1 Consumer Theory

1.1 Lecture 1: Introduction to Microeconomics

1.1.1 What is microeconomics?

- Microeconomics is the study of how individuals and firms maximize their well-being in a world of **scarcity**.
- The core of microeconomics is the study of **constrained optimization** and assessing **tradeoffs**.
- The key concept behind tradeoffs is **opportunity cost**: every action or inaction has a cost in terms of what could have been done instead.

1.1.2 Modeling in microeconomics

- A model is any description of the relationship between two or more economic variables.
- Economic models are simplified representations of relationships between variables.

Supply and Demand Model:

- **Demand curve** is downward-sloping. It shows the relationship between price and quantity demanded. It measures the willingness of consumers to buy a certain good.
- **Supply curve** is upward-slowing. It shows the relationship between price and quantity supplied. It measures the willingness of producers to sell.
- The intersection of supply and demand curve is the **market equilibrium**. Each point on the demand curve shows how much consumers will demand at a given price. Each point on the supply curve shows how much producers will supply at a given price. At the equilibrium price, suppliers are willing to supply as much as demanders will demand.

1.1.3 Positive vs. normative economics

- **Positive analysis** is the study of the way things are (e.g. eBay auctions).
- **Normative analysis** is the study of the way that things should be (e.g. should organ sales be legal?).

1.1.4 Market economy

- **Capitalistic economy**: individuals and firms decide what to produce and consume, subject to limited restrictions by the government (similar to laissez-faire).

- **Command economy**: government in control with production and allocation (e.g. inefficiency and corruption of Soviet Union).
- **Invisible hand**: Adam Smith's concept, self-regulating nature of markets and self-interest

1.1.5 TO KNOW – Conceptual Understanding

- Microeconomics studies how individuals and firms make optimal choices under scarcity, focusing on trade-offs and opportunity cost
- Models are simplified tools to understand behavior; positive economics explains what is, while normative economics debates what should be

1.2 Lecture 2: Preferences and Utility Functions

1.2.1 Consumer preferences

- Consumer choices are based on **preferences** and **budget constraints**
- To model consumer preferences, there are three assumptions:
  - **Completeness**: when comparing two bundles of goods, you either prefer one, prefer the other, or are indifferent
  - **Transitivity**: If consumer prefers bundle x to bundle y, and bundle y to bundle z, then must prefer bundle x to bundle z
  - **Non-Satiation**: More of a good is always better, consumers never get satiated

1.2.2 Indifference curves

- We use **indifference curves** as the basic graphical tool of consumer theory. There are four important properties of indifference curves:
  - Consumers prefer higher indifference curves
  - Indifference curves are downward-sloping
  - Indifference curves never cross
  - There is one indifference curve through each possible consumption bundle

1.2.3 Utility

- **Utility** is a way of mapping preferences. We use utility to get ordinal ranking, not cardinal ranking
- **Utility function** translates consumer utility from different consumption bundles into units, that can then be compared.
- **Marginal utility** is the derivative of utility with respect to good. It measures how utility changes as consumers consume more of a good. The important principle of **diminishing marginal utility** states that consumers receive less utility from each unit of a good they consume.
- The slope of the indifference curve is called the **marginal rate of substitution (MRS)**.
  - marginal rate of substitution (MRS) = rate at which consumers are willing to trade Y axis for X axis
  - $$MRS = -\frac{MU_x}{MU_y} = -\frac{\delta U/\delta x}{\delta U/\delta y}$$
  - MRS is the ratio of marginal utilities
  - MRS is diminishing as you move along the indifference curve

1.2.4 TO KNOW – Graphical and Math Understanding

- Prove that indifference curves never cross using a figure
- Prove that indifference curves are downward sloping using a figure
- Draw indifference curves corresponding to perfect complements and perfect substitutes
- Know how to sketch an indifference curve given a verbal description of a consumer's preferences
- Calculate marginal utilities given a utility function
- Calculate marginal rate of substitution given a utility function

1.3 Lecture 3: Budget Constraints

1.3.1 Budget constraint

- Consumers have limited resources: their **budget constraint**. One simplifying assumption is that budget is equal to income (I). Budget over two goods X and Y is defined to be

$$I = p_X X + p_Y Y$$

- The slope of budget constraint is defined as **marginal rate of transformation (MRT)**: rate at which you can transform one good into the other in the marketplace

$$MRT = -\frac{p_X}{p_Y}$$

  Intuitively, with a fixed budget, by choosing one thing you are by definition reducing the money you have to spend on other things.

- Shifts in price and income alter the position and slope of the budget constraint.
  - For example, if the price of good X increases, the budget constraint flattens.
  - If the income decreases, the budget constraint shifts inwards.

1.3.2 Constrained optimization

- The goal of constrained choice is to maximize utility subject to the budget constraint. Preferences are represented by indifference curves.

- The optimal bundle that a consumer can choose is defined by the point where indifference curve is tangent to the budget constraint:

$$MRS = -\frac{MU_X}{MU_Y} = -\frac{\delta U/\delta X}{\delta U/\delta Y} = -\frac{p_X}{p_Y} = MRT$$

  At this point, slope of indifference curve = slope of budget constraint. This is equivalent to equating the marginal cost and benefit of consuming each good.

- The above equation defines an interior solution (in which the consumer consumes some of each good); if indifference curves are fat, there can also be **corner solutions** in which the consumer only consumes one good

1.3.3 TO KNOW – Graphical and Math Understanding

- Know how to write down a budget constraint given prices and income

- Show graphically how to find the bundle that maximizes the consumer's utility subject to the budget constraint

- Solve for the optimal bundle mathematically for a consumer given a utility function, prices of the two goods, and income; be sure to check for corner solutions

2 Demand

2.1 Lecture 4: Demand Curves

2.1.1 Deriving demand curve

- **Demand curve** shows the relationship between price and quantity demanded. Often we connect consumer choice theory to demand curves by varying prices while holding income constant.

2.1.2 Elasticity

- **Price elasticity** of demand is defined to be

$$\epsilon = \frac{\delta Q/Q}{\delta P/P}$$

  For example, if quantity demanded falls by 2% for each 1% increase in price, $\epsilon = -2$.

- **Perfectly inelastic demand**: demand does not change regardless of what happens to price, $\epsilon = 0$. When there is no plausible substitute, demand is likely to be perfectly inelastic.

- **Perfectly elastic demand**: demand will drop to zero if price moves at all, $\epsilon = -\infty$. When there are perfect substitutes, demand is likely to be perfectly elastic.

- The elasticity affects consumers' response to a shift in price: if the elasticity is between 0 and -1, then firms can raise revenues by raising the price (since consumers will still buy the good in significant quantities); if $\epsilon < -1$, then raising the price results in a decline in firm revenue.

- Accurately estimating an elasticity requires a shift along the supply curve (e.g., a tax on suppliers would shift the supply curve up, causing the equilibrium price to rise and quantity to fall, from where we can calculate the price elasticity of demand).

2.1.3 Shifts in demand curve

- To **trace out** a demand curve, we change prices holding income constant. To **shift** a demand curve, we change income holding prices constant.

- The **"Engel Curve"** shows the direct relationship between income and consumption.

- The **income elasticity of demand** shows what happens to consumption as income changes.

$$\gamma = \frac{\delta Q/Q}{\delta Y/Y}$$

- Most goods are **normal goods**: they have a positive income elasticity. Consumption of normal goods increases as income rises.
- **Inferior goods** have a negative income elasticity. Consumption of inferior goods falls as income rises.
- **Necessities** are goods with $\gamma < 1$. You spend a smaller share of your income on necessities as income rises.
- **Luxuries** are goods with $\gamma > 1$. You spend a larger share of your income on necessities as income rises.

2.1.4 Income and substitution effect

- An increase in price has two effects: **income effect** and **Substitution effect**.
- **substitution effect** is the change in quantity of good demanded when good's price changes, holding utility constant.
  - When one good gets relatively expensive, the substitution effect is the extent to which you shift away from that good.
- **Income effect** is the change in quantity of a good demanded because of a change in income, holding prices constant.
  - Rise in price effectively lowers the consumer's income, and this has a distinct effect on demand.
- Income effect reinforces substitution for normal goods, as both have a negative effect on the quantity demanded as income rises. But income effect works against it for inferior goods. Therefore, substitution effect is always negative, but income effect can be positive.
- Accordingly, the overall effect of a price increase on consumption of a good can be negative (for a normal good), or positive, it is an inferior good. And the income effect is larger than the substitution effect.

price change	substitution effect	income effect	total effect
normal good price rises	≤ 0	≤ 0	≤ 0
normal good price falls	≥ 0	≥ 0	≥ 0
inferior good price rises	≤ 0	≥ 0	uncertain
inferior good price falls	≥ 0	≤ 0	uncertain

- **Giffen good** is a good with a positive own-price elasticity.

2.1.5 TO KNOW – Conceptual Understanding

- Explain the difference between a movement along the demand curve and a shift of the demand curve
- Explain what the elasticity of demand/supply imply about changes in equilibrium
- Explain what quantities observed after price changes imply about the income and substitution effects

2.1.6 TO KNOW – Graphical and Math Understanding

- Given an algebraic expression for demand, calculate the price elasticity of demand at any point along the curve
- Graph budget constraint lines and show how the line shifts or rotates when a price of a good changes or the agent's income changes
- Derive a demand curve mathematically given a utility function, the price of one of the goods, and an income level
- Derive an Engel curve mathematically given a utility function and the price of both goods
- Show and calculate the effect of a price change in a graph showing a consumer's optimal bundle; decompose the effect graphically into the income and substitution effect

3 Production and Costs

3.1 Lecture 5: Production

3.1.1 Production function

- The goal of firms is to maximize profits by minimizing costs, given technological constraints.
- **Production functions** describe what is technologically feasible for firms to produce. Firm converts inputs (or factors of production) into outputs through a production process. Here outputs are the goods and services produced by the firm, and inputs are **capital** and **labor**.

  $$q = f(L, K),$$

  where q is output, L is labor, and K is capital.
- In the **short run**, at least one input is fixed. In the **long run**, all inputs are variables.

3.1.2 Short run production

- Recall that in the short run, at least one input is fixed. Suppose we have fixed capital and variable labor. **Marginal product of labor** is the change in the total output resulting from using an extra unit of labor, holding other inputs constant.

  $$MP_L = \frac{\delta q}{\delta L}$$

  Generally, we assume **diminishing marginal products**: the next worker increases output more than the previous one.
- **Marginal product of capital** is the additional output gained from one extra unit of an capital, holding the other inputs constant.

  $$MP_K = \frac{\delta q}{\delta K}$$

3.1.3 Long run production

- **Isoquants** are curves showing all (L, K) combinations producing the same output. The shape of isoquants is determined by the degree of substitutability between inputs.
- The slope of isoquant is the **marginal rate of technical substitution (MRTS)**. $MRTS$ varies along the isoquant. $MRTS$ falls as labor increases. Isoquants exhibit diminishing marginal rates of technical substitution.

  $$MRTS = \frac{\delta K}{\delta L} = -\frac{MP_L}{MP_K}$$

3.1.4 Returns to scale

There are three cases when you increase all inputs proportionally:

- **Constant returns to scale**: input increases proportionally, and output increases proportionally. For example, $f(2L, 2K) = 2f(L, K)$.
- **Increasing returns to scale**: input increases proportionally, and output increases more than proportionally. For example, $f(2L, 2K) > 2f(L, K)$.
- **Decreasing returns to scale**: input increases proportionally, and output increases less than proportionally. For example, $f(2L, 2K) < 2f(L, K)$.

3.1.5 TO KNOW – Conceptual Understanding

- Understand the inputs and outputs of production function
- Identify the differences between short run and long run production
- Identify different cases of returns to scale: constant, increasing, decreasing

3.1.6 TO KNOW – Graphical and Math Understanding

- Calculate the marginal product of labor, marginal product of capital
- Graph isoquants, and see how its slope is the marginal rate of technical substitution. Calculate $MRTS$ given production function

3.2 Lecture 6: From Production to Costs

3.2.1 Short run costs

- **Fixed costs** are the costs of inputs that can't be varied in the short run.
  - In this course, we usually assign capital as fixed costs.
- **Variable costs** are the costs of inputs that can be varied in the short run.
  - In this course, we usually assign labor as variable costs.
- **Total costs** are the sum of fixed and variable cost: $C = F + VC$.
- **Marginal costs** are the change in costs for another unit of output:

$$MC = \frac{\Delta C}{\Delta q}.$$

  In the short run, marginal cost is just the change in variable costs.

- **Average costs** are the average cost of production per unit produced.

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

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

$$AFC = \frac{FC}{q}$$

- Graphically, marginal cost is constant upward slope, average fixed cost is steadily declining, average variable cost is rising but more slowly than marginal cost, average total cost is first declining then rising. Note that where the average costs are at a minimum is where they cross the marginal cost curve.
- **Sunk costs** are costs that cannot be recovered through any change in production patterns. Sunk costs cannot be recovered and should not affect future production decisions.

3.2.2 Long run costs

- Recall that in the long run, all input costs are variable. So choice is over input mix to maximizes production efficiency, or minimizes costs.
- **Isocost line** is the combination of capital and labor that yield the same total level of costs. Total costs is

$$C = rK + wL.$$

- Firms choose economically efficient combination of inputs for a given level of output.
- Cost minimization is achieved when isoquant $f(L, K)$ is tangent to isocost $C = wL + rK$:
$$\frac{MP_L}{MP_K} = \frac{w}{r} \Rightarrow \frac{MP_L}{w} = \frac{MP_K}{r}.$$
Economically efficient point is where the last dollar spent on labor adds as much to output as the last dollar spent on capital.
- **Expansion path** traces cost-minimizing (K, L) combinations for all output levels.

3.2.3 Economic and accounting profits

- **Accounting profits** measure only cash inflows of revenues and outflows of costs
- **Economic profit** also accounts for opportunity costs that aren't necessarily paid in cash

3.2.4 TO KNOW – Conceptual Understanding

- Identify the definition of fixed costs, variable costs, and sunk costs
- Know the difference between short run and long run production. In the short run, at least one input (capital) is fixed. In the long run, all inputs are variable
- Explain why average costs are at a minimum when they cross the marginal cost curve
- Firms choose input combinations to produce a given output at lowest cost

3.2.5 TO KNOW – Graphical and Math Understanding

- Derive different cost functions: total costs, fixed costs, variable costs, marginal costs, average costs
- Know the shape characteristics of AFC, AVC, MC in a graph
- Show graphically in the isoquant–isocost diagram how to yield the cost-minimizing (L, K)

3.3 Lecture 7: Competition I

3.3.1 Perfect competition

- Firms in the market are price takers, on both the output and input sides. Conditions for perfect competition are:
  - Firms sell identical products
  - Consumers know prices charged by all firms in market
  - There are very low transaction costs in searching across possible purchase opportunities

3.3.2 Short run profit maximization

In the short run, we assume no firm entry or exit.

- Firms choose output q to maximize $\pi(q) = R(q) - C(q)$, where $R(q)$ is the total revenues the firm receives from selling output q, and $C(q)$ is the total cost

$$\max \pi(q) = R(q) - C(q)$$
$$\frac{\partial \pi(q)}{\partial q} = \frac{\partial R(q)}{\partial q} - \frac{\partial C(q)}{\partial q} = 0$$
$$\frac{\partial R(q)}{\partial q} = \frac{\partial C(q)}{\partial q}$$
$$MR = MC$$

- In perfect competition, marginal revenue MR equals the market price p. Therefore, firms produce until $MR = MC = p$.
- In the short run, competitive firm faces a perfectly elastic demand curve $MR = p$. Hence, for a perfectly competitive firm, $P = MC$.
- Shutdown decisions: firms continue producing in the short run as long as it covers its variable costs. Firms shut down only if $P < \min AVC$.

3.3.3 Short run and long run supply

- A firm's short-run supply is its MC curve above the minimum AVC
- A firm's long-run supply is its MC curve above ATC
- Market supply is the horizontal sum of individual firms' supply curves
- Short run equilibrium happens at the intersection of market demand with market supply determines the equilibrium price; each firm then produces where $MC = p$.

3.3.4 TO KNOW – Conceptual Understanding

- Explain/know the condition when a firm will shut down (1) in the short run and (2) in the long run
- Explain when firms will enter/exit in the long run
- Know why $MR = MC = p$ in the short run for a firm in a perfectly competitive market

3.3.5 TO KNOW – Graphical and Math Understanding

- Calculate MR and MC given production function and cost function
- In a perfectly competitive market, given a short run cost curve, find the short run supply curve for a firm
- In a perfectly competitive market, show graphically how aggregate market supply changes as there are more firms
- In a perfectly competitive market in the short-run, given cost curves for firms, demand, and the number of firms, find the equilibrium price, what each firm produces, and the total quantity

3.4 Lecture 8: Competition II

3.4.1 Long run competition

- In the long run, there will be entry and exit in a perfectly competitive market until all firms make zero profit.
- Free entry/exit with identical firms implies the long-run supply price equals the minimum of the long-run average cost curve.
- Long run supply curve is only flat under very restrictive conditions. It is flat only when firms are identical and input prices constant. It is upward-sloping if
  - Barriers to entry exist
  - Firms differ in efficiency
  - Input prices rise with industry expansion

  Long run supply curve is flatter than the short run supply curve due to the potential for entry and exit.

3.4.2 Agent problem

- Separation of ownership and control: ead managers to pursue personal perks over cost-minimization

3.4.3 TO KNOW – Graphical and Math Understanding

- Know the condition for long run equilibrium
- Show graphically that flat LR supply curve at min ATC, and LR supply is upward-sloping if input prices rise or firms differ

4 Welfare Economics

4.1 Lecture 9: Supply and Demand, Consumer and Producer Surplus

4.1.1 Demand and supply

- **Demand curve** measures the willingness of consumers to buy the good
- **Supply curve** measures the willingness of suppliers to supply the good
- Supply and demand curves can shift when there are
  - changes in the ability of producers to supply (driven by cost of an input or technology)
  - changes in consumer tastes or preferences
  - changes in income
  - changes to the price of complement or substitute goods. A rise in the price of a substitute good for good X raises the demand for X.

  For example, suppose that tastes change so that folks want to drive big cars. Gas guzzling cars are a complement for gas, because as people want more of gas guzzling cars, they want more gas. This will shift out the demand for gas.

  Now suppose that there is a war in the middle east and we suddenly it is harder to get as much gas. This makes it more expensive to get gas, so for each quantity of gas the suppliers need to charge more, which causes an upward shift in the supply curve.
- Case of perfectly elastic demand: demand will drop to zero if price moves at all from the original equilibrium

4.1.2 Consumer surplus

- **Consumer surplus** is the area under the demand curve and above the price since the demand curve represents the marginal willingness to pay for a good.
- Consumer surplus is inversely related to elasticity of demand.

4.1.3 Producer surplus

- **Producer surplus** is the area above the supply curve and below the price since the supply curve represents the marginal cost of producing the good.
- In the long run, producer surplus is the profit.

4.1.4 Total welfare

- Social welfare is the sum of producer and consumer surplus.
- In competitive equilibrium, where supply equals to demand maximizes total welfare.

4.1.5 Deadweight loss

- **Deadweight loss** is the loss in welfare that is a result of moving away from the perfectly competitive equilibrium.
- Deadweight loss can be caused by monopolies, government taxation.

4.1.6 TO KNOW – Conceptual Understanding

- Describe factors that shift supply and demand curves
- Explain how consumer surplus depends on the elasticity of the demand curve
- Explain what deadweight loss is intuitively
- Explain why competition maximizes total surplus

4.1.7 TO KNOW – Graphical and Math Understanding

- Know how to calculate consumer surplus, producer surplus, and deadweight loss from various government policies (quantity restriction, price ceiling, price floor, tax, etc.)

4.2 Lecture 10: Welfare Economics

4.2.1 Government interventions

- Interventions in market can also lead to disequilibrium. For example, imposing a minimum wage means that more people will want to work than employers want to hire at the minimum wage. This creates unemployment. The cost of these interventions is found in reduced efficiency (trades that are not made); there may be benefits in greater equity.
  - **Price ceiling** is a legal maximum price that for a good or service. A valid price ceiling is usually before the equilibrium price. With price ceiling, at equilibrium, quantity demanded is greater than quantity supplied.
  - **Price floor** is a legal maximum price that for a good or service. With price floor, at equilibrium, quantity demanded is less than quantity supplied.
- These restrictions generate deadweight loss and efficiency loss.

4.2.2 TO KNOW – Conceptual Understanding

- Know what price ceiling and price floor are, and identify their effects in the market
- Know "what's wrong" with excess supply or excess demand

4.2.3 TO KNOW – Graphical and Math Understanding

- Analyze the effect of a price ceiling in a graph
- Analyze the effect of a price floor in a graph

5 Monopoly

5.1 Lecture 11: Monopoly I

5.1.1 Monopoly profit maximization

- **Monopoly** is a market with only one firm. Firms are price makers, not price takers.
- **Total revenue** is
$$TR = P(Q) \cdot Q$$
- **Average revenue** is given by the demand curve
$$AR = P(Q)$$
- **Marginal revenue** is additional revenue from selling one more unit
$$MR = \frac{\partial TR}{\partial Q}$$
- Monopoly faces downward sloping demand curve and therefore
$$MR = \frac{\partial TR}{\partial Q} = \frac{\partial P(Q) \cdot Q}{\partial Q} = P(Q) + Q\frac{\partial P}{\partial Q}$$
And because
$$MR = P(Q) + Q\frac{\partial P}{\partial Q} < P(Q)$$
Monopolist has to decrease price on all units sold in order to sell one additional unit. This is not the case with a perfectly competitive firm, which cannot influence the price at which it sells. Therefore, MR curve for monopolist is below AR curve (the demand curve).
- A monopoly never produces at the inelastic part of the demand curve
$$MR = P(Q) + Q\frac{\partial P}{\partial Q} = P(1 + \frac{1}{\epsilon_D})$$
for $|\epsilon_D| < 1, MR < 0$.
- To maximize profit in a monopoly, firms produce at $MR = MC$.
$$MR = P(1 + \frac{1}{\epsilon_D}) = MC$$
$$\frac{P - MC}{P} = -\frac{1}{\epsilon_D}$$
is the markup, or measure of monopoly power, which depends on the elasticity of demand. Higher markup means demand is more inelastic.

5.1.2 Welfare effects of monopoly

- Monopolists produce less than the competitive quantity, reducing total surplus and producing deadweight loss.
- Social welfare can be maximized under perfect price discrimination.

5.1.3 TO KNOW – Conceptual Understanding

- Explain why marginal revenue is less than average revenue for a monopolist but not for a competitive firm
- Know why both a monopolist and perfectly competitive firm want to set $MR = MC$
- Explain why a monopolist's market power depends on the elasticity of demand
- Explain why there is deadweight loss (DWL) when a monopolist cannot price discriminate
- Explain why there is no deadweight loss (DWL) when a monopolist can price discriminate

5.1.4 TO KNOW – Graphical and Math Understanding

- Given a cost function and a demand curve, solve for the price and quantity in a market with a monopolist; be sure to check whether the monopolist will want to shut down
- Derive an equation relating the monopolist markup to the elasticity of demand
- Graphically, identify the producer surplus, consumer surplus, and DWL of monopoly in the uniform price case

5.2 Lecture 12: Monopoly II

5.2.1 Origins of monopoly

- **Natural monopoly** occurs when when a single firm's average cost continuously declines over the relevant output range, due to very high fixed costs and low marginal costs.
- Government-created monopolies include state provision (postal services, utilities) and patents.

5.2.2 Addressing monopolies

- Mandating $p = MC$ eliminates monopoly power and deadweight loss but requires knowing the true competitive price
- Setting p too low can shrink output below even monopoly levels, reducing total welfare

5.2.3 TO KNOW – Conceptual Understanding

- Know reasons monopoly may rise
- Discuss the pros and cons of patents

5.2.4 TO KNOW – Graphical and Math Understanding

- Graphically show the welfare impact of patents
- Graphically show the welfare effects of government regulation of monopolies

6 Other Market Structures

6.1 Lecture 13: Oligopoly

6.1.1 Oligopoly overview

- **Oligopoly** is a small group of firms in a market with substantial barriers to entry by additional firms
- In an oligopoly, firms can behave cooperatively or noncooperatively. If they behavior cooperatively, they can form a **cartel**. If they act noncooperatively, they can move back towards the competitive outcome, with lower profits.
- A market with two firms is called a duopoly.

6.1.2 Game theory

- Two key points of game theory are:
  - Each firm will produce a strategy, which will be dependent on what it thinks the other firms are doing, and these set of strategies taken together will jointly determine the outcome
  - Game will end when the market is in equilibrium
- **The Nash Equilibrium**: o firm wants to change its strategy given what other firms are doing
- **Prisoner's dilemma**: a simple example of game theory. We illustrate the problem with a **payoff matrix**.
- **Dominant strategy**: the best thing to do no matter what the other guy does

6.1.3 Cournot Model of Noncooperative Equilibrium

- **Cournot equilibrium**: the set of quantities for each firm such that, holding the quantities of all other firms constant, no firm can obtain a higher profit by choosing a different quantity
- **Reaction curve**: relationship between firm's profit maximizing output and output it thinks its competitor will produce. Cournot equilibrium is where the reaction curves intersect.
- Math to calculate the Cournot equilibrium:
  - Calculate residual demand for a given firm (in other words, the demand for a firm's product subtracting out other firm' output decisions)
  - Create a total revenues function

- From the total revenues function, derive marginal revenues
- Solve its profit maximization problem ($MR = MC$). This will give you a firm's best response function to other firms' output decisions.
- Solution is a set of quantities (one for each firm) that solves the system of equations in 4.

6.1.4 TO KNOW – Conceptual Understanding

- Explain the "prisoner's dilemma"
- Understand why cooperation can be sustained in a infinitely repeated game but not in a game with finite periods
- Explain why cartels are unstable

6.1.5 TO KNOW – Graphical and Math Understanding

- Find the Nash equilibrium of a game, given a payoff matrix
- Solve for quantities and prices when two firms compete in Cournot equilibrium
- Solve for a cartel equilibrium with n firms

6.2 Lecture 14: Oligopoly Continued

6.2.1 Cartels

- Cartels are fundamentally unstable (incentive to "cheat" and raise own production) and because they are illegal (antitrust laws).
- Each member has an incentive to cheat on a cartel, and they can get away with it, because their additional production is fairly small relative to the total. If one firm cheats, it gets all of the benefit of selling more quantity, but only a part of the poisoning effect – that gets shared with all other firms in the market.

6.2.2 Many firms

- Noncooperative equilibrium leads to less output and more profits than does the competitive market case
- In terms of welfare, usually perfect competition > oligopoly > monopoly
- Quantity as an indicator of social welfare. Deadweight loss in welfare analysis comes from trades that aren't made.
- As the number of firms get large, the Cournot equilibrium approaches perfect competition – as the number gets small, it approaches monopoly.

6.2.3 Price competition

- **Bertrand competition**: firms set prices (instead of quantities) at the same time
- Two firms may be enough to remove market power if products are identical
- To avoid Bertrand competition, firms can product differentiate. Identical Bertrand duopolists drive price down to marginal cost. In other words, firms will set their prices at marginal cost.

6.2.4 TO KNOW – Conceptual Understanding

- Explain why cartels are unstable
- Compare welfare from different forms of competition (monopoly, oligopoly, perfect competition)
- Know the difference between quantity (Cournot) and price (Bertrand) competition

6.2.5 TO KNOW – Graphical and Math Understanding

- Solve for price and quantity when firms compete in a model of Bertrand price competition

7 Labor Market

7.1 Lecture 15: Input Markets I: Labor

7.1.1 Factor demand

- **Factor markets** is the markets for labor and capital that determine input prices. **Factor demand** is the general model for labor and capital.
- We are interested in the marginal benefit and cost of adding an additional unit of labor.
- **Marginal revenue product (MRP)** is the value to the firm of another unit of labor:
$$MRP_L = MR \cdot MP_L$$
  - The marginal cost of another unit of labor in a competitive labor market is wage w.
  - If the market is perfectly competitive, $MR = p$. The equation above becomes $MRP_L = w = p \cdot MP_L$. Firms hire until the wage equals the value of what that worker is producing.

7.1.2 Capital demand

- Similarly, **Marginal revenue product of capital(MRP_K)** is the value to the firm of another unit of capital:
$$MRP_K = MR \cdot MP_K,$$
where MP_K is the increment in output from one extra unit of capital, holding labor fixed. Firms purchase additional capital until rental rate $= MRP_K$.

7.1.3 Labor supply

- Deriving labor supply is essentially exploring utility over **consumption** and **leisure**. We treat leisure as a good and consumption as its complement. Wage rate is the opportunity cost of leisure.
- The slope of the budget line, the rate at which you can trade off goods for leisure, is wage rate. The wage rate is the price of leisure in terms of goods, and is also the opportunity cost of leisure.
- We discuss labor supply using income and substitution effect. Income effect works against substitution effect if leisure is a normal good.
- When wage increases, the "price" of leisure rises. But higher wage also increases real income.

7.1.4 TO KNOW – Conceptual Understanding

- Derive factor demand in firms, explain marginal revenue product, marginal revenue product of labor, and marginal revenue product of capital
- Individuals choose between leisure and work
- When the wage rises, leisure becomes more expensive (substitution effect): people tend to work more. Simultaneously, a higher wage increases real income (income effect).

7.1.5 TO KNOW – Graphical and Math Understanding

- Plot the graph that reflects individual trade-off between leisure and consumption
- Illustrate the income and substitution effect in the leisure vs. consumption graph
- The intersection of aggregate labor-demand and labor-supply curves is the equilibrium wage and employment level

7.2 Lecture 16: Input Markets II: Labor and Capital

7.2.1 Labor market equilibrium

- Firms demand for labor is driven by the additional revenue generated by hiring an extra unit of labor, which is the value of marginal product.
- The supply of labor reflects the trade-off between income and leisure for workers.
- Equilibrium wage and employment is where aggregate labor demand equals aggregate labor supply.

7.2.2 Minimum wage effect

- A legally imposed wage floor (minimum wage) above the equilibrium wage creates a gap between the quantity of labor supplied and demanded.
- Employers reduce hiring when faced with a higher mandated wage, while more workers are willing to work at that wage, resulting in a surplus of labor (unemployment).

7.2.3 Monopsony

- A monopsonistic employer faces an upward-sloping labor supply curve, meaning that hiring additional workers requires raising wages for all employees.
- The marginal cost of labor exceeds the wage paid, leading the monopsonist to hire fewer workers and pay a lower wage compared to a competitive market.
- Introducing a moderate minimum wage can counteract monopsony power by setting a wage that aligns with a competitive market.

7.2.4 Capital supply

- Capital is all the machines, land, and other physical inputs
- Price of capital is the interest rate. The interest rate functions as the cost of borrowing and the reward for saving.
- Firms demand for capital depends on the expected return from investing in productive assets relative to the interest rate.
- Households decide how much to save based on **intertemporal preferences** – tastes for consumption today vs. consumption in the future
- Wage rate is the price of forgoing productive work to take leisure, the interest rate provides the price of forgoing productive savings to take consumption.

- Interest rate on savings operate in exactly the same way as changes in the wage rate on labor.

7.2.5 TO KNOW – Conceptual Understanding

- A wage floor set above the market equilibrium reduces the quantity of labor demanded and increases the quantity supplied, thus creating unemployment
- A monopsonistic employer faces an upward-sloping labor supply curve, so hiring additional workers requires raising wages for all, making the marginal cost of labor exceed the wage
- Households allocate consumption across periods by weighing the benefits of consuming now against consuming later, constrained by the interest rate which determines the trade-off

7.3 Lecture 17: Making Choices Over Time

7.3.1 Present value

- Key insight for thinking about capital markets: a dollar tomorrow is worth less than a dollar today.
- Money available today is more valuable than the same amount in the future because it can be invested or used immediately.
- Comparing sums across time requires adjusting future amounts to their present-day equivalent.
- The rule of making choices over time is to pick the option with the highest present value.

7.3.2 Inflation and real interest rate

- Inflation erodes purchasing power over time, so nominal returns must be adjusted to reflect real gains in buying power.
- real interest rate = nominal interest rate − inflation rate
- What matters to individuals is real interest rate when making decisions.

7.3.3 Investment decisions

- When making investment decisions, we invest if net present value > 0.
- Firms evaluate their decisions by weighing up front costs against expected future payoffs under present values.
- Consumers think about long-run gains when making decisions about whether or not to incur expenses today.

7.3.4 TO KNOW – Conceptual Understanding

- A dollar today is worth more than a dollar tomorrow because it can be used or invested immediately
- Rising prices reduce the purchasing power of money over time
- When evaluating future sums, individuals and firms think in terms of what those dollars will actually buy, not just their face value

8 International Trade

8.1 Lecture 18: International Trade

8.1.1 What is international trade?

- The extent to which countries participate in international trade can be described by two quantities: **exports** (or the value of the goods a country sells to the rest of the world) and **imports** (or the value of the goods a country buys from the rest of the world)

8.1.2 Production possibilities frontier

- **Production possibilities frontier** shows the maximum combination of outputs that can be produced from a given set of inputs.
- An **economy of scope**: it is more efficient to produce goods jointly than separately. Graphically, it is represented by a convex production possibilities frontier.

8.1.3 Comparative advantage and gains from trade

- We say a country has a **comparative advantage** in the production of a good when the opportunity cost of producing a particular good is lower in any one country.
- Differences in opportunity costs lead to comparative advantage in different goods.
- Even when countries have an **absolute advantage** in producing a good, there can be comparative be a comparative advantage.
- When countries have different comparative advantages in production of different goods, there are potential gains from trade through **specialization** – each country produces what it has a comparative advantage in producing.
- Comparative advantages can come from:
  - Differences in **factor endowments** (for example, Canada is a major exporter of lumber & paper products since so much of that country is forested — this gives them a comparative advantage in that area)
  - Differences in **technology** (for example, Japan is a major exporter of autos despite no natural factor endowment advantage)

8.1.4 TO KNOW – Conceptual Understanding

- Distinguish between comparative advantage and absolute advantage

8.1.5 TO KNOW – Graphical and Math Understanding

- Given costs of production for two nations, determine, for each good, which country has an absolute and/or comparative advantage
- In diagrams and math, show the welfare impact of imports and exports in US markets

8.2 Lecture 19: International Trade: Welfare and Policy

8.2.1 Welfare impacts of international trade

- International trade produces efficiency gains from specialization. International trade also unambiguously raises social welfare.
- In competitive model, opening to trade unambiguously increases total welfare but usually at the expense of either consumers or producers

8.2.2 Trade policy

- **Import tariffs** are taxes levied only on imports.
- Some people oppose free trade because they believe free trade is not good enough at compensating the losers, and that it could be socially damaging routes to comparative advantage.
- The same set of principles about trade in goods applies also to the free flow of workers – immigration.

8.2.3 TO KNOW – Conceptual Understanding

- Explain why international trade unambiguously raises social welfare
- Give arguments for and against free trade

8.2.4 TO KNOW – Graphical and Math Understanding

- Analyze the welfare impact of an import tariff

9 Uncertainty

9.1 Lecture 20: Uncertainty

9.1.1 Expected utility and expected value

- **Expected value** is equal to the probability of each outcome times the value of that outcome.
  - If a random variable X can take the values $x_1, x_2, \cdots, x_k$ and each value occurs with probability $p_1, p_2, \cdots, p_k$. Then the expected value of X is
    $$E[X] = x_1 \cdot p_1 + x_2 \cdot p_2 + \cdots + x_k \cdot p_k.$$
  - A fair gamble means zero expected value.
- **Expected utility** is the probability weighted average of utility.
  $$EU[X] = u(x_1) \cdot p_1 + u(x_2) \cdot p_2 + \cdots + u(x_k) \cdot p_k.$$
  - In a coin flipping game,
    $$EU[X] = Pr(lose)U(lose) + Pr(win)U(win).$$
  - Different than utility of expected value, since utility functions usually concave (due to diminishing marginal utility of income). Diminishing marginal utility of income means that the next dollar is worth less to you than the last one was in terms of happiness you gain.

9.1.2 Risk preferences

- **Risk averse**: concave utility, diminishing marginal utility income
  - For example, $U(C) = \sqrt{C}$.
- **Risk neutral**: linear utility, constant marginal utility income, when an agent only cares about expected value
  - For example, $U(C) = C$.
- **Risk loving**: convex utility, increasing marginal utility income
  - For example, $U(C) = C^2$.

9.1.3 Applications

- Insurance
  - Risk averse people will pay money to turn a gamble into a certain payoff since they get higher utility from certain income than from a gamble with the same expected value.

  - Maximum amount they're willing to pay for this is their **risk premium**. The risk premium rises as the size of the loss rises (holding other variables constant). The risk premium falls as income rises (because loss is closer to linear).
  - Lottery behavior is a puzzle – maybe risk averse at low incomes and risk loving at high incomes.

9.1.4 TO KNOW – Conceptual Understanding

- Explain why there is less risk aversion for small gambles

9.1.5 TO KNOW – Graphical and Math Understanding

- Given a utility function, be able to determine whether the agent is risk neutral, risk averse, or risk loving
- Calculate the expected value and expected utility from a gamble, given a utility function and a description of the gamble
- Calculate the risk premium for insurance, given a utility function and a description of the relevant risks

9.2 Lecture 21: Asymmetric Information and Social Insurance

9.2.1 Social insurance

- In the insurance market, there is information asymmetry. The purchasers of insurance may know more about their insurable risks than the seller (insurer) does.
- In this case, the insurer will be reluctant to sell insurance, since he will be worried that only those with the insured-against problems will demand insurance.
- Moral hazard is a central feature of insurance markets:
  - If families buy fire insurance for their homes, they may be less likely to keep fire extinguishers handy
  - If people have health insurance, they may be less likely to take precautions against getting ill
  - If workers have unemployment insurance, they may be less likely to search hard for a new job
- Moral hazard is a problem because it
  - lowers efficiency by removing productive trades
  - causes revenue raising

9.2.2 Social insurance in the U.S.

- These programs share the following features:
  - Insure you against some adverse event: retirement, illness, injury, job loss
  - Financed by universal payroll taxes: all workers pay in as a function of their earnings
  - Key programs are
    - Social Security insures against loss of earnings due to retirement, disability, and longevity risk.
    - Medicare provides health coverage to the elderly.
    - Disability Insurance, Workers' Compensation, and Unemployment Insurance each protect against specific labor-market contingencies.

9.2.3 TO KNOW – Conceptual Understanding

- Insurance markets face adverse selection: when individuals know their own risk but insurers cannot, high-risk individuals disproportionately enroll, driving up premiums and potentially collapsing the market
- Moral hazard arises once insured: protection against losses reduces precautionary effort, leading to overuse of benefits or riskier behavior that imposes additional cost
- Government intervention (mandates, subsidies, or public provision) can solve adverse selection by pooling risk across a broad population, but must balance against increased moral hazard

10 Efficiency and Equity

10.1 Lecture 22: Efficiency and Equity

10.1.1 Choosing the socially optimal allocation

- **Social welfare function (SWF)** can be thought of as a utility function for society taking individual utilities as inputs

$$SWF = f(U_1, U_2, \cdots)$$

- **Isowelfare curve** shows distributions of utility across which society is indifferent
  - **Utilitarian SWF**: $SWF = U_1 + U_2 + \cdots$
  - **Rawlsian SWF**: $SWF = min(U_1, U_2, \cdots)$

10.1.2 Inequality in the US and around the world

- The rate of absolute deprivation matters, and we measure that by poverty line.

10.1.3 Sources of Leakage

- Transfer programs lead to decrease in labor supply especially among those who qualify or are originally near the cutoff to receive the subsidy.
- Distortionary taxation leads to DWL–this is the cost of redistribution.

10.1.4 TO KNOW – Conceptual Understanding

- Explain what different social welfare functions imply about optimal allocations
- Intuitively describe the efficiency cost of redistribution

10.1.5 TO KNOW – Graphical and Math Understanding

- Show in a consumption-leisure graph how taxes on labor income could affect labor supply; then in a labor market graph, show the DWL of putting taxes on labor income
- Do simple calculations to determine welfare under different SWF

11 Taxation and Redistribution

11.1 Lecture 23: Taxation and Redistribution

11.1.1 Taxation in the U.S.

- Different types of taxes in the U.S. are:
  - Income tax (progressive, main tax in the U.S.)
  - Payroll tax (fat)
  - Consumption tax (regressive, paid on spending rather than earnings)
  - Property tax (tax on wealth)
  - Corporate tax (tax on businesses, small share of total tax revenue)

11.1.2 Taxation in the U.S.

- Importance of targeting assistance programs
- Earned Income Tax Credit (EITC) is a wage subsidy program that balances targeting and efficiency

11.1.3 TO KNOW – Conceptual Understanding

- Identify whether a particular tax is progressive, flat, or regressive

11.2 Lecture 24: Externalities

11.2.1 Externality theory

- An **externality** occurs whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so.
- **Negative externality**: negative impacts on society which the individual does not pay for. Must abide by two conditions:
  - Costs on others, not self
  - Costs that the individual doesn't pay for
  - For example: smoking, drinking
  - Individuals tend to overconsume these as they do not bear all of the costs
- Society wants individuals to internalize the externality – price of the good includes the cost of the good to society.

11.2.2 Government solution

- Government has its regulation: if the government knows what the socially optimal outcome is, the government can just impose it.
- Government can impose a corrective tax of the magnitude of this externality. As a result, the tax effectively internalizes the externality and leads to the socially optimal outcome.

11.2.3 TO KNOW – Conceptual Understanding

- Describe what externality is, describe examples and impacts of negative externality
- Describe ways how government deals with externality

12 Behavioral Economics

12.1 Lecture 25: Behavioral Economics

12.1.1 Introduction of behavioral economics

- Key of behavioral economics is bringing psychological insights into our models to enrich them.
- Time inconsistency or self-control model: individuals are unable to carry out their optimal consumption plans.
- Exponential discounting:

$$U = u(C_1) + \sum_{i=2}^{T} u(C_i) \cdot \delta^i$$

- Hyperbolic discounting:

$$U = u(C_1) + \beta \sum_{i=2}^{T} u(C_i) \cdot \delta^i$$

- In response, policies include information, taxation, regulation, supply, "nudges".

12.1.2 TO KNOW – Conceptual Understanding

- Write out (1) exponential discounting model and (2) the hyperbolic discounting model; contrast the models
- Explain what behavioral economics study and some important models
- Explain how corrective taxes can address time-inconsistency

14.01 Principles of Microeconomics
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