Part I: Consumer theory

1. Preferences

Consumption bundle: Combination of goods/market basket. List with quantities of goods or services

Preference: Weakly/Strictly preferred / Indifferent: A >= B, A > B, A ~ B; Completeness, Transitivity,
Monotonicity: More is better than less, Goods are assumed to be *good*

Indifference curve: Consists of all bundles that correspond to the same utility level (satisfaction)

- Points on indifference curves farther from origin are preferred to those closer to origin
- There is an indifference curve through every possible bundle, <u>cannot intersect</u>

Convex: Better together. Too much of X → give up X for Y; Concave: Better separate, Not give up much X
Well-behaved preferences: Monotonic, Convex
MRS: Maximum amount of good Y consumer is willing to give up to obtain one additional unit of good X

Good: Downward sloping; **Bad**: (x is bad): Upward sloping; **Neutral** (x no effect on utility) : Slope = 0
Substitute: $U = \alpha x + \beta y$; Slope: $-\frac{\alpha}{\beta}$; **Complement**: $U = \min(\alpha x, \beta y)$; Kink: $\alpha x = \beta y = k$; Slope: $\frac{\alpha}{\beta}$
Cobb-Douglas: $U = x^{\alpha} y^{\beta}$; Indifference curve: $U = k$: $y = k^{1/\beta} x^{-\alpha/\beta}$
<u>**Quasi-linear utility function**</u>: $U(x, y) = f(x) + y$; Indifference curve: $y = k - f(x)$

2. Choice

Budget constraint: Upper boundary of budget set (all affordable consumption bundles)
$p_1 x_1 + p_2 x_2 = I$; Slope: $-\frac{p_1}{p_2}$; x-intercept: $\frac{I}{p_1}$, y-intercept: $\frac{I}{p_2}$

- Holding prices constant, an increase in oncome cannot make a consumer worse off
- Holding income constant, an increase in price will make a consumer worse off
- The slope of a budget constraint remains unchanged if P of both goods change at the same rate
- Consumers choose goods to maximize the satisfaction they can achieve, given limited budget available
  - Maximizing basket: Located on budget line; Think: For this utility, what is the least I need to pay?

Well-behaved preferences: Maximizing bundle at where budget line and indifference curve <u>tangent</u>
Perfect substitute / Concave preferences: <u>Push the utility curve inward</u> until it hits budget line (*corner*)

Solution: $MRS = -MU_x/MU_y = -p_x/p_y$, $p_x x^* + p_y y^* = I$; Cobb-douglas: $x^* = \frac{\alpha}{\alpha+\beta}\frac{I}{p_x}, y^* = \frac{\beta}{\alpha+\beta}\frac{I}{p_y}$
Equi-marginal principle: $MU_x/p_x = MU_y/p_y = \lambda$: Not equal if we are spending too much on some good

Bundle change as price of one good changes: Intercept of budget line shift!

- Price-consumption/Price-offer curve: $X: x_1, Y: x_2$
- Demand curve: $X: x_1, Y: p_1$; Every point is a utility maximizing bundle
  - Perfect substitutes: x1 originally 0 when p1 > p2. Decrease p1 to some point, x1 = Income / p1
  - Perfect complement: Intersection between "kink line" and budget line, x1 = y / (p1 + p2)
- Cross-price changes: Substitute: $\frac{dx_1}{dp_2} > 0$; Complement: $\frac{dx_1}{dp_2} < 0$; Independent: $\frac{dx_1}{dp_2} = 0$

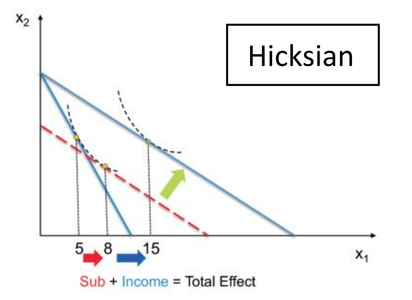
Bundle change as income changes: Parallel shift of budget line!

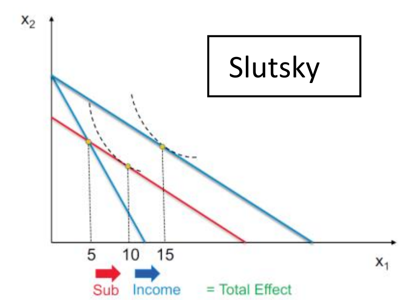
- Income-consumption curve: $X: x_1, Y: x_2$
- Engel curve: $X: x_2, Y: I$; Income elasticity of demand: $\frac{\Delta Q/Q}{\Delta I/I}$, Normal: $\epsilon_i > 0$; Inferior: $\epsilon_i < 0$
  - Non-Homothetic preferences: Engel curve not straight, MRS not const., Quasilinear preference
    - MRS only depends on income for X, consumption of Y independent of income (need vs want)

3. Demand

Hicksian Decomposition:
Change in consumption of a good, with level of utility held constant
(can just touch original indiff. curve)

Slutsky Decomposition:
Change in consumption of a good, with purchasing power held constant
(can just purchase original bundle)





- If both commodities are good, substitution effect is negative; **Income effect -ve**: Inferior goods
- Giffen good: Inferior good (negative income effect) and income effect dominates substitution effect

- Horizontal summation of individual demand: Sum quantities for each price level, curve shift right
- Elasticity: More elastic at higher price level. Unit elastic at mid-point of demand curve.
  - Point elasticity: $\varepsilon = \frac{1}{slope} \times \frac{P}{Q}$; Midpoint formula: $\varepsilon = \frac{\Delta Q}{avgQ} / \frac{\Delta P}{avgP}$
- Revealed preferences: Draw table of which bundles are affordable under certain prices

Part II: Producer theory and Perfect Competition

4. Production technology

- **Production function**: Highest output that is technically feasible when firm operates efficiently, for every specified combination of outputs. $q = f(L, K)$: Monotonic, convex
- **Isoquant**: A curve that shows all the possible combinations of inputs that yield the same output
- **Isocost**: Shows all combinations of inputs that require same total cost. $wL + rK = C \Rightarrow K = \frac{C}{r} - \frac{w}{r}L$
  - Move further away from origin as cost increases, Parallel to each other

Short run: At least <u>one factor</u> of production <u>cannot be varied (fixed input)</u>

- *Average product of labor* & *Marginal product of labor* intersect at maximal of average product
- Law of diminishing marginal returns: As the use of an input increases with other inputs fixed, the resulting additions to output will eventually decrease, may fall below zero; MC fall at low q, then rise

Long run: <u>All inputs can be varied</u>

- MRTS: How many units of capital can be replaced with an extra unit of labor, holding output constant
  - $MRTS = -\frac{\Delta K}{\Delta L} = \frac{MP_L}{MP_K}$, falls along an isoquant as the firms increases labor
- Returns to scale: Output change from proportionate increase in *all* inputs; $f(\lambda x_1, \lambda x_2) > \lambda f(x_1, x_2)$
  - $AC(\lambda q) < \frac{TC(\lambda q)}{\lambda q} = AC(q)$; Economies/diseconomies/no economies of scale, ↓/↑/const as q ↑
  - Cost-output elasticity: $\varepsilon_C = \frac{\Delta C/C}{\Delta q/q} = \frac{MC}{AC}$, $< 1 \Rightarrow$Produce more
- Technological progress: Neutral: $\uparrow MP_k = \uparrow MP_L$; Labor (capital) saving: $\uparrow MP_k > (<) \uparrow MP_L$;

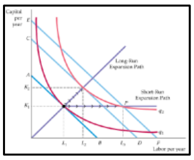
5. Cost of production

- Explicit cost: Direct payment; Implicit cost: No monetary payment; Sunk cost: Incurred, irrecoverable
- Opportunity cost: The value of the next best alternative that is forgone
- Accounting cost: Expenses + Capital depreciation; Economic cost: Explicit and implicit costs

Economies of scope: TC of single firm producing two gods < TC of separate firms producing each good

$S = \frac{TC(Q_1,0)+TC(0,Q_2)-TC(Q_1,Q_2)}{TC(Q_1,Q_2)} > 0 \Rightarrow$ Cost higher when producing separately; $MRTS = \frac{w}{r} \Rightarrow \frac{MP_L}{w} = \frac{MP_K}{r}$

LR Cost minimization: Firm choose the bundle of inputs where the isocost line is tangent to isoquant



- Expansion path: Cost minimizing input combination for each output
- SR marginal cost is lower for higher fixed input (and larger fixed cost)
  - $K' < K'' \Rightarrow MP_L(K', L) < MP_L(K'', L) \Rightarrow MC(K', L) > MC(K'', L)$
- Long run TC/AVC curve is the lower envelope of the short-run cost curves

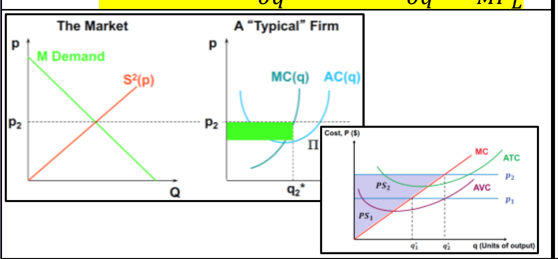
6. Profit Maximization

Perfect competition: Identical products, Perfect information, Low transaction cost, Free entry & exit

- Price taker: Cannot significantly affect market price for its output or the price at which it buys inputs
- Each firm faces a *perfectly elastic demand curve* and *perfectly elastic input supply curve*
  - If charge a price higher than market price, nobody buy your good. Lower than p, everyone buys

Output decision: $\max \prod(q) = R(q) - C(q) = pq - FC - VC(q) \Rightarrow p = MC(q^*)$, upward sloping MC
Multiple inputs: $MR = MC$ for all inputs; $AC, MC\ in\ SR \neq LR$

- Fixed cost (FC): Cost fixed in SR; no q
- Variable cost (VC): Expense that changes with q; $AVC = VC/q = \frac{w}{AP_L}$
- Total cost (TC): $TC = FC + VC$
- Marginal cost (MC): Cost change from one more q; Cut AVC, ATC at min pt.
  - $MC(q) = \frac{\partial VC(q)}{\partial q} = w * \frac{\partial L}{\partial q} = \frac{w}{MP_L}$



SR: Produce +ve iff $\prod(q) - \prod(0) > 0 \Rightarrow p > \frac{VC(q)}{q} = AVC(q)$

- Otherwise, shutdown immediately, lose only FC
- If $p < AC$, still produce at $p = MC$ in SR (recover FC), exit in LR
- SR market supply curve: #firms fixed, $Q^S = \sum_{i=1}^{n} MC^{-1}(p)$
- M.supply, M.demand → M.eqm, firms take price as given

Firm supply curve in LR (SR): Portion of MC above AC (AVC)

LR: Enter iff $\prod(q) > 0 \Rightarrow p > \frac{C(q)}{q} = AC(q)$, else exit (no FC)

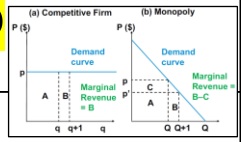
- LR market supply curve: Firms can freely enter and exit
  - Horiz: free entry/exit, identical firm, const input prices
  - Sloped: Entry is limited/cost, firms have diff. LR AC, input prices vary with output: inc/cons/dec-cost market
- +ve profit → firm entry → market supply↑, market price↓
  - Stop until $p = AC(q) = MC(q)$, $minpoint\ of\ AC(q)$

Producer surplus = Revenue – Min price (AVC in SR); Profit = Revenue – Total cost $(q * AC(q))$

Part III: Monopoly

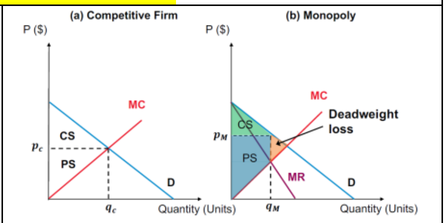
7. Monopoly

Monopoly: Market with only one seller, completely controls amount of output supplied to the market
- Cause: Legal entitlement/License, Patent/control of scarce resource, Economies of scale, Low Cost
- Price-setter: Set P by adjusting Q: $MR(q) = p(q)\left(1+\frac{1}{\varepsilon}\right) = \frac{dp(q)}{dq} * q + p(q) < p(q)$
- Faces a downward-sloping supply curve: To increase output, must decrease price



Profit maximization: $\frac{d}{dq}\left(R(q) - C(q)\right) = 0 \Rightarrow Choose\ q^*\ s.t. MR = MC, p^* = p(q^*)$

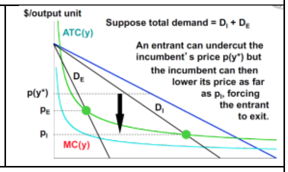
- Market eqm depends on MC, MR and D, no supply curve, inefficient
- Profit max. in elastic portion of demand curve (upper) ($\varepsilon < -1$)
- Shut down in SR (LR): Monopoly price < AVC (AC)
- **Market power**: Ability of a firm to charge P>MC and earn +ve profit
  - Markup (monopoly) pricing: $p(q) = \frac{MC(q)}{1+(1/\varepsilon)} = MC(q) + \frac{-MC(q)}{1+\varepsilon}$
  - Lerner index: $L = \frac{p-MC}{p} = -\frac{1}{\varepsilon}$, , $[0,1]$, 0 for competitive firms



$P = a - bQ, MR(q) = a - 2bQ$

$Welfare = CS + PS$

Natural monopoly (<u>Economies of scale</u>): $C(Q) < C(Q_1) + C(Q_2), Q = Q_1 + Q_2$
- Can supply whole market at lower AC than cost with >1 firm in market
- **Entry deterrence via predatory pricing**: Incumbent firm set low price when entrant appears, causing entrant's economic profits to be -ve, exit market

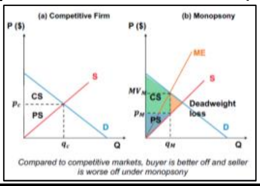


- **Price regulation**: Price ceiling, tax (MC↑), restore maximum welfare => Limited information on D/MC
- **Prohibit anti-competitive practices**: Design laws that <u>prevent firms from dumping</u>, predatory pricing, bundling, exclusive dealing, etc. => Damage has already been done, Large expenses on legal fees

Monopsony: Market with only one buyer, faces upward sloping market supply (competitive: horizontal)
- Purchase until **marginal value** (demand) = marginal expenditure (increasing ∝Q)
- Monopsonist marginal expenditure curve: $ME(q) = p(q) + \frac{dp(q)}{dq} q > p(q)$

Monopsony power: Ability to purchase good at lower price than competitive price

Decreased by: Elasticity of market supply↑, #buyers↑, Buyer Competitiveness↑

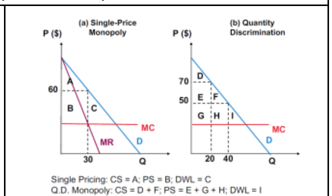


8. Price Discrimination

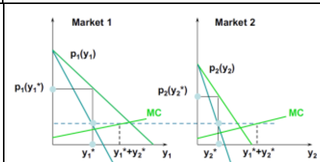
Price discrimination: Allow the firm to capture consumer surplus, turn it into producer surplus

1st degree: Perfect: Firm sells each unit at customer's maximum *willingness* to pay
- Convert CS,DWL into PS, no DWL (sold to all consumers with willingness to pay >= MC), efficient
- PS: Capture all value created; CS: No gains, equal to 0 (Price is at each customer's reservation price)
- Problem: Info. about consumer demand (WLP), Implementation (diff. price @), Resale, Unfairness

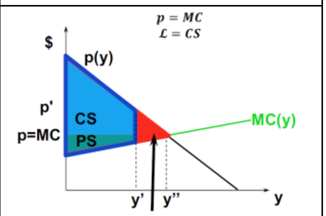
2nd degree: Quantity: Charge diff price depend on *quantity* purchased
- Assumption (valid): Consumers are willing to pay less for each additional unit
- Block pricing: Charge P_1 for first Q_1, P_2 for next Q_2 (same for all customers)
- $\max_{Q_1,Q_2} \Pi = p(Q_1)Q_1 + p(Q_2)(Q_2 - Q_1) - C(Q_2) \Rightarrow solve\left(\frac{\partial\Pi}{\partial Q_1}, \frac{\partial\Pi}{\partial Q_2}\right) = (0,0)$



3rd degree: Multimarket: Charges different *groups* of customers different prices
- Assumption: Firms know which groups have higher reservation price
- $\max_{Q_A,Q_B} \Pi = R_A Q_A + R_B Q_B - C(Q_A + Q_B) \Rightarrow MR(Q_A) = MR(Q_B) = MC(Q_A + Q_B)$
- CS: ↑for one group, ↓for other, ↕overall; PS↑; Total welfare↕, have DWL



Two-part tariffs: For each customer, total cost to purchase q units $= L + p * q$
- Lump sum fee (L): Right to purchase; Usage fee (p): Price per unit
- Sell maximum Q: Must set $p = MC$; Capture most CS: Set $L = CS$
  - Each consumer will pay <u>up to</u> entire surplus. Purchase until $ME = MV$
- $\max_{p} \Pi = CS(p) + p * q(p) - C\big(q(p)\big) \Rightarrow p = MC, L = CS$
- Equilibrium: Efficient, Monopolist captures all potential CS



Additional profit from setting p = MC

Inter-temporal: Charges different prices at different points in time, consumers self-select into groups

Peak-load pricing: Charge higher prices during peak hours: e.g. MC higher during peak due to capacity

Pure bundling: Goods are not sold separately but are sold only together

Mixed bundling: Offers consumers the choice of buying goods separately or as a bundle

Analysis: For each individual good, and for bundle, for each reservation price, what is total revenue?

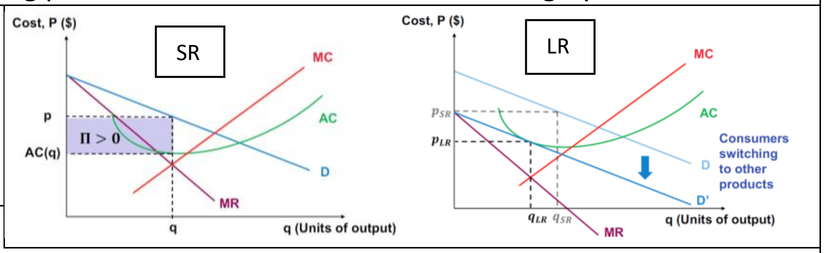
Quality discrimination: Increase profits by lowering quality at bottom without improving quality at top

Part IV: Oligopoly and Efficient Equilibrium

9. Oligopoly

Monopolistic Competition: Many firms, free entry/exit, Each firm faces downward sloping demand
- Product differentiation: Compete by selling products that are differentiated but highly substitutable

LR eqm: $p > MC, q < q^* = \min(AC)$
- $MR = MC \Rightarrow \frac{\partial p(q)}{\partial q} q + p(q) = \frac{\partial c(q)}{\partial q}$
- $\pi = 0 \Rightarrow p(q) \cdot q = c(q)$
- $\frac{\partial p(q)}{\partial q} = \frac{\partial}{\partial q}\frac{c(q)}{q}$: Demand tangent to AC



- DWL, consumers worse off
- Zero profit output in monopolistic competition less than zero profit output in competitive equilibrium

Oligopoly: Only a few firms, substantial barriers to entry, Each firm has some degree of market power;
Cournot: Fixed #firms, Identical goods, Each firm takes quantities of others as given, Simultaneous

$$\begin{cases} q_1^* = R_1(q_2) = \max_{q_1} \pi_1 = q_1 * p(q_1 + q_2) - C(q_1) \\ q_2^* = R_2(q_1) = \max_{q_2} \pi_2 = q_2 * p(q_1 + q_2) - C(q_2) \end{cases} \Rightarrow (q_1^*, q_2^*), p^* = p(q_1^* + q_2^*)$$

Market power: $L = \frac{p - MC}{p} = -\frac{1}{n\varepsilon}$

Stackelberg: Choose output sequentially, solve backwards: If leader chooses sth, what will follower do?
- Assume: Perfect information - Firm 2 observes firm 1's action, Firm 1 knows firm 2 observes its action
- Compared to Cournot: Higher output, lower price;

$$q_1^* = \max_{q_1} \pi_1 = q_1 * p\big(q_1 + R_2(q_1)\big) - C(q_1), \qquad q_2^* = R_2(q_1^*), \qquad p^* = p(q_1^* + q_2^*)$$

Bertrand: Choose price; Eqm: Ceteris Paribus, no firm can obtain a higher profit by choosing diff. price
- Think: If I set a higher price, will I have customer? If I set a lower price, will I have positive profit?
  - e.g. Assume same cost, identical product, no collude: $\Rightarrow p_1^* = p_2^* = MC$.
- Q-type: Given $Q_i = f(q_1, q_2)$, find eqm -> Derive best response function, solve like Cournot

Cartel: A group of firms that explicitly agree to coordinate their actions: Reduce output tgt to raise price
- Maximize joint profit: $\max_{p_1, p_2}(q_1(p_1)p_1 - TC_1) + (q_2(p_2)p_2 - TC_2) \Rightarrow Solve \left(\frac{\partial(\pi_1+\pi_2)}{\partial p_1} = \frac{\partial(\pi_1+\pi_2)}{\partial p_2} = 0\right)$

Cheating incentive: Increase profit by producing more, steal from others
- Best response to collusive price: Plug in other firm's rice into firm's best response

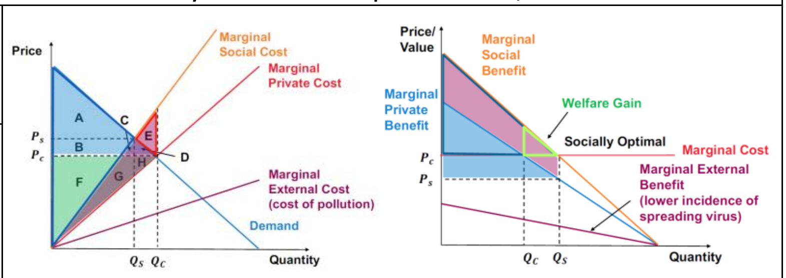
- *Dominant strategy*: Strategy that is optimal regardless of the other player's actions
- *Nash equilibrium*: Each party is doing the best it can, given what other parties are doing (can multiple)
- *Pareto efficient*: A state, in which there does not exist an alternative and feasible outcome where some individuals may be better off without making anyone else worse off

10. Externalities

Externality: A cost/benefit imposed upon someone by actions taken by others, impacts a third party
- Negative externality: Excess quantity; Positive externality: Insufficient production; Market failure

Private cost/benefit: Cost of production
External cost/benefit: Affect the town
Social cost/benefit: Private + External cost

Reducing externalities: Tax/Subsidy to shift marginal private cost to socially optimal eqm
- May not hold for monopoly: May produce more or less than social optimum



(Open-access) **Common property** (everyone has free access, equal right to exploit): Rival, Non-exclusive
- E.g. Public amenities (restrooms), Public lands for hunting/grazing, atmosphere, oceans, rivers, forests
- *Coase theorem*: "Under sufficiently low transaction costs and successful bargaining, assigning property rights results in the efficient outcome regardless of who receives the property rights."
- Tragedy of the commons: Congestion/Overuse/Pollution; Social optim.: $MR = MC$, Ind. decide: $\pi = 0$
  - Solution: Restrict access/taxation, Assign private property rights

Public good: Consumption by one person does not preclude others consumption (no rivalry (deplete))
- e.g. Exclusive (club good): Cable TV, software; Non-exclusive: National defense, fresh air, knowledge
- *Demand for private good*: SMB =Individual MB, Market demand =horizontal sum of individual demand
- *Demand for pubic good:* SMB = Sum of all individual MB, Market demand = vertical sum of ind. demd.
- Free-riding: Benefiting from resources of others without paying; Inefficient, under-production
- Reduce free-riding: Social pressure, Assign property rights (exclusive good), Tax the beneficiary