1 Supply and demand

1.1 Lecture 2: Supply and Demand

1.1.1 Supply and demand diagrams:

- **Demand Curve** measures willingness of consumers to buy the good
- **Supply Curve** measures willingness of producers to sell
- Intersection of supply and demand curve is market equilibrium.
- Supply and demand curves can shift when there are
  - shocks to the ability of producers to supply
  - shocks in consumer tastes
  - shocks to the price of complement/substitute goods. A rise in the price of a substitute good for good X raises the demand for the X.
- Interventions in market can 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.

1.1.2 TO KNOW- Conceptual Understanding

- Explain the difference between a movement along the demand (supply) curve and a shift of the demand (supply) curve
- Describe factors that shift supply and demand curves
- Know "what's wrong" with excess supply or excess demand

1.1.3 TO KNOW- Graphical and Math Understanding

- Find a market equilibrium given a demand and supply curve- (a) graphically and (b) using algebraic expressions
- Analyze the effect of a price ceiling in a graph
- Analyze the effect of a price floor in a graph

1.2 Lecture 3: Applying supply and demand

1.2.1 Elasticity

- Price elasticity of demand is defined

$$\epsilon = \frac{\frac{\partial Q}{Q}}{\frac{\partial P}{P}}$$

- **Perfectly inelastic demand** is $\epsilon = 0$ and **perfectly elastic demand** is $\epsilon = -\infty$.
- 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).
- Perfectly inelastic demand is characteristic of a good with no substitutes; perfectly elastic demand is a good with perfect substitutes

1.2.2 TO KNOW- Conceptual Understanding

- Explain what the elasticity of demand/supply imply about changes in equilibria.

1.2.3 TO KNOW- Graphical and Math Understanding

- Given an algebraic expression for demand, calculate the price elasticity of demand at any point along the curve
- Given an algebraic expression for supply, calculate the price elasticity of supply at any point along the curve
- Analyze the effect of a specific tax in a graph
- Analyze the effect of a specific tax using algebra

2 Consumer Theory

2.1 Lecture 4: Preferences and utility

2.1.1 Preferences

- We impose three assumptions about consumer preferences: preferences are complete, transitive and non-satiated.
- These yield four assumptions about utility curves:

  - consumers prefer higher indifference curves,
  - they are downward-sloping,
  - they never cross
  - there is one indifference curve through every consumption bundle.

2.1.2 Utility

- Utility function is a function that transfers bundles of goods into a scale of utils; however, it provides only an ordinal ranking, not a cardinal one.
- A general assumption employed is diminishing marginal utility: consumers receive less utility from each unit of a good they consume.
- The slop of the indifference curve is called the **marginal rate of substitution**
  - MRS is the ratio of marginal utilities;

$MRS = -\frac{MU_x}{MU_Y} = -\frac{\frac{\partial U}{\partial X}}{\frac{\partial U}{\partial Y}}$

  - diminishing as you move along the indifference curve.

2.1.3 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
- Explain why consumers prefer high indifference curves 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

2.2 Lecture 5: Budget constraints and constrained choice

2.2.1 Budget Constraint

- Budget constraint over two goods X and Y is defined

$I = p_X X + p_Y Y.$

- Slope of the budget constraint is defined as **marginal rate of transformation**: rate at which you can transform one good into the other in the marketplace.

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

- Shifts in price and income alter the position and slope of the budget constraint.

2.2.2 Constrainted Optimization

- The optimal bundle that a consumer can choose is defined by the point of tangency between the indifference curve and the budget line:

$MRS = -\frac{MU_x}{MU_Y} = -\frac{\frac{\partial U}{\partial X}}{\frac{\partial U}{\partial Y}} = -\frac{p_X}{p_Y} = MRT$

- 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 flat, there can also be **corner solutions** in which the consumer only consumes one good.

2.2.3 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

2.3 Lecture 6: Deriving demand curves

- We can use the constrained optimization problem to derive the demand curve. In other words, as we change prices of goods, we can observe how quantities demanded for those goods change, thereby tracing out the demand curve (the relationship between quantity and price demanded)

2.3.1 Changes in income

- As you change income, you can trace out the relationship between income and consumption- the **Engel Curve**

- This also allows us to define the income elasticity of demand:

$\gamma = \frac{\frac{\partial Q}{Q}}{\frac{\partial Y}{Y}}$

- **Normal goods**- the income elasticity is positive, so as income rises, you consume the same or more of these goods
- **Inferior goods**- consumption declines when income increases
- **Necessities are goods** with $\gamma < 1$ - goods where you spend a smaller share of your income on them as income goes up - like food
  - Not saying that you buy less food as income rises - only that you spend a smaller fraction of your income on food as income rises
- **Luxuries** are goods with $\gamma > 1$ - goods where you spend a larger share of your income on them as income rises - like cars, jewelry

2.3.2 Changes in prices

- An increase in price, has two effects:
  - it makes the consumer relatively poorer **(income effect)**
  - and it also makes this specific good less attractive relative to alternatives **(substitution effect)**.
- The substitution effect can be interpreted as the shift in goods consumed from the original point to the optimal point for a budget constraint that has the new slope, but is tangent to the old indifference curve.
- 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, if the good is **inferior** and the income effect is larger than the substitution effect.
- A good with a positive own-price elasticity is known as a **Giffen good**.

Price Change	Substitution Effect	Income Effect	Total Effect
Normal Good			
Price Rises	≤ 0	≤ 0	≤ 0
Price Falls	≥ 0	≥ 0	≥ 0
Inferior Good			
Price Rises	≤ 0	≥ 0	????
Price Falls	≥ 0	≤ 0	????

2.3.3 TO KNOW- Conceptual Understanding

- Explain what quantities observed after price changes imply about the income and subsitution effects

2.3.4 TO KNOW- Graphical and Math Understanding

- 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

2.4 Lecture 7: Income / substitution effects and labor supply

- Income and substitution effects can be used to analyze labor supply:
  - leisure (time not spent working) is a consumption good
  - the price of that good is the wage, since that is the opportunity cost of time not spent working.
  - When the wage rate increases, this also has both an income effect and a substitution effect.
    - Income effect: each worker is now richer, and may want to work less (consume more leisure).
    - Substitution effect: returns to working are higher, each worker may want to work more.
    - If the income effect more than offsets the substitution effect, labor supply may go down when income increases.

2.4.1 TO KNOW- Graphical and Math Understanding

- Calculate the income and substition effects due to changes in wages
- Show the effect of a change in wage in a graph of the labor supply decision; decompose the effect graphically into the income and substitution effect

1 Production and Costs

1.1 Lecture 8- Production Theory

1.1.1 Production Function

1. $q = f(L, K)$
   (a) q= units of output
   (b) L, K= labor and capital inputs
2. **Marginal Product**
   (a) The additional output gained from one extra unit of an input, holding the other inputs constant
   (b) **Marginal Product of Labor-** The additional output gained from one extra unit of an labor, holding the other inputs constant
      i. $MP_L = \frac{\partial q}{\partial L}$
   (c) **Marginal Product of Capital** The additional output gained from one extra unit of an labor, holding the other inputs constant
      i. $MP_K = \frac{\partial q}{\partial K}$
3. **Isoquants**

- Slices of the production function that show combinations of K and L that produces the same level of output q
  - Isoquants are the analogues of indifference curves
  - Their shape is determined by the substitutability between K and L
- The slope is called the **Marginal Rate of Technical Subsitution (MRTS)**
  - $MRTS = -\frac{MP_L}{MP_K} = -\frac{\frac{\partial q}{\partial L}}{\frac{\partial q}{\partial K}}$
  - The isoquant exhibits diminishing margins- each additional unit of labor (capital) increases q less than the previous unit and it worth less in terms of forgone capital (labor)
  - Math side note for how to derive MRTS
    * Take the total derivative of our production function to see how total output is changing with respect to changes in inputs
      1. $q = f(L, K)$
      2. $dq = \frac{\partial q}{\partial L} * dL + \frac{\partial q}{\partial K} * dL$
    1. To produce an isoquant, we want to take a slice of the production function such that output is not changing ($dq = 0$)
    2. What is the slope for the isoquant? Just rearrange the terms
       (a) $0 = \frac{\partial q}{\partial L} * dL + \frac{\partial q}{\partial K} * dK$
       (b) $-\frac{\partial q}{\partial L} * dL = \frac{\partial q}{\partial K} * dK$
       (c) $\frac{dL}{dK} = -\frac{\frac{\partial q}{\partial L}}{\frac{\partial q}{\partial K}}$= **MRTS**

1.1.2 Short Run Production

- At least one input is fixed
- For the purposes of our course, we will assume that capital (K) is fixed in the short run and that labor is variable

1.1.3 Long Run Production

- All inputs are variable- Firms can fully decide how much capital (K) and labor (L) to hire

1.1.4 Returns to Scale

1. **Constant-**$f(2L, 2K) = 2f(L, K)$
2. **Decreasing-** $f(2L, 2K) < 2f(L, K)$
3. **Increasing-** $f(2L, 2K) > 2f(L, K)$

1.1.5 Productivity

1.2 Lecture 9- Production and Costs

1.2.1 Short Run Costs

1. **Fixed Costs** are the costs of inputs that can't be varied in the short run
   (a) In this course this is capital
2. **Variable Costs** are the costs of inputs that can be varied in the short run
   (a) In this course this is labor
3. **Total Costs** are the sum of fixed and variable costs: C = F + VC
4. **Marginal Cost** is the extra cost for another unit of output:
   (a) $MC = \frac{dC}{dq}$ where C is the total cost
   (b) In the short run-$MC = \frac{dVC}{dq}$ - the marginal cost is determined by the increase in the variable cost (since fixed costs do not vary with output)
5. **Average Cost** the average cost of production per unit produced.
   (a) $AC = \frac{C}{q}$
   (b) $AVC = \frac{VC}{q}$ **Average variable costs**
   (c) $AFC = \frac{FC}{q}$ **Average fixed costs**

1.2.2 Long Run Costs

- In the very long run, all input costs are variable - so choice is over input mix to maximizes production efficiency, or minimizes costs

1.2.3 How much to produce?

To tackle this question, you want to divide your takes into two parts

1. Derive the cost function (short or long run)
    (a) Derive a cost function that produces a given quantity of q most efficiently by combining K and L for a given set of factor prices w and r
2. Choose a quantity that maximizes profits for a given price

1.2.4 Deriving the Cost function

The question we are trying to answer is for a given unit of q, what is the cheapest way for me to combine K and L

1. We start by defining the analogue of the budget constraint- **the isocost line**
    (a) **Isocost Line- combinations of labor and capital that produce the same level of cost**
        i. $C = w * L + r * K$
2. Like in consumer optimization, we want to produce at the tangency point between the isocost and the isoquant. In other words, we want to find the lowest isoquast for a given isoquant
    (a) $MRTS = -\frac{MP_L}{MP_K} = -\frac{w}{r}$
3. Deriving the total cost curve
    (a) Use your production function and point (2) to derive relationships between inputs and q
    (b) Plug these relationships back into the total cost function $C = w * L + r * K$

Remember that in the short run, capital is fixed so your cost function should reflect this

1.2.5 Long run average cost vs short run average cost curves

the LRAC is the lower envelope of the SRAC for different plant sizes. The LR cost of production is lower than the SR cost of production

1.2.6 Economies of Scope

1.3 Lecture 10- Competition

1.3.1 Perfect Competition

Firms and consumers are price takers. Why?

1. many small buyers and sellers
2. identical products
3. symmetric information
4. no transactions costs
5. free exit and entry in the long run

1.3.2 Residual Demand

Does the fact that a firm is a price taker (ie the demand curve they face is perfectly elastic) mean that the market demand is perfectly elastic? No. The residual demand (or the demand curve a firm faces) is much more elastic than the overall demand curve of the market.

1.3.3 Profit maximization

This refers to the second step in from 1.2.3. The firm wants to maximize profits, defined as

$\pi = R(q) - C(q)$

where $R(q)$are the total revenues the firm receives from selling output q and $C(q)$ is the cost we derived in 1.2.4

A firm therefore solves the following problem

$max_q \pi(q) = R(q) - C(q)$

$\frac{\partial \pi(q)}{\partial q} = \frac{\partial R(q)}{\partial q} - \frac{\partial C(q)}{\partial q}$

$\frac{\partial R(q)}{\partial q} = \frac{\partial C(q)}{\partial q}$ (want the point at which profits are maxed, or $\frac{\partial \pi(q)}{\partial q} = 0$)

$MR = MC$

1.3.4 Profit Maximization in the short run

- firm maximizes profits by producing output where MR = MC;
- competitive firm faces a perfectly elastic demand curve, MR = P. Hence, for a perfectly competitive firm, P = MC;
- in short run firms use short run cost curves (SRMC, ATC, AVC) to make profit maximization and shut down decisions;
- firm shuts down if P $<$ min AV C;
- derive individual firm short run supply curve using P = MC and Q = 0 (shut down) for P $<$ min AV C.
- SR market supply curve is horizontal sum of individual firm SR supply curves.
- industry profits can be positive or negative in SR.

1.4 Lecture 11- Competition II

1.4.1 Competition in the Long Run

- in LR free entry and exit drives economic profits to 0, i.e. P = MC = AC. Hence, LR industry supply curve is perfectly elastic at P = min AC and each firm produces at q = arg min AC;
- with barriers to entry, problem is as in the SR only firms use their LR cost curves; LR individual supply curve with barriers to entry is LRMC curve above minimum of AC and 0 below.
- SR supply less elastic than LR supply with entry barriers, which is less elastic than LR supply with free entry.
- Increasing input prices can lead to an upward sloping LR supply curve even with free entry;

1.4.2 Factor Demand in Competitive Markets

- In SR and in LR, demand for labor will be its marginal revenue product
  - $MRP_L = MR * MP_L$
  - where MR is marginal revenue from additional unit of output (MR = p if competitive output market). These will differ in LR and in SR because MP_L in LR will take into account optimal capital adjustments.
- LR labor demand more elastic than SR

1.5 TO KNOW- Conceptual Understanding

- Explain the difference between the short run and the long run
- Explain why average costs are at a minimum when they cross the marginal cost curve
- 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
- Explain why, in theory, long run supply in a perfectly competitive market will be flat at min ATC when there are identical firms
- Know why AT C = MC = p in the long run for a firm in a perfectly competitive market
- Explain three cases in which long run supply may be upward sloping; for each of these three cases, discuss whether firms earn profits and why

1.6 TO KNOW- Graphical and Math Understanding

- Calculate marginal products given a production function
- Graph isoquants and isocost curves, finding the (L,K) combination that will produce any level of q most cheaply; don't forget to check for corner solutions
- Know why the firm wants to set MPK *w = MP L *r .Know what this means intuitively and what would happen if this was $<$ or $>$ rather than an equality
- Determine whether a production function exhibits constant, increasing, or decreasing returns to scale
- Calculate and graph various cost curves: ATC, AVC, MC, AFC
- Given input prices and an isoquant, calculate (1) the short run total cost function, (2) long run total cost function, and (3) the long-run expansion path
- Determine whether a production process represented by c (q 1 ; q 2) exhibits returns to scope
- Determine based on the production possibilities frontier whether a production process exhibits returns to scope
- In a perfectly competitive market with n firms, calculate residual demand that a single firm faces
- 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
- In a perfectly competitive market in the long run, given a cost curve for each firm and demand, determine the equilibrium price, what each firm produces, the total quantity, and the number of firms
- Graph how factor demand and the wage is determined in the labor market a single firm faces
- Given incentives/a compensation scheme, be able to calculate what actions a CEO/manager may take (see problem set 5 for an example)

2 Welfare Economics

2.1 Lecture 12- Competition III

1. Agency Problems
   (a) agency problem when manager of firm does not own full stake in the firm;
   (b) allign incentives by using stock options and other payment schemes - can lead to excessive risk taking and short term behavior
2. Stock
   (a) A share of the company
3. Stock Option
   (a) A contract which gives the buyer (the owner) the right, but not the obligation, to buy or sell the stock at a specified strike price on or before a specified date.
   (b) Intuitively, want to exercise a stock option if the price of the stock on the specified date is higher than the strike price. Why? You can buy the stock at the strike price and then sell it at the higher market price. There is no additional cost to not exercising a stock option
4. Expected value
   (a) A random variable X can take the values $x_{1,}x_{2,}...x_k$and each value occurs with probability $p_{1,}p_{2,}...p_k$. Then the expected value of X is

$E[X] = x_{1*}p_1 + x_{2*}p_2 + ...x_kp_k$

2.2 Lecture 13- Welfare Economics

2.2.1 Consumer Surplus

- The area under the demand curve and above the price since the demand curve represents the marginal willingness to pay for a good

2.2.2 Producer Surplus

- The area abve the supply curve and below the price since the supply curve represents the marginal cost of producing the good

2.2.3 Total Welfare

- The addition of consumer and producer surplus
- It is maximized under perfect competition- when demand=supply

2.2.4 Deadweight Loss

- The loss in welfare that is a result of moving away from the perfectly competitive equilibrium
- Can be caused by monopolies, government taxation, etc

2.3 TO KNOW- Conceptual Understanding

- Explain how consumer surplus depends on the elasticity of the demand curve
- Explain what deadweight loss is intuitively
- Explain why competition maximizes total surplus

2.4 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, ect.)

3 Monopoly

3.1 Lecture 14 - Monopoly I

3.1.1 Monopoly Profit Maximization –

- **Total Revenue** is

$$TR = P(Q) \cdot Q;$$

- **Average Revenue** for a firm is given by **demand curve**

$$AR = P(Q);$$

- **Marginal Revenue** is additional revenue from selling one more unit,

$$MR = \frac{\partial TR}{\partial Q}$$

- **Perfectly Competitive** firm faces a perfectly elastic demand curve, $P(Q) = P$ and hence, $MR = P = AR$.
- **Monopoly** faces downward sloping demand curve and hence

$$MR = \frac{\partial TR}{\partial Q} = \frac{\partial (P(Q) * Q)}{\partial Q} = P(Q) + Q\frac{\partial P}{\partial Q}$$

Notice that

$$MR = P(Q) + Q\frac{\partial P}{\partial Q} < P(Q)$$

since $\frac{\partial P}{\partial Q} < 0$.

- 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.
  - MR curve for monopolist is below AR curve (the demand curve)
- A monopoly never produces at the inelastic part of the demand curve

$$MR = \frac{\partial TR}{\partial Q} = \frac{\partial (P(Q)*Q)}{\partial Q} = P(Q) + Q\frac{\partial P}{\partial Q} = P(Q)(1 + \frac{Q}{P(Q}\frac{\partial P}{\partial Q} = P(1 + \frac{1}{\epsilon_D})$$

For $|\epsilon_D| < 1$, $MR < 0$

- **Profit maximization**
  - $\Rightarrow$ MR = MC.

$$MR = P(1 + \frac{1}{\epsilon_D}) = MC$$

$$\text{Markup} \rightarrow \frac{P - MC}{P} = -\frac{1}{\epsilon_D}$$

- Hence mark-up, measure of monopoly power, depends on the elasticity of demand
- Shut down decision is like that of a competitive firm.

3.1.2 3 Welfare Effects of Monopoly

- Because MR $<$ AR, monopolist would supply less than the socially optimal (welfare maximizing) level of output, which leads to a deadweight loss

3.2 Lecture 15 - Monopoly II

3.2.1 I. Price Discrimination –

- above analysis is for a uniform pricing monopoly
- the monopolist sets the same price for every unit sold or for every consumer type.
- monopolist can price discriminate - set different prices for different units, charge different uniform prices for different consumer groups, use two part tariffs, etc.
- **perfect price discrimination/1st degree price discrimination**
  - monopolist charges each consumer their willingness to pay for the good, and hence extracts all the consumer surplus. MR curve is now the AR curve, i.e. the demand curve.
  - Set output where new MR curve equals MC, i.e. where demand intersects MC.
  - hence, a perfectly price discriminating monopolist produces the socially optimal output level.

3.2.2 How do Monopolies Arise?

1. **cost advantages** - natural monopoly, for any output produce at lower AC than any other firm can (AC is declining);
2. **barriers to entry** - fixed costs, patents;

3.2.3 Regulating Monopolies

- Government regulation of monopoly, through a price ceiling can improve welfare.
- Setting a price ceiling at the competitive price leads to zero DWL.
- Effect of a unit tax on the price of good - price of good can increase by less than 1 for 1 with the tax or by more
- difference with perfectly competitive market.

3.2.4 IV. Contestable Markets –

- threat of entry "disciplines" monopolist and they charge a price close to the perfectly competitive price.

3.3 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
- Know reasons monopoly may rise
- Discuss the pros and cons of patents

3.4 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
- Graphically, identify producer surplus, consumer surplus, and DWL when a monopolist can perfectly price discriminate
- Graphically show the welfare impact of patents
- Graphically show the welfare effects of government regulation of monopolies (a) Three cases:
  - mandated price above p , mandated price below p; mandated price at p

4 Other Market Structures (Chapter 13)

4.1 Lecture 16 - Other Market Structures

4.1.1 Oligopoly

- small number of firms that interact strategically (not price takers but have to take into account other firms' decisions when making their own decisions);
- duopoly - narket with two firms;

4.1.2 Game Theory –

- study of the outcome of strategic interactions;
- player's objective is to maximize payoffs given actions of others;
- **non-cooperative games** - players cannot enforce mutually beneficial strategies;
- **strategies** - possible actions that players choose from to maximized payoffs;
- **dominant strategy** - strategy that maximizes a player's payoff no matter what the other player does;
- **Nash equilibrium** - each player is doing the best it can (maximized payoff) given the actions of its opponents;

4.1.3 Cournot Model of Noncooperative Equilibrium

- **Cournot doupoly** - two firms compete by setting output levels simultaneously. Each firm treats the output of its competitor as fixed; –
- **Reaction curve** - relationship between firm's profit maximizing output and output it thinks its competitor will produce;
- **Cournot equilibrium** - Nash equilibrium of Cournot duopoly game. Output levels for which reaction curves intersect.
- **Cournot Math** : All firms set quantities at the same time

1. Calculate residual demand for a given firm (in other words, the demand for a firm's product subtracting out other firms' output decisions)
2. Create a total revenues function
3. From the total revenues function, derive marginal revenues
4. Solve its profit maximization problem (MR=MC). This will give you a firm's best response function to other firms' output decisions.
5. Solution is a set of quantities (one for each firm) that solves the system of equations in 4.

4.2 Lecture 17 - Oligopoly continued I

- Cooperative Equilibrium -Cartels
  - Firms can form a cartel and behave like a single monopolist, maximizing total industry profits.
  - Cartels are unusual because they are fundamentally unstable (incentive to "cheat" and raise own production) and because they are illegal (antitrust laws).
- Comparing Equilibria –
  - In terms of welfare, usually Perfect Competition > Oligopoly > Monopoly
  - Quantity as an indicator of social welfare
  - DWL in welfare analysis comes from trades that aren't made
- Many Firms
  - In Cournot, as number of firms $\to \infty$, Cournot equilibrium approaches competitive equilibrium
  - As number of firms $\to 1$, approaches monopoly
  - Markup over competitive price depends on number of firms and elasticity of demand: $\frac{P-MC}{P} = -\frac{1}{n*\epsilon_D}$
- Price Competition
  - Bertrand: firms set prices (instead of quantities) at the same time
  - Two firms may be enough to remove market power (i.e. restore competitive outcome) if products are identical
  - Recall proof from class that identical Bertrand duopolists drive price down to marginal cost. In other words, firms who compete a la Betrand, will set their prices at marginal cost.

4.3 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
- Compare welfare from different forms of competition (monopoly, oligopoly, perfect competition)
- Know the difference between quantity (Cournot) and price (Bertrand) competition

4.4 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
- Solve for price and quantity when firms compete in a model of Betrand price competition

1 International Trade

1.1 Lecture 18: International Trade

1.1.1 What is International Trade?

- **Autarky-** an environment in which trade does not exist
- **trade decit** = imports-exports

1.1.2 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.

1.1.3 Welfare Implications from International Trade

- In competitive model, opening to trade unambiguously increases total welfare but usually at the expense of either consumers or producers

1.1.4 Trade Policy

- Effects of **import tariffs** (tax levied on imported goods) and quotas

1.1.5 TO KNOW- Conceptual Understanding

- Distinguish between comparative advantage and absolute advantage
- Explain why international trade unambiguously raises social welfare
- Give arguments for and against free trade

1.1.6 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 (In lecture, we did an example with roses and computers.)
- Analyze the welfare impact of an import tariff

2 Uncertainty

2.1 Lecture 19- Uncertainty

2.1.1 Expected Utility and Expected Value

- **Expected value**

  1. A random variable X can take the values $x_{1,}x_{2,}...x_k$and each value occurs with probability $p_{1,}p_{2,}...p_k$. Then the expected value of X is

$E[X] = x_{1*}p_1 + x_{2*}p_2 + ...x_kp_k$

  - In other words, the expected value is the sum of the probability of each outcome times the value of that outcome
  - **A fair gamble**- zero expected value

- **Expected utility:**

  - Probability-weighted average of utility

$EU[X] = u(x_1) * p_1 + u(x_2) * p_2 + ...u(x_k) * p_k$

  - EU = Pr(Lose) U(Lose) + Pr(Win) U(Win)
  - Different than utility of expected value, since utility functions usually concave (diminishing MU of income)! Diminishing MU of income means that the next dollar is worth less to you than the last one was in terms of happiness you gain

2.1.2 Risk preferences

- **Risk Averse-** Concave utility (decreasing MU income)

$U[C] = \sqrt{C}$

- **Risk Neutral-** Linear utility (constant MU income) - an agent only cares about expected value!

$U[C] = C$

- **Risk Loving-** Convex utility (increasing MU income

$U[C] = C^2$

2.1.3 Applications

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

2.1.4 TO KNOW- Conceptual Understanding

- Explain why there is less risk aversion for small gambles

2.1.5 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

3 Capital Supply and Capital Markets

3.1 Lecture 20- Capital Supply and Capital Markets

3.1.1 Capital and Intertemporal Choice

- **Capital Markets-** pools of money that firms can draw on to make investments
- **Supply of capital** comes from household decisions about how much to save - increasing in the interest rate
- **Demand for capital** comes from firms with potentially productive investments to make- decreasing in the interest rate
- **Interest Rate-** rate firms have to pay a household to lend money

3.1.2 Intertemporal choice

- Graph over consumption in period one (C1 on x-axis) and in period 2 (C2 on y-axis).
- Slope of the BC is -(1 + r)
- When r changes, effect on savings depends **on relative size of IE and SE**

3.1.3 Present Value

- A dollar today is worth less than a dollar tomorrow because today's dollar can be invested and an interest rate can be earned
- Need to translate all future dollars into today's terms in order to compare investment and consumption options
- **Present value-**the value of eaach period's payment in today's terms- each payment is weighed according to how far in the future it is
- For a single payment of FV in year t:

$PV = \frac{FV}{(1+r)^t}$

- Value of a perpetuity- constant payment of f every period forever:

$PV = \frac{f}{r}$

- Importance of compunding
- Real interest rate r is the one we care about - the nominal interest rate$i$ minus inflation π

$r = i - \pi$

3.1.4 Present value, utility functions, budget constraints and household maximization

- Households maximize utility over time subject to an intertemporal budget constraint
- The total utility of a household that lives in two periods and consumes $c_1$in period 1 and $c_2$in period 2 and discounts the future with discount factor β is

$U = u(c_1) + \beta u(c_2)$

- Budget Constraint
  - Household can save s of its income in the first period (y_1), or it can borrow against its second period income (y_2)

- Interest rate on both savings and on loans is equal to r
- Budget constraint in first period of life $c_1 + s = y_1$
- Budget constraint in second period of life $c_2 = y_2 + (1 + r)s$
- Together $c_1 + \frac{c_2}{1+r} = y_1 + \frac{y_2}{1+r}$

3.2 Lecture 21 - Capital Market

3.2.1 Choices Over Time - How to choose between investment options with different payout streams over time?

- Choose option with highest present value when choosing between projects or investments

3.2.2 Investment Decisions

- **Net Present Value (NPV)** = PV of revenues - PV of costs
- Rule: Invest if NPV greater than zero
- if revenues R_t in each period and costs C_t, NPV of investment is:

$NPV = [(R_0 - C_0) + \frac{R_1 - C_1}{(1+i)^1} + \frac{R_2 - C_2}{(1+i)^2} ... + \frac{R_t - C_t}{(1+i)^t}]$

- NPV decreasing in interest rate for projects with up-front costs and future payos

3.2.3 Increasing Savings

- Savings important for economic growth
- Government encourages savings using tax subsidies to retirement savings

3.3 TO KNOW- Conceptual Understanding

- Explain how the interest rate is determined in a capital market equilibrium
- Describe how individuals make intertemporal consumption decisions
- Intuitively describe the income and subsitution effects on current consumption when the interest rate changes
- Explain the reasons why supply of funds in a capital market is upward sloping while demand for funds in downward sloping

3.4 TO KNOW- Graphical and Math Understanding

- Show in a graph and calculate how a consumer chooses C_1 (consumption this year) and C_2 (consumption next year) given an income in the first year and a utility function
- Show in a graph the income and substitution effects on C_1 (consumption this year) and C_2 (consumption next year) when the interest rate changes
- Solve problems involving present and future values
- Solve problems in which agents have different potential income streams over time and have to make intertemporal utility maximization decisions. Note: we did not cover mathematical intertemporal maximization (utility function subject to an intertemporal budget constraint), but you need to be able to think through intertemporal problems conceptually.
- Calculate the present value (PV) of a payout stream over time
- Calculate the net present value (NPV) of an investment choice for a firm

4 Equity and Efficiency

4.1 Lecture 22: Equity and Efficiency

4.1.1 Choosing the Socially Optimal Allocation

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

$SWF = f(U_1, U_2, ...)$

- **Isowelfare curves**- distributions of utilty across which society is indifferent
- **Utilitarian**
  $SWF = U1 + U2 + ..$
- **Rawlsian SWF**

$SWF = min(U1, U2, ...)$

4.1.2 Inequality in the US and Around the World

- See class handouts on inequality, poverty line, poverty rates over time

4.1.3 Sources of Leakage

- Recall transfer program discussed in class - leads 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

4.2 TO KNOW- Conceptual Understanding

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

4.3 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

5 Taxation and Redistribution

5.1 Lecture 23: Taxation and Redistribution

5.1.1 Taxation in the U.S.

1. Income tax (progressive, main tax in the U.S.)
2. Payroll tax (flat)
3. Consumption tax (regressive, paid on spending rather than earnings)
4. Property tax (tax on wealth)
5. Corporate tax (tax on businesses, small share of total tax revenue)

5.1.2 What Should We Tax?

1. European countries raise most revenue through VAT on consumption
2. Consumption taxes encourage savings but not progressive
3. Excise taxes usually on "sin goods"
   (a) **Negative externality-** negative impacts on society which the individual does not pay for. Must abide by two conditions
      i. Costs on others, not self

ii. Costs that the individual doesn't pay for
iii. ex: smoking, drinking
iv. Individuals tend to overconsume these as they do not bear all of the costs

(b) **Corrective taxation**

i. Society wants individuals to internalize the externality- price of the good includes the cost of the good to society

5.1.3 What is the Right Tax Rate?

1. Tax revenues $= base * t$
2. As tax rate rises, base shrinks

$\frac{d(taxrevenue)}{dt} = base + t * \frac{d(base)}{dt}$

1. **Laffer curve** - tax revenue initially rising, then falling with tax rate (depends on elasticity of tax base)

5.1.4 Low Income Programs in the U.S.

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

5.2 TO KNOW- Conceptual Understanding

- Identify whether a particular tax is progressive, flat, or regressive
- Discuss the Laffer curve and implications for the tax rate

6 Social Insurance

6.1 Lecture 24: Social Insurance

6.1.1 Why social insurance?

- Reason to believe that private insurance **underinsures** individuals
- **Information Asymmetry**
  - The difference in information that is available to sellers and to purchasers in a market
  - Can cause **failure in competitive markets**- when trades that are valued by buyers and sellers do not occur due to asymmetric information

- **Adverse selection**: when only riskiest people will buy insurance

- What can the government do?
  - Subsidize health insurance
  - Mandate health insurance
  - Directly provice insurance (social security, disability insurance)

6.1.2 The Social Insurance Tradeoff

- **Moral hazard**
  - Adverse behavior that is encouraged by insuring against adverse events
  - Becomes a major problem in social insurance programs
    - Can lower efficiency by removing productive trades
    - Need to raise revenues to pay for insuring these individuals (reduces efficiency)

- The trade off
  - Between benefits of helping overcome insurance market failure and costs of encouraging moral hazard.

6.2 TO KNOW- Conceptual Understanding

- Explain how adverse selection can lead to unraveling so that private firms no longer offer insurance
- Describe three ways the government can combat unraveling in an insurance market
- Define moral hazard and explain how it arises from insurers having imperfect information

7 Behavior Economics

7.1 Lecture 25- Behavioral Economics

7.1.1 Exponential discounting

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

7.1.2 Hyperbolic discounting

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

7.2 TO KNOW- Conceptual Understanding

- Write out (1) exponential discounting model and (2) the hyperbolic discounting model; contrast the models
- Explain what behavioral economists mean by
  - Loss aversion
  - Unstable preferences
  - Biases in statistical judgments
  - Intrinsic vs. extrinsic motivation
  - Defaults and presentation effects
- Explain how corrective taxes can address time-inconsistency (ex. smoking)
- Explain how government bans can address biases in statistical judgments