# Econ 301: Microeconomic Analysis

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# Asymmetric Information

# Motivation

- So far, assumed easy to tell quality of goods bought
- This assumption not realistic in some markets. Examples?
  - Labor markets: some people more productive that others, but had to tell before hiring
  - Used car markets: seller (owner) knows quality, but buyer may not
- Todays lecture: what happens when one side of the transaction knows more than the other about the quality of the good

# Adverse Selection and Moral Hazard

# Example: The Market for Lemons

- Suppose there are 100 cars being sold: 50 “plums” and 50 “lemons”
- There are 100 buyers
- Seller’s lowest price willing to sell at:
  - \$2000 for plums
  - \$1000 for lemons
- Buyer’s highest price willing to buy at:
  - \$2400 for plums
  - \$1200 for lemons
- What happens if quality of cars is observable to buyers and sellers?
  - All cars are sold
  - Plums are sold for anywhere between \$2000 and \$2400
  - Lemons are sold for anywhere between \$1000 and \$1200

# Adding Asymmetric Information

- Suppose now sellers know type of car they have but buyers cannot observe it
- What happens in market?
  - Assuming both types of car on market, buyers are only wiling to spend up to expected value

$$\frac{1}{2}\$1200 + \frac{1}{2}\$2400 = \$1800$$

  - Only owners of lemons will sell at this price
  - Knowing this, buyers will pay only up to \$1200
- What is the market failure here?
  - Plums are not sold despite the fact that there are willing buyers and sellers of them (if they can be identified)
- Any solutions to this?
  - Forced revelation of quality
  - Warranties

# Hidden Quality: Umbrellas

- Let's see another example where quality is unknown to buyers
- Consider competitive market for umbrellas
- Can be either low or high quality
- Consumers:
  - High quality worth \$14, low quality worth \$8
  - Cannot tell difference between high and low quality at time of purchase
- Sellers:
  - High quality sellers have fraction $q$ of market
  - Both high and low quality cost \$11.50 per umbrella to make
  - Seller cannot choose quality, only whether to produce or not
- How much are consumers willing to spend?
  - Spend up to expected value: $\$14q + \$8(1 - q)$

# Umbrellas, con't

- What happens if $q = 0$?
  - Buyers only willing to pay \$8
  - No sellers produce at this price
- What happens if $q = 1$?
  - Buyers willing to pay \$14
  - Since market is competitive, price is \$11.50
- What happens if $q \in [0, 1]$?
  - Consumers will buy at price \$11.50 only if $\$14q + \$8(1 - q) \geq \$11.50$
  - So if $q \geq \frac{7}{12}$ we have an equilibrium where all firms sell at \$11.50
    - Note that profit is always 0, but consumer surplus increases as $q$ increases
  - So if $q < \frac{7}{12}$, no transactions are made

# Adverse Selection

- In examples with umbrellas and cars, the low-quality items have externality on high-quality items, causing high-quality items not to be sold
- This is because consumers are not getting an ideal or even random selection from quality of goods, but an *adverse selection*
- The classic example of adverse selection is the insurance market:
  - Insurance companies cannot tell risk of individual people, so insurance rates are based on average risk of individuals
  - For low-risk people, buying insurance at this price is not sensible
  - So only high-risk people buy insurance, but this drives up insurance rate
  - Again, market failure/inefficiency: insurance company willing to insure low-risk people if could tell who they were, but instead they get an *adverse selection* of customers

# Getting Around Adverse Selection

- How can we structure insurance market to avoid this failure?
- One option: mandated insurance purchasing
  - Government can penalize anyone that does not buy insurance
  - This is done for car insurance and health insurance
- Another option: insurance pools
  - Instead of government mandating, firms can require employees to buy health insurance through group plan
  - Reduces rates because no longer have adverse selection of only high-risk consumers

# Moral Hazard

- Insurance market has another potential inefficiency: once insured, consumer have less incentive to take care
  - Examples? Drive recklessly if car insured; live unhealthy lifestyle if health is insured
- This is called *moral hazard*: consumer's actions affect probability of a high-quality outcome
- What can we do to get around moral hazard?
  - If insurer can observe taking care, can charge different rates depending on care taken
    - Examples? Lower car insurance rates if you drive safely; lower health insurance rates if you don't smoke
  - But effort is usually only partially observable
    - Another tactic: align consumer's incentives with a *deductible*, where consumer pays first part of cost of coverage
    - That way, consumer bears the marginal risk of their action
    - This is called *incomplete insurance*

# Principal-Agent Problems

# Moral Hazard Example: Setup

- Suppose landowner wants to hire someone to work the land for them
- If worker puts in effort $x$, land will produce output $y = f(x)$
- Landowner will pay them according to function $s(y)$
- Worker can choose instead to take *outside option*, worth $\bar{u}$ to them
- Effort costs $c(x)$ to worker
- Good $y$ has price 1
- Utility functions:
  - Landowner: $y - s(y)$
  - Worker: $s((f(x)) - c(x)$
- In general, landowner is called *principal* and worker is called *agent*

# The Principal's Problem

- Note that the principal must ensure that the agent actually wants to work for the principal and not take the outside option
  - This gives us the *participation constraint (PC)* of the agent:

$$s(f(x)) - c(x) \geq \bar{u}$$

- The principal would like to maximize profits, subject to this participation constraint:

$$\max_x f(x) - s(f(x)) \text{ s.t. } s(f(x)) - c(x) \geq \bar{u}$$

- Solution?
  - Note we can rearrange the constraint and plug in to the maximand:

$$\max_x f(x) - c(x) - \bar{u}$$

  - The FOC of this problem is then $f'(x^*) = c'(x^*)$, ie MP=MC

# The Agent's Problem

- The principal want to ensure that the agent will choose effort level $x^*$
- Need this to be utility maximizing for the agent, ie need $x^*$ to solve

$$\max_x s(f(x)) - c(x)$$

- Alternatively, can write this as

$$s(f(x^*)) - c(x^*) \geq s(f(x)) - c(x) \text{ for all } x$$

- This is known as *incentive compatability constraint (IC)*
- Note that there may be many possible $s(\cdot)$ functions (ie *contracts*) that principal can choose to use
- For contracts to work (ie achieve $x^*$), <u>must satisfy both PC and IC</u>

# Example Contract: Rent

- Suppose agent must pay rent $R$ to principal (independent) of output, and then keep the rest of output
- Contract function is $s(f(x)) = f(x) - R$
- Is IC satisfied? Yes:
  - Agent solves $\max_x f(x) - R - c(x)$
  - First order condition is $f'(x^*) = c'(x^*)$
  - Since this $x^*$ is principal's optimum as well, IC is satisfied
- Is PC satisfied? Yes, for the correct $R$:
  - Need $f(x^*) - R - c(x^*) \geq \bar{u}$
  - That is, $R = f(x^*) - c(x^*) - \bar{u}$
- Note that PC is what determines contract (ie size of rent $R$)

# Example Contract: Wage Labor

- Suppose principal instead pays wage $w$ and lump sum transfer $K$
- Contract function is $s(x) = wx + K$
- Is IC satisfied? Yes, for the correct $w$:
  - Agent's problem: $\max_x wx + K - c(x)$
  - FOC: $w = c'(x)$
  - If the principal sets $w = f'(x^*) = MP(x^*)$, IC is satisfied
- Is PC satisfied? Yes, for the correct $K$:
  - We need $\underbrace{w}_{MP(x^*)} x^* + K - c(x^*) \geq \bar{u}$
  - Satisfied when $K = c(x^*) + \bar{u} - MP(x^*)x^*$
- Note that in this case, PC determines lump sum $K$ but IC determines wage rate $w$

# Example Contract: Sharecropping

- Another possible contract: agent gets share $\alpha < 1$ of output, plus lump sum $F$
- Contract function is $s(x) = \alpha f(x) + F$
- Does IC hold? No:
  - Agent solves $\max_x \alpha f(x) + F - c(x)$
  - FOC: $\alpha f'(x) = c'(x)$, call solution $\hat{x}$
  - But principal needs effort $x^*$ such that $f'(x^*) = c'(x^*)$
- From principal's point of view, agent will provide less than optimal level of effort, ie $\hat{x} < x^*$. Why?
  - Sharecropper is not *residual claimant* of all of his effort
- So why would principal ever consider using sharecropping as contract?

# Return of Asymmetric Information

- We're assuming that principal can directly observe effort because it is perfectly correlated with output, ie $y = f(x)$
- But in reality there is noise (good and back luck) that can determine output in addition to effort, ie $y = f(x) + \epsilon$
- Thus we are back to the case where one side of the market (agent) observes quality (effort) but the other side (principal) does not
- What does this do to different contracts?
  - Rent: agent bears risk, so will supply less effort than principal would want due to risk aversion
  - Wage: not feasible since need to observe effort $x$
    - Workaround in reality: pay for hours worked as proxy for effort
  - Sharecropping: both worker and landlord bear risk of bad luck, so their incentives are aligned