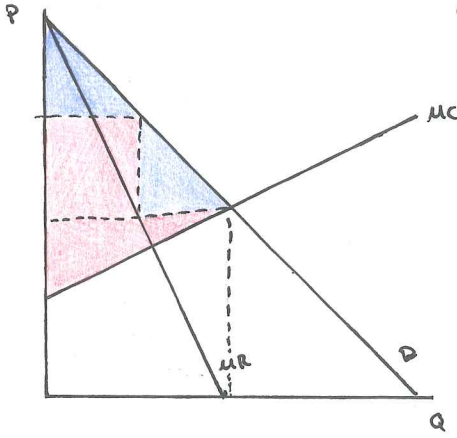
Price Discrimination

Price discrimination is when a producer charges different consumers different prices based on their individual willingness to pay.

Perfect Price Discrimination: A situation in which each customer is charged their exact willingness to pay. This results in no DWL or loss of efficiency. But, consumers are much worse off and producers are much better off.



Imperfect Price Discrimination: A situation in which different customers are charged different prices, but not perfectly. Still results in no loss of efficiency or DWL, but CS increases.



* Difficulty with price discrimination occurs because:
  - It is impossible for firms to have sufficient information to properly discern each customer's willingness to pay
  - Incentive compatability: consumers will falsely represent their true willingness to pay
  - Menu costs: it takes resources to price goods at multiple price points
  - Perceptions of unfairness from consumers

Lecture 17

Labor Supply

In the labor market, the roles of individuals and firms are reversed. Individuals now sell an output product: their labor! They are price-takers; they do not determine the wage.

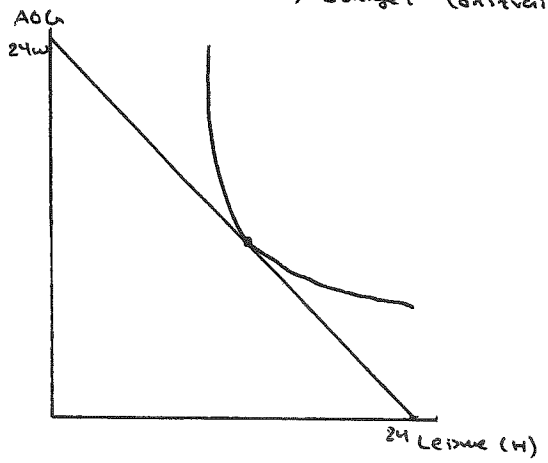
Firms consume labor; they pay the market wage and the higher the price, the less they consume.

Representing individuals through indifference curves represents the decision making process of the allocation of time between labor and leisure. (Number of hours spent working vs. not working.)

- The price of AOG is standardized to $1 (numeraire good)
- The cost of leisure is the opportunity cost of not working (= wage)
- This is the Labor-Leisure Tradeoff

- To do so, will consider labor a bad, rather than a good
- Not working (i.e. leisure) is a good
- So, individuals face a trade off between leisure and AOG (the goods the money from labor can be used to purchase)

Consumer (Individual) Budget Constraint



- Y-intercept = 24w because the most you can earn in a day is 24 x w
- X-intercept = 24 because there are 24 hours in a day
- Slope of the budget constraint = -w
- Indifference Curve represents combinations of AOG and leisure that result in the same utility
  - It is downward sloping because you need to give up leisure for consumption, and vice versa
  - Convex because the more of one good you have, the more of it you will give up for an additional unit of the other
  - Note that AOG is determined by H

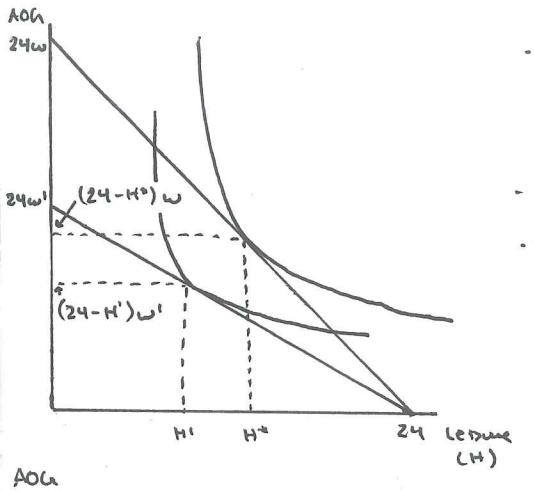
- At the optimal point, MRS = w, and it is the maximum utility that can be derived from given w

Comparative Statics

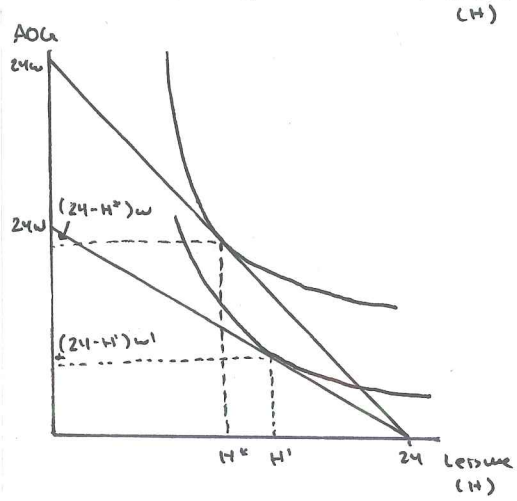
number of hours in a day

- The cost of AOG and the ~~wage~~ can't be adjusted, so the two comparative exercises that can be done are:
  1. Changes in preferences for labor-leisure tradeoff (the shape of position of indifference curve changes)
  2. Changes in the hourly wage (changes the y-intercept; the total amount of AOG that can be purchased with 24w)

Example: Wage Decrease



- Y-intercepts falls and the budget constraint shifts downwards because a lower wage decreases the total amount of AOG that can be purchased by 24w
- The slope of the new budget constraint will be $-w'$
- The new optimal point will almost certainly feature a lower level of consumption of AOG, but the change in H will be determined by the individual's preference for the labor-leisure tradeoff
- Utility will fall because the individual's income decreases and because their budget constraint shifts inward, their maximum is closer to the origin



- Alternatively, the individual could end up working less, as demonstrated here by an increase in leisure (H)
  - This would necessarily result in a lower level of consumption of AOG than in the previous section

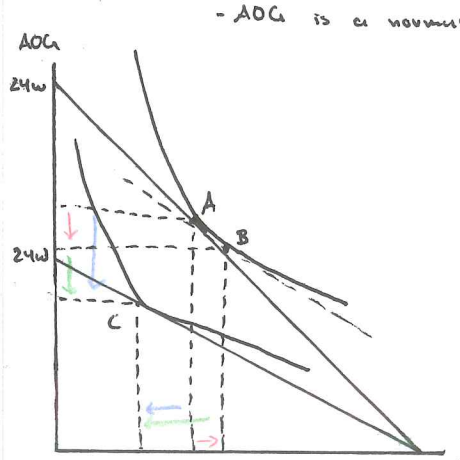
Income and Substitution Effects

When w changes, there will be both income and substitution effects for how the consumer chooses their new combination.

Substitution Effect: when w changes, the relative prices of labor and leisure change, so consumers will substitute toward that which has become relatively cheaper. ($\uparrow w, \downarrow H$) ($\downarrow w, \downarrow P_{leisure}, \uparrow H$)

Income Effect: when w changes, level of income changes. Leisure is a normal good, so changes in income will change consumption accordingly. ($\uparrow w, \uparrow H$)($\downarrow w, \downarrow H$)

- AOG is a normal good, so ($\downarrow w, \downarrow AOG$) and ($\uparrow w, \uparrow AOG$)

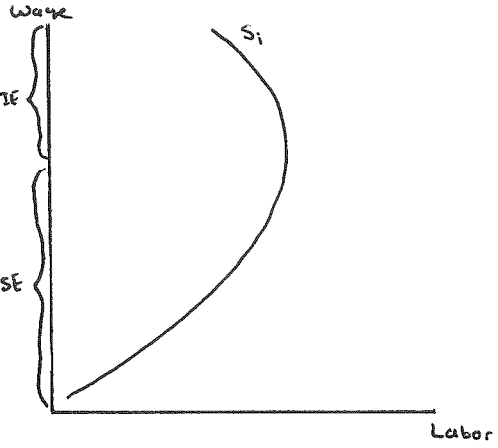


- To Model: draw a budget constraint tangent to old indifference curve and parallel to the new budget constraint.
  - Label point B, this is the SE
  - Point B to C is the IE
  - Total is the TE (A→C)

Individual Labor Supply Curve

Labor supply curve maps the response of labor to the market wage

Individuals' labor supply curve will resemble:



- Backbending supply curve that shows that at low wages, increases in wage result in increases in labor. At high wages, wage increases result in a decrease in labor.
- At low wages, the SE dominates the IE
- At high wage, the IE dominates the SE

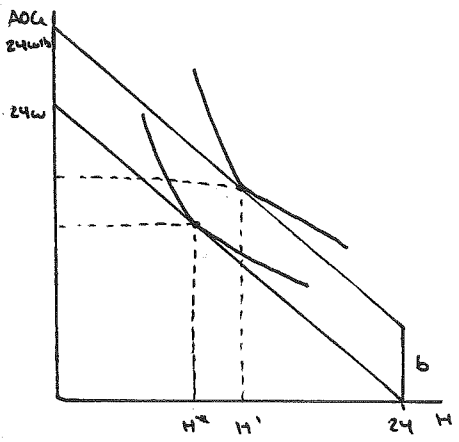
Market Labor Supply Curve

The market supply curve is the sum of all individual supply curves for potential workers in that market

- It is usually upward sloping at all wages because:
  - SE tends to dominate IE (with high wages, people substitute towards labor)
  - Wage increases bring people previously not in the market into the market
- Reservation Wage: the minimum wage that one would accept for any job
  - Employed people: market wage > reservation wage
  - Not in the labor force: market wage < reservation wage
  - Unemployed: market wage > reservation wage, but excess labor supply in the market

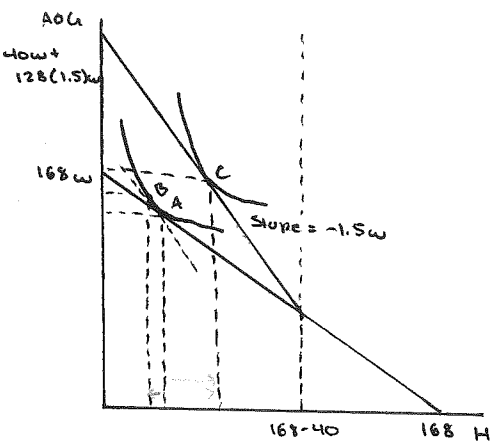
Non-Linear Budget Constraint

① Non-Labor Income



- Non-labor income is any income that is not dependent on labor
- At H=0, consumer can consume AOC=$b
- This effectively raises income, so consumer will substitute towards leisure
- Relative prices have not changed, so there is no SE and the slope of the budget constraint remains =w

② Overtime

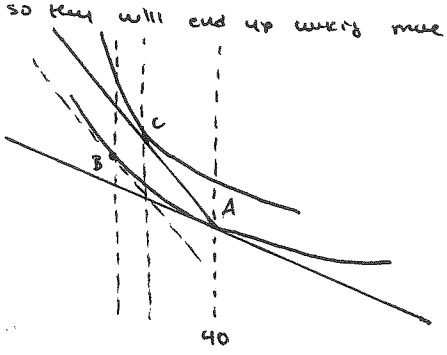


- Those who work many hours will exhibit a change. They will reduce the number of hours worked and increase consumption
- SE: price of leisure increases, so less leisure
- IE: wage increases increases income, work less
- TE: IE dominates SE

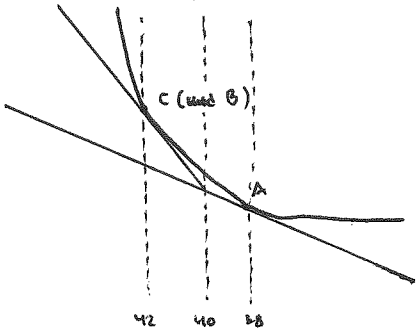
- Example: After 40 hours, consumer gets paid at 1.5 w
- After 40 hours, the budget constraint will pivot upwards to reflect both the higher wage (slope = -1.5w) and the increase in the maximum amount of AOC that can be consumed
- Those who work for below 40 hours per week will be unaffected

Overtime Continued

(2b) Those who work exactly 40 hours will have a big SE towards working more and a relatively small IE, so they will end up working more.

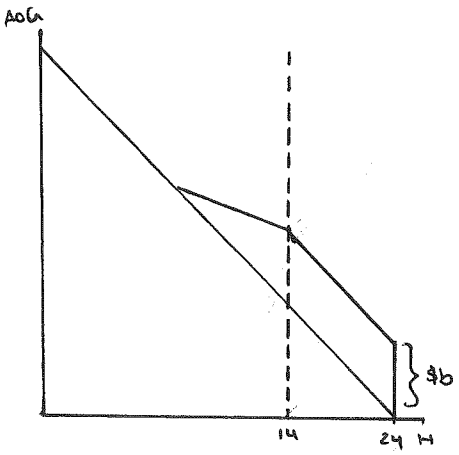


(2c) Those who work just below 40 hours per week can be indifferent between working the same and working one if their indifference curve is tangent to new budget constraint.



- If they do change, they will work more, but this change would be all SE, no IE

(3) Multiple Kinks: Social Security



- If you begin drawing on your social security at 62 while still working, your benefits are reduced by $1 for every additional $2 wage income above a certain ~~wage~~ amount of labor income
- $b represents the payment of social security
- You can work up to 14 hours per week without losing benefit. Above $ 14 hours, benefits begin to decline

Lecture 18

Labor Demand

- In the labor market, firms are consumers
- Derivation of labor demand comes from profit maximization, i.e. where MR = MC. Labor demand uses the same principle; firms should hire labor until the marginal benefit = marginal cost

Marginal Revenue Product of Labor (MRP_L)

- Defined as the additional revenue a firm makes from employing additional labor

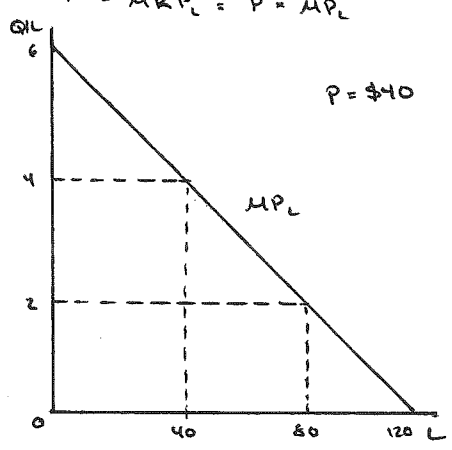
$$MRP_L = \frac{\Delta TR}{\Delta L} \equiv \frac{\Delta TR}{\Delta Q} \times \frac{\Delta Q}{\Delta L} \equiv MR \times MP_L$$

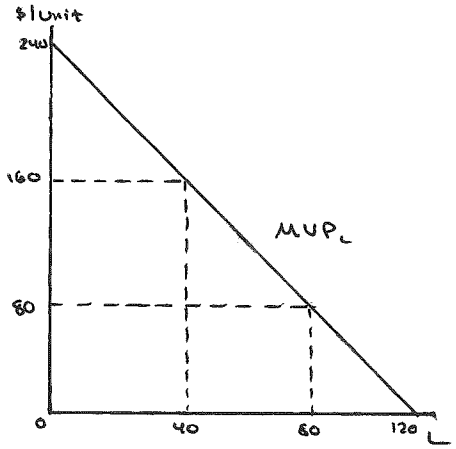
Marginal Factor Cost of Labor (MFC_L)

- Defined as the cost a firm incurs by employing an additional unit of labor
- For firms that are price-takers, MFC_L = Market Wage (w)
- So, firms should hire labor until $MRP_L = MFC_L$ (note that if: $MRP_L > MFC_L$ the firm can increase profit by employing more labor, and if $MRP_L < MFC_L$ the firm can increase profit by employing less labor)
- If firms are price-takers on both the input and output markets, then $MFC_L = w$ and $MRP = P \times MP_L$

Marginal Value Product (MVP)

MVP is used when the firm is a price-taker in the output market. $MVP = MRP_L = P \times MP_L$



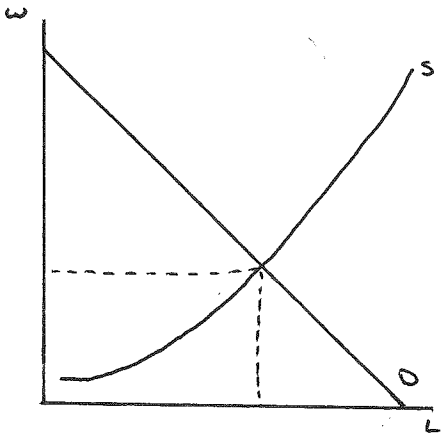


The MVP curve is the Labor Demand curve; it summarizes how much labor the firm uses at every possible market wage.

- Firms should employ labor such that $w = MVP$
- Because the firm is a price-taker on the input market, it faces a perfectly elastic labor supply curve...

$$S_L = w = MFC_L = AFC_L$$

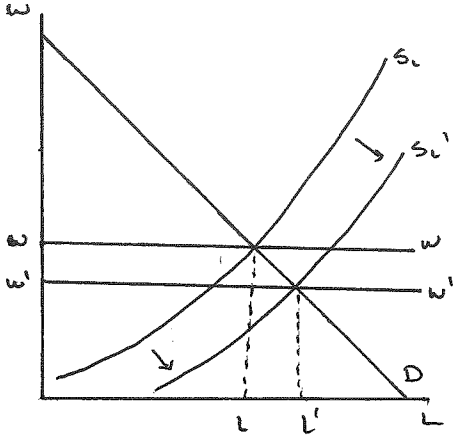
Labor Market Equilibrium



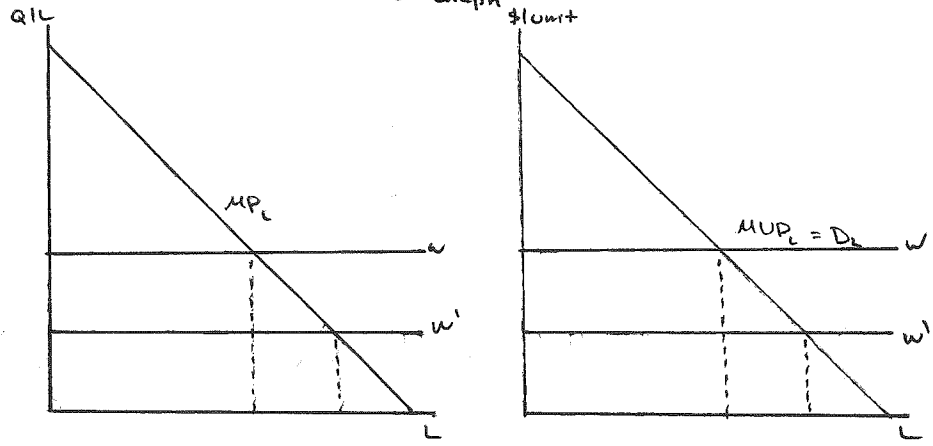
- The position of the labor demand curve is dependent upon the marginal productivity MP_L and output price P
  - D_L shifts in response to changes in output price and marginal productivity
- The position of the labor supply curve is dependent upon preferences for labor and leisure
  - S_L shifts in response to changes in preferences

Comparative Exercise: Decrease in the Market Wage

- Imagine that individuals' preference for labor/leisure change, shifting the labor supply curve out. This means preference for labor increases, preference for labor decreases, and that at any wage, individuals want to work more.



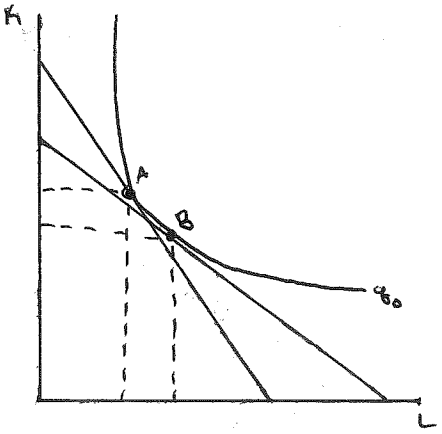
Change in Labor Demand Curve Graph



- Decrease in wages signals the firm to hire more labor because MP_L has decreased (diminishing marginal product of labor)

Long-Run changes from Decrease in Market Wage

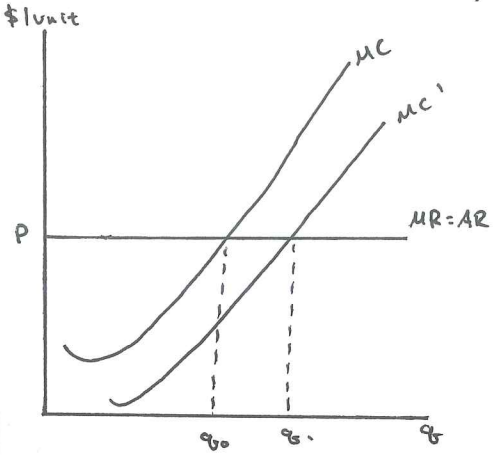
- In the long-run, both capital and labor are variable, so the firm can change input combinations. If they want to keep output quantity but change combinations, the TC cost curve would demonstrate a changed isocost and the same isoquant.



- The firm will substitute towards labor because it has become relatively cheaper in comparison to capital

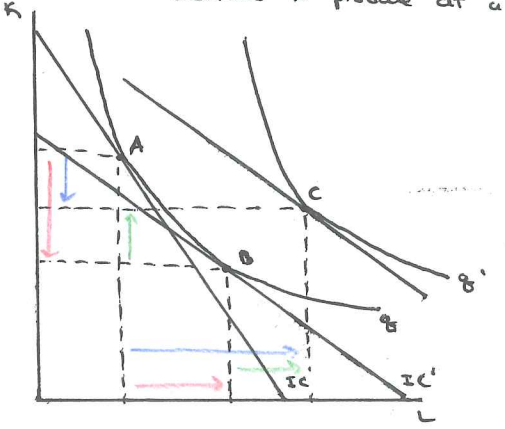
Comparative Exercise (Continued)

Because the market wage has changed, marginal costs have changed. Therefore, the profit-maximizing quantity has changed and it is unlikely the firm will want to continue producing the same quantity.



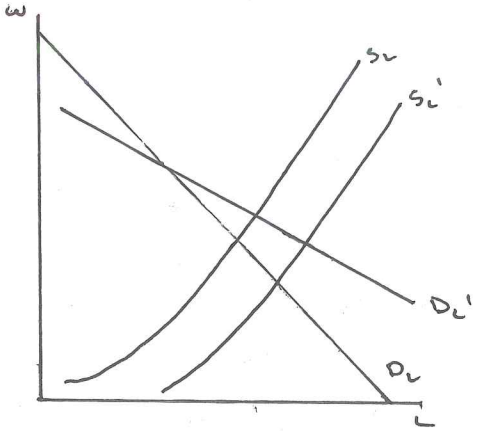
- Now, MC=MR at a higher quantity because at every quantity, you can produce at a low total cost

If the firm decides to produce at a higher quantity, isocost/isoquant dynamics change as such:



- Point A represents the original wage, output quantity, and K/L combination
- Point C represents the new wage, output quantity, and optimal K/L combination
- Point B represents the new wage, original output quantity
- Decomposition is analogous to IE, SE, & TE:
  - SE: substitution effect measures change from K to L from falling wage
  - OE: MC falls, so Q rises at identical TC, so the firm employs more of both K and L
  - TE: varies

Long-Run Labor Demand Curve



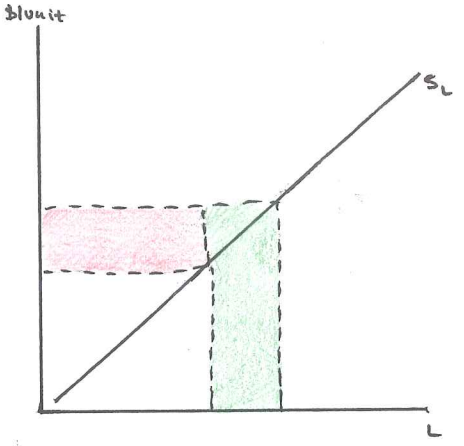
- Because all inputs are variable in the long-run, the firm will respond by employing less labor, i.e. demanding less, and will have a more elastic demand curve.

Monopsony

Monopsony is the input market equivalent of monopoly, in which there is only one buyer of an input good.

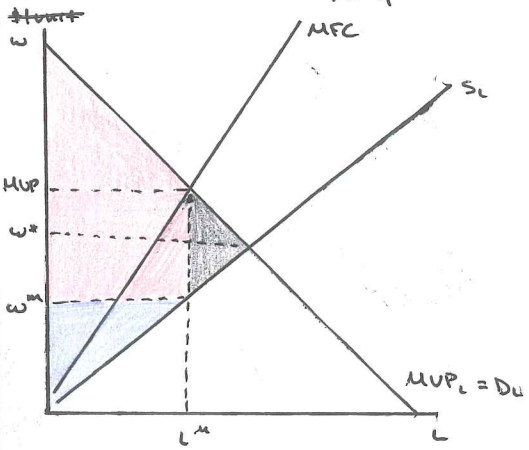
- For monopsony, hiring more labor requires increasing wages for both new and existing employees.

Therefore, monopsonies faces an upward-sloping labor supply curve.



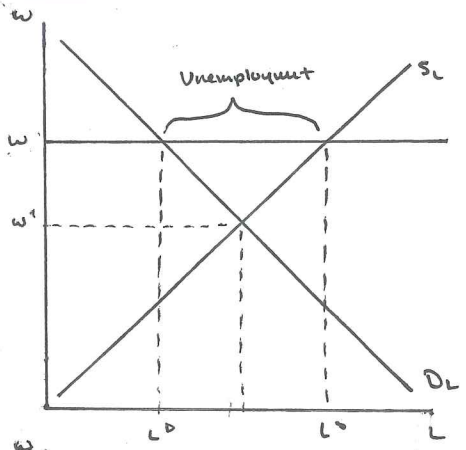
- MFC is now no longer equal to the market wage, it's higher...
  equal to twice the slope of the labor supply curve
  (similar to how MR = 2m (demand curve))

Market Wage in a Monopsony

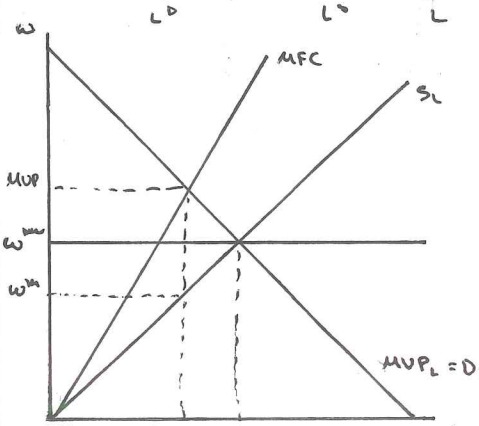


- Monopsonist will hire labor until the MFC = MVP
- But, they will only pay w^m because that is the worker's willingness to supply labor at L^m
- Both the market wage and labor quantity are lower than at competitive equilibrium. This increases the firm's surplus and results in DWL.

Minimum Wage



- Minimum wage is a kind of price floor
- This creates an excess of supply in the labor market, which causes unemployment
  (for these people, market/minimum wage > reservation wage)



- Minimum wage in a monopsony can be set above w^m and at the competitive equilibrium
- This corrects the wage and L^m back below equilibrium, and corrects inefficiency

Lecture 19: Intertemporal Optimization

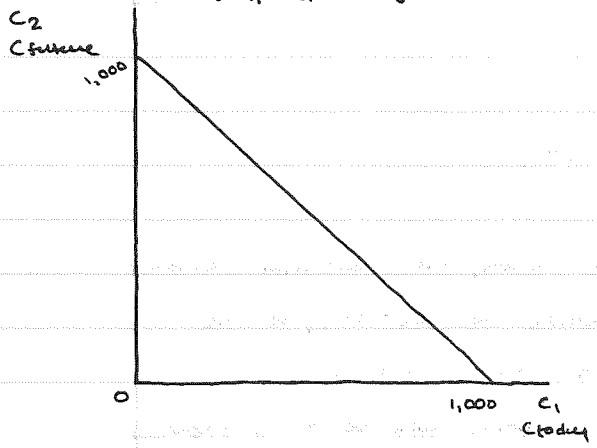
Intertemporal optimization describes the process by which individuals decide how much and when to spend. Divide income into two categories: consumption today and consumption in the future (i.e. saved money.)

$C_{today} \leq I$

$C_{future} \leq I - C_{today}$

The goal across spending is to maximize lifetime utility.

Intertemporal Budget Constraint



Example: $I = \$1000$

Slope $= -1$

Individuals have unique preferences between the trade-off of C_{today} and C_{future}; this is represented by an indifference curve.

Marginal Rate of Time Preference (MRTP): the amount of C_{future} an individual would be willing to give up for one additional unit of C_{today}.

* Is diminishing marginally

Optimal point of C_{today} vs. C_{future} is where the indifference curve is tangent to the intertemporal budget constraint. (slope here $= -1$)

Discount Rate: An individual's discount rate is the rate by which they discount the future.

"At what rate are you indifferent between income today and income tomorrow?"

$100 today = $110 future if discount rate = 10%

Present Value: a future amount's equivalent in today's dollars

(if $r = 0.1$, today's $100 invested yields $110, so $110 has a present value of $100)

Future Value: $FU = PU(1+r)^t$ where: r = discount rate

t = number of years until payment

Rearranged, $PU = \frac{FU}{(1+r)^t}$

Examples:

a) You work for 5 years with a salary of $50,000. What is the present value? ($r = 3\%$)

$$PU = 50{,}000 + \frac{50{,}000}{(1+0.03)} + \frac{50{,}000}{(1+0.03)^2} + \frac{50{,}000}{(1+0.03)^3} + \frac{50{,}000}{(1+0.03)^4} = \$234{,}850$$

Lecture 20

Externalities and Public Goods

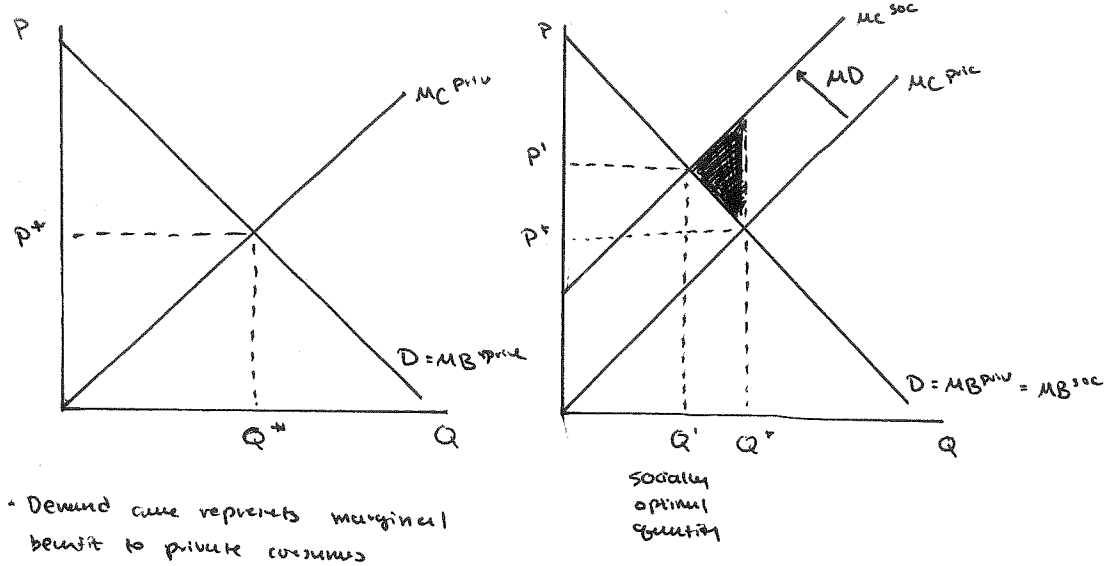
Externality: an externality occurs when one party's activities affect the welfare of another party in ways that are not taken in account by prices.

This resolves the action to be reciprocal, meaning it affects another party.

Positive: externality leads to another party benefit

Negative: externality leads to another party's detriment

Example: Negative externality (Production)



- Demand curve represents marginal benefit to private consumers
- Supply curve represents marginal cost to individual firms

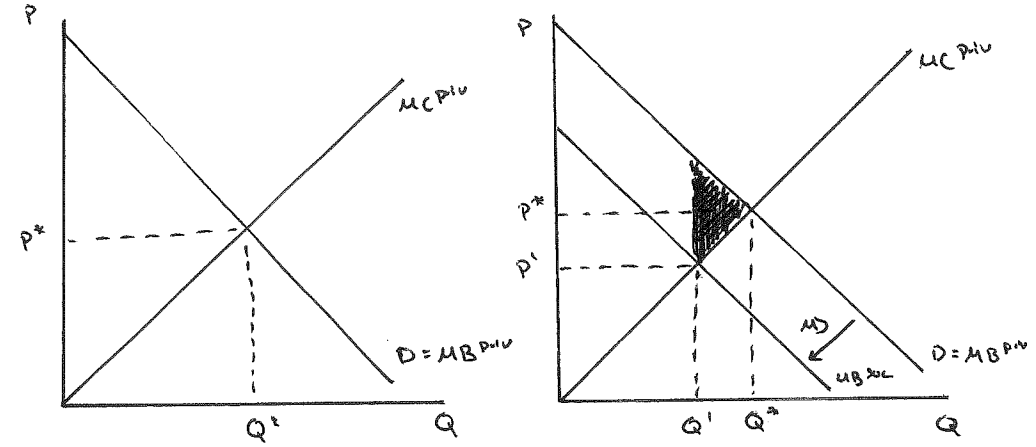
- With negative production externality, $MC^{soc} = MC^{priv} + MD$

- Note that socially optimum is lower and the price higher

*Overproduction ($Q^* > Q'$) results in DWL because transactions that shouldn't occur do

$$DWL = (\tfrac{1}{2})(Q^* - Q')(MD)$$

Example: Negative Consumption Externality



- Negative consumption externalities occur when one individual's consumption negatively impacts another's utility, leading to over consumption
- Results in DWL because transactions occur that shouldn't

*Holding out: the least victim can demand more
Free rides: the least payer receives benefits from previous payers' contributions

Solutions to Externalities

① Internalize the Externality

Externalities occur because producers / consumers don't take into account another's utility. To make them account for this, merge the perpetrator and victim, internalizing the externality.

② Coase Theorem

- One solution to internalize externalities is to assign property rights. Theorem states:

① When property rights are well-defined and bargaining is costless, the negotiations between the party creating the externality and the party affected by the externality will bring about the socially

④ The efficient solution to an externality does not depend on which party is assigned the property rights, as long as someone is assigned them rights

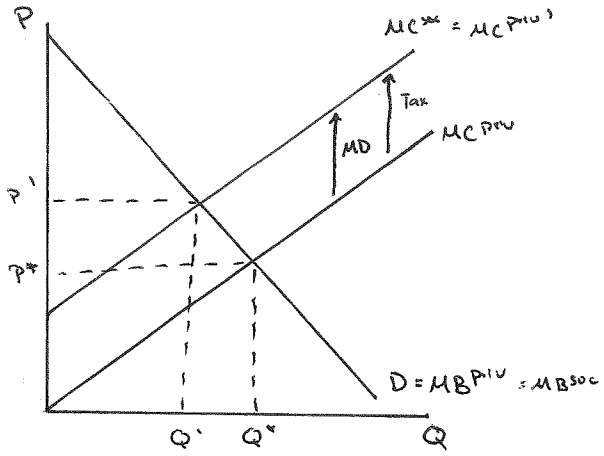
Problem: - Bargaining isn't costless (time & effort, legal fees)
- Enforcement is difficult
- Calculating damages

Public Sector Solutions to Externalities:

① Pigouvian Tax

Tax the externality producing agent at a rate equal to the marginal damage, leading production/consumption to be equal to the socially optimal amount.

$MC^{priv} = MC^{soc}$

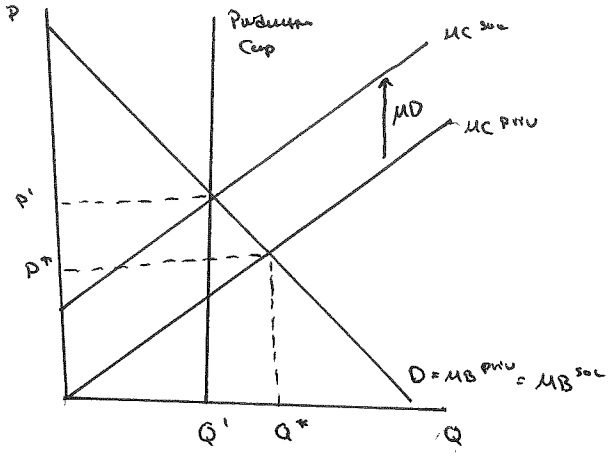


Potential Problems:

- Consumers bear some of this corrective tax
- What do you do with the revenue? Don't give to victims, usually goes to general fund

② Regulation

The government can impose regulation enforcing the quantity produced to be equal to the socially optimal quantity.



Potential Problems:

- The government would have to know the firm's costs, the cost of the externality, and Q^*
- The government must keep up with technology (if new technology reduces externality, new regulation must allow increased production)
- Firm has no motivation to reduce the cost of the externality (there would with PT)

Encouraging Positive Externalities:

- Regulation mandating the production of positive-externality producing good
- Merge: two firms that benefit from each other's production can merge and internalize positive externality
- Pigouvian Subsidy: government can give monetary incentive to those who create positive externalities
- Bargaining: two firms/groups can strike a deal to benefit each other

Public Goods

Pure Public Goods:

① Nonexclusivity: ~~one individual's~~ No one can be prevented from consuming it

② Nonrivalry: one individual's consumption of the good doesn't inhibit another's consumption

} Pure Public Goods are <u>both</u> nonexclusive and nonrivalrous

- Nonexclusive goods can be rivalrous, and nonrivalrous goods can be excludable
- A good is considered congestible if it is non-rivalrous at low utilization rates, but rival near capacity (think parking lots)

Common Definition:

- You can get it even if you don't pay for it
- One's consumption doesn't inhibit another's
- Additional consumption doesn't require paying an additional unit, thought of as having a zero cost associated with production

* Public goods induce market failure:

- No one person can extract all the benefit of a public good
- No one can restrict the use of the good by others
- Societal benefit will be greater than the benefit to any individual
- So, individuals do not take into account the societal benefit, and will only take private benefit into account
- So, public goods are underprovided, as in the positive externality case

Problem with Public Goods:

① Free Riders

Free riders are individuals who hope to consume public goods made available by the payment of others, who themselves do not pay. If individuals believe they will be held to their stated demands for public goods, they have incentive to misrepresent their true demand.

- Some governments/policy makers have attempted to develop mechanisms to discern and hold individuals to their true demand, but this is highly unrealistic
- In the case that the government can accurately assess everyone's demand, they would tax each individual as such and would then provide the socially optimal quantity.
- Realistically, peoples' demands are unclear. Also, rational and selfish consumers have incentive to misrepresent their true demand.

Solutions!:

② Compulsory Financing

- Organizations that hold some kind of power that can assist individuals can require finance in order to help

③ Tiebout Equilibrium

- One solution is to provide public goods at local levels so that people can live with those who share their preferences. If they disagree, they can move.
- Tiebout Equilibrium occurs, when in the long-run, everyone moves to a location in which their preferences match exactly (requires an infinite number of locations)

④ Other Solutions:

- Social norms
- Stigma
- Promote good publicity
- Appeal to religious/ethical values
- Attempting to exclude non-payers
- Theft
- Being annoying

*Also, charitable giving does give people a warm glow, so people donate above their demand

Lecture 21

Game Theory

- Game theory attempts to model how actors choose outcomes strategically given the actions of others
- Setup: two decision makers (players)
  each decision yields a payoff
  available choices are individual strategies

- Assumptions:
  - All players know the full rules of the game, including the other players' payoffs
  - All players are rational and flawless
  - All players are risk-neutral over payoffs

  } Result: everyone plays the best strategy, conditional on everyone else's best strategy

① Simultaneous Games
- Both players play at the same time
- They don't know what strategy the other has played until the game is over
- Normal form is a matrix of strategies/payoffs

Example: Prisoner's Dilemma
- Two suspects, both arrested, if both confess = 3 years
  one confesses = 10 & 1 years
  no one confesses = 2 years

		Avon: Confess	Avon: Silent
Strange	Confess	-3, -3	-1, -10
	Silent	-10, -1	-2, -2

- Each player's best response is dependent upon the other's choice
- If the other confesses, they should confess
- If the other stays silent, they should confess
- So, either way, they should confess

- The game is symmetric, so both will choose the reports in the same way
- Here, confessing is a Dominant Strategy: no matter the other's choice, it is the best response
  Thus, staying silent is the Dominated strategy: the non-dominant strategy
- Because the game is symmetric, both players have identical dominant strategies, and will deviate, this is a Nash Equilibrium
- It would be most ideal for each to cooperate and stay silent, this could happen if:
  ① They derive positive utility from the other's payoff
  (this violates the assumption of rational, risk-neutral, selfish actors)
  ② If there are elements of the deal the other can cut
  (this violates the assumption of complete information)
  ③ One of them makes a mistake (Trembling Hand)
  (this violates the assumption of flawless strategies)
  ↳ with some probability, the other player makes a mistake, which changes your optimal strategy
- This a scenario of a one-shot game, but, if it was a repeated game, they must cooperate. This would be assuming they were likely to get arrested again.

① Simultaneous Games (continued)

- If the prisoners' dilemma was a repeated game, they may choose to cooperate
- They may employ a Trigger Strategy: they would agree to cooperate with the condition that noone defects, which would cause the other to defect
- But, if this was played a finite number of times, cooperation wouldn't occur because each player would defect in the last round. Knowing this would lead players to defect before that, and this would happen repeatedly until it reaches the first round.

a) Calculating best response in an indefinitely-repeated game with calculated payoffs and probabilities

Payoff from staying silent forever = -2

Payoff from confessing this round = -1

Probability of another round = r

Probability of N games = r^{N-1}

- Payoff from staying silent forever = $(-2)/(1-r)$
- Payoff from confessing right now = $(-1)+(-3)(r+r^2\dots) = (-1) - 3r/(1-r)$
- So, stay silent if $-2/(1-r) > -1-3r(1-r)$

$r > \frac{1}{3}$

Example 2: Matching pennies

- Two players, each with one penny, face it up or down
  - If pennies match, Player 1 wins
  - If pennies don't match, Player 2 wins
- This is a Zero-Sum Game: one player's loss is associated with the other's loss, and total expected change in wealth = 0

Matrix:

Player 1 \ Player 2	Heads	Tails
Heads	$\underline{1}, -1$	$-1, \underline{1}$
Tails	$-1, \underline{1}$	$\underline{1}, -1$

- There is no pure strategy Nash equilibrium here
- This is a situation of mixed-strategy in which the best strategy is inconsistent
- Expected payoff = $(\frac{1}{2})(1)+(\frac{1}{2})(1)+(\frac{1}{2})(-1)+(\frac{1}{2})(-1) = 0$

- If either player deviates from $\frac{1}{2}$ tails and $\frac{1}{2}$ heads, the other player will adjust, and then they would revert to $\frac{1}{2}$ & $\frac{1}{2}$
So, there is no profitable deviation. This is a mixed-strategy Nash equilibrium.

Example 3: Battle of the Sexes

- Matt prefers grocery shopping
- Kara prefers clothes shopping

} But, they can only do one

Matt \ Kara	Grocery	Clothes
Grocery	2, 1	0, 0
Clothes	0, 0	1, 2

- Here, Matt prefers groceries if Kara chooses groceries, and clothes if Kara chooses clothes, but overall prefers groceries
- Kara prefers groceries if Matt chooses groceries, and clothes if Matt chooses clothes, but overall prefers clothes

- Here, there is no dominant strategy, but two pure strategy Nash equilibria

Best Response Functions

- Let w be the probability that Kara chooses clothes shopping, and 1-w be the probability she chooses groceries
- Let h be the probability that Matt chooses clothes shopping, and 1-h be the probability he chooses groceries
- Best response functions describe the payoff-maximizing choice for each a continuum of other players' actions

Kara's Expected Payoffs:

Kara plays groceries: $(1)(1-h) + (0)(h) = 1-h$

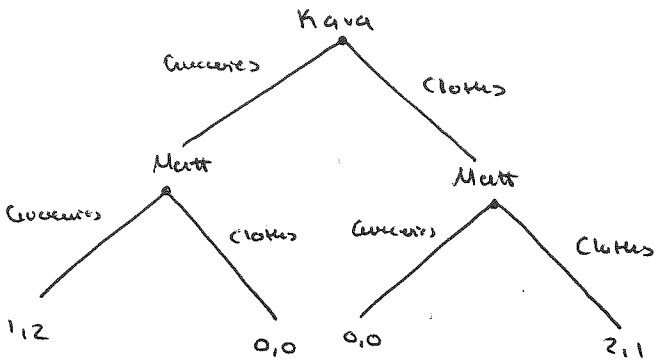
Kara plays clothes: $(0)(1-h) + (2)(h) = 2h$

② Sequential Games

Sequential games involve one player move first, then another player choosing strategy.

These games are most easily represented in Extensive Form.

Example with Battle of the Sexes':



• = Decision nodes

Kaya should use backwards induction (considering Matt's likely response) when making her initial decision she will anticipate what Matt will do, and accordingly.

- Matt's decision in each subgame are each a Nash Equilibrium, as he has no incentive to deviate
- Thus, Kaya has first mover advantage.

Lecture 22

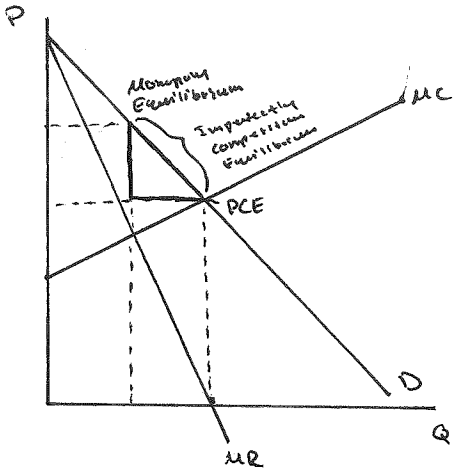
Imperfect Competition

- In reality, most markets are not perfectly competitive or monopolies
  - ↳ Imperfect Competition!

① Oligopoly

Market in which there are only a few sellers

Graphing oligopoly:



- Imperfectly competitive equilibrium is somewhere between monopoly and perfect competition
- DWL is smaller than monopoly but still in existence

$$P^{CE} < P^{IC} < P^{M}$$

$$Q^{CE} > Q^{IC} > Q^{M}$$

② Collusion

Collusion occurs when the existing firms in a market join to essentially make a functional monopoly. The resulting organization is a cartel. The will set a high price and low quantity, such that profits are maximized and then $\frac{\Pi}{n}$.

- Individual firms within a cartel face incentive to deviate and sell at lower prices under the table
- Thus, cartels should create incentive not to deviate → benchmark

③ Cournot Duopoly

- Simplest model of imperfect competition in which there are two firms who set their quantities as a function of the output quantity of the other firm
- We assume that the good is homogenous, and the firms' goods are perfect substitutes

Example: Demand: $Q = 30 - \frac{P}{2}$ Supply: Firm 1: $MC_1 = 2q_{01}$

Firm 2: $MC_2 = 4q_{02}$

To Solve: ① Find MR_1 and MR_2

② set $MR_1 = MC_1$ and $MR_2 = MC_2$ to get best response functions

③ Find q_{01} and q_{02} by finding intersection of two best response functions

④ Find $Q = q_{01} + q_{02}$ and then find P using Q

⑤ Determine profits, $\pi_i = (P - AC_i)q_{0i}$

① Find MR_1 and MR_2

Rewrite Demand Curve: $Q = 30 - \frac{P}{2}$

$P = 60 - 2Q$

$Q = q_{01} + q_{02}$

$P = 60 - 2q_{01} - 2q_{02}$

$MR_1 = 60 - 4q_{01} - 2q_{02}$

$MR_2 = 60 - 2q_{01} - 4q_{02}$

② Set $MR_1 = MC_1$ and $MR_2 = MC_2$

$MR_1 = MC_1$

$60 - 4q_{01} - 2q_{02} = 2q_{01}$

$BR_1: q_{01} = 10 - (\frac{1}{3})q_{02}$

$MR_2 = MC_2$

$60 - 2q_{01} - 4q_{02} = 4q_{02}$

$BR_2: q_{02} = 7.5 - (\frac{1}{4})q_{01}$

③ Find q_{01} and q_{02} by finding intersection

$q_1 = 10 - (\frac{1}{3})[7.5 - (\frac{1}{4})q_{01}] = 8.18$

$q_2 = 7.5 - (\frac{1}{4})[10 - (\frac{1}{3})q_{02}] = 5.45$

④ Find equilibrium price

$Q = q_{01} + q_{02}$

$Q = 13.64$

$P = 60 - 2(13.64) = 32.73$

⑤ Profits

$\pi_1 = (P - AC_1)q_{01} = \$200.8$

$\pi_2 = (P - AC_2)q_{02} = \$119.0$

Firm 1 has competitive advantage in production, and thus has higher profits

④ Bertrand Duopoly

Market situation in which there are two firms who compete on price. Their best response, as a function of the other's price, is to undercut. So is the other's, so they undercut eachother, and eventually, according to the Bertrand Paradox, they end up at a perfectly competitive equilibrium where $P = MC$.

this can be undone if one firm faces capacity constraints or if one product becomes differentiable.

⑤ Stackelberg Duopoly

Market setup similarly to Cournot duopoly, except one firm has first mover advantage. So, instead of a simultaneous game, it is a sequential game. The first mover must use backwards induction to discern best response.

$BR_1: q_1 = 10 - (\frac{1}{2})q_2$ $BR_2: q_2 = 7.5 - (\frac{1}{4})q_1$ Demand: $P = 60 - 2Q$

$P = 60 - 2(q_1 + q_2)$

$P = 60 - 2q_1 - 2(7.5 - (\frac{1}{4})q_1)$

$P = 60 - 2q_1 - 15 - \frac{q_1}{2}$

$P = 45 - \frac{3q_1}{2}$

So, $MR_1 = 45 - 3q_1$

$MR_1 = MC_1$

$45 - 3q_1 = 2q_1$

$q_1 = 9$ $BR_2: q_2 = 7.5 - (\frac{1}{4})9$ $q_2 = 5.25$

$Q' = 9 + (5.25) = 14.25$

$P' = 60 - 2(14.25) = 31.25$

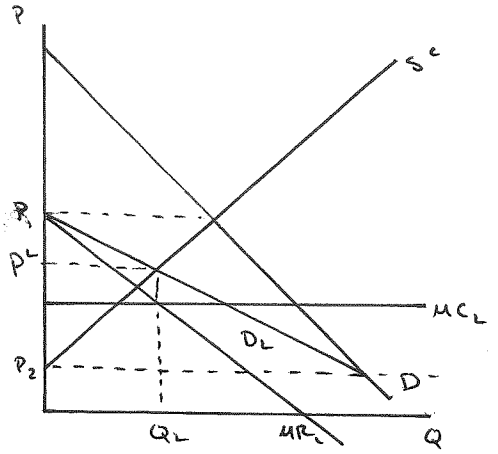
$\pi_1' = 202.5$ $(> 200.8 = \pi_1)$

$\pi_2' = 110.25$ $(< 119 = \pi_2)$

Under Stackelberg duopoly, first mover will have higher profits

⑥ Price Leadership

- Under price leadership, there's one large firm that is the market leader, and exploits its power to make profits
- There are also firms in the market ("competitive fringe") that act as price takers



- Market demand curve for homogenous good is D
- Price leader faces MC_L
  - No supply curve, similar to monopoly
- S^C is supply curve for competitive fringe
- Because of its market power, the leader faces a different demand curve, D_L
  - At P_1 the competitive firms produces entire market demand
  - At P_2 the market leader produces entire market demand
  - Line connecting the two = D_L

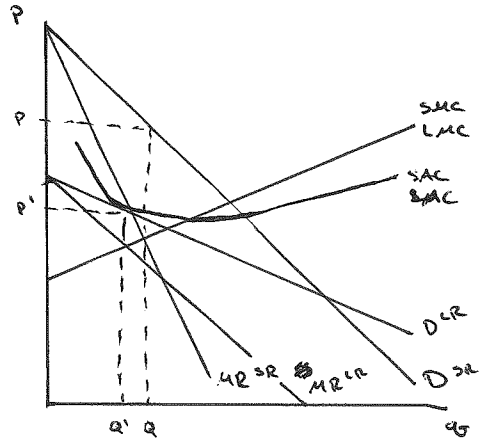
- Set up MR_L (still 2x slope of demand curve)
- Equal to $MR_L = MC_L$ at profit maximizing point where this quantity meets $D_L = P^L$

⑦ Product Differentiation

Most of our assumptions have involved homogenous products. This is both unrealistic and unattractive. Firms want to distinguish their products.

⑧ Monopolistic Competition

The most realistic model may be Monopolistic Competition.
In the short-run, firms have a differentiable product and are able to enjoy monopoly profits.
But the long-run, competitors enter the market with close substitutes.
This shifts the demand curve in (less demand for product) and makes it flatter (demand becomes more elastic)
In the long-run enough firms have entered and substitutes are close enough that profits = 0.



- In the short-run, leader can set up where $MR_{SR} = MC_{SR}$
- In the long-run, the new point where $MR_{LR} = MC_{LR}$, where P and Q are lower