Networks II: Market Design—Lecture 20 Information and Networked Behavior

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- Reminder: Midterm next week, Thursday April 18th, in-class
  - Reminder (yet again!): No alternate exams available, so make sure to **be there**
  - Location: 155 Olin Hall (our usual classroom)
  - Time: 2:55-4:10pm; *please arrive early to get settled down*
  - Syllabus: Everything covered in class upto (and including) today's class
  - **Closed-book exam**:
    - No materials **except** 1-page cheat sheet allowed
    - Yes, you can write on both sides of the (standard-sized) sheet, in any font you like, including your own handwriting

Recap: Information and networked behavior

- Information asymmetry in markets:
  - Some subset of agents in market have more information about goods or services exchanged
  - Information asymmetries arise in many important markets
    - Markets for lending and mortgages
    - Markets for insurance: Health, life, vehicle, property, fire, ...
    - Labor markets: Traditional jobs; online labor markets (oDesk, crowdwork platforms, ...)
    - Online platforms: E-commerce(eBay, Amazon), P2P markets, ...,
- Specific setting: Matching markets **with** money

Recap: Last time

- Markets with money; valuations v_{ij}: Market-clearing prices and welfare maximization
- Modifying the model towards studying information asymmetry:
  - Make buyers identical
  - Introduce seller with value s_j for item j: Sellers *choose* whether to sell (bring item to market)
- Two questions:
- 'What should happen'? (Last time)
- What does happen: Equilibrium concept (today)

Recap: Last time

'What should happen?': The basics of trade

- The meaning of value: Buyer value v_b, seller value v_s
  - Buyer: Prefer to buy for prices $p < v_b$, not for $p > v_b$
  - Seller: Prefer to not sell for prices $p < v_s$, sell for $p > v_s$
- Trade is (Pareto-)efficient outcome if $v_s \leq v_b$
- Strictly better than (Pareto-dominates) no trade if $v_s < v_b$

Information asymmetry: Basic features

Markets with information asymmetries ('Hidden information')

- Market has items of different qualities
- Sellers know quality of item they sell; buyers *do not*
  - Sellers are 'informed' side of market
  - Buyers are 'uninformed' side
- Buyers **know** that sellers are better informed

A preview: The 'adverse selection' phenomenon

- What we'll see: Information asymmetry can substantially affect equilibrium outcome
  - Buyers value items more than sellers: Market would clear with full information
  - Yet no trade occurs in market in equilibrium!
  - Asymmetry **endogenously** determines which items are offered for sale in market: No common price supporting trade

Towards understanding adverse selection

(The Market for Lemons: Akerlof, 1970)

- Market for used cars
  - Assume more buyers than sellers
  - Two types of cars, good and bad
  - Say all buyers value good cars at b_H and bad cars at b_L
  - Sellers value good cars at s_H, bad cars at s_L
- Two questions:
  1. What 'should' happen?
  2. What happens with asymmetric information?

Part 1: What should happen?

- Efficient outcome: If $s_H < b_H$ and $s_L < b_L$, all cars sold
- What happens with *complete information*?
  - Complete information: **All** agents (buyers and sellers) in market can identify good and bad cars *pre-purchase*
- Outcomes with complete information: An example
  - n buyers and m sellers: $n > m$
  - Sellers of good cars value car at 10, of bad cars at 4
  - Buyers value good cars at 12, bad cars at 6

  What happens if sellers and buyers can both identify car quality?

  A Good cars sold at price 10, bad cars sold at price 4
  B Good cars sold at price 12, bad cars sold at price 4
  C Good cars sold at price 12, bad cars sold at price 6
  D Good cars sold at price 12, bad cars unsold

Let's go on: Towards understanding adverse selection

(The Market for Lemons: Akerlof, 1970)

- Market for used cars
  - Assume more buyers than sellers
  - Two types of cars, good and bad
  - Say all buyers value good cars at b_H and bad cars at b_L
  - Sellers value good cars at s_H, bad cars at s_L
- Two questions:
  1. What 'should' happen?
  2. What does happen with asymmetric information?
     - Sellers know quality of item they sell; buyers *do not*
     - Buyers *know* that sellers are better informed
- Remember: We're seeking the elements of a model to explore the consequences of information asymmetry

The used car market with asymmetric information

How would you reason about 'what happens' in markets with such asymmetric information?

- 'What happens': What items are traded, and at what price
- Two components to this question:
  - Given prices in market, what do buyers and sellers choose to do?
  - What prices might we expect to see?

The used car market with asymmetric information

- Prices of cars: How many different levels of prices can we have with *asymmetric information*?
  - Good and bad cars are indistinguishable to buyers
  - *Uniform price* for all cars!
- How do sellers act?
  - Compare value and price to decide whether to sell or not
- How do buyers in the market act?
  - No information about quality pre-purchase: Evaluate *expected* value of car and compare with price
  - (Assume buyers are risk-neutral)

Information asymmetry: Towards a model

- A toy model: Market for used cars (Akerlof, 1970)
  - n buyers, m sellers: Assume $n > m$
  - Each seller sells one car, each buyer wants (at most) one car
    - Matching market; unit supply and unit demand for each agent
  - Two types of cars, good and bad
  - Say all buyers value good cars at b_H and bad cars at b_L
  - Sellers value good cars at s_H, bad cars at s_L
- Remaining ingredient of model (to address incomplete information): Distribution of qualities of cars

'What happens' in markets with asymmetric information?

- g: Fraction of sellers in population with good cars
  - Assumption: All agents (buyers and sellers) know g
- What is expected value of cars on market to buyers in our example?
  - A $12 * g + 6 * (1 - g)$
  - B $10 * g + 4 * (1 - g)$
  - C That's not an easy question
- Indeed, it's **not** an easy question!

Equilibrium outcomes in the used car market

- Fundamental point: Expectation over *what distribution of qualities*?
- g: Fraction of cars in **population** that are good
- h: Fraction of cars **for sale in market** that are good
- Why would h be different from g?
  - Outcome in market depends on *all* traders' decisions: Buyers' choices about buying, but *also* sellers' willingness to sell!
  - Endogeneity in participation: **Who** comes to market

Equilibrium outcomes in the used car market

- Buyers cannot distinguish quality: Uniform price p for both types of cars
- Key idea: Sellers who find it profitable to sell at price p **depends** on p!
  - Sellers want to sell iff $p \geq v_s$
  - Not all used car owners may be willing to sell at price p that buyers are willing to pay!
- **Endogenous** fraction **h** of good cars in *market* need not be same as **exogenous** fraction **g** of good cars in *population*
- What h—namely the extent of good cars traded—might we see?

Reasoning about outcomes: Self-fulfilling expectations

What outcome (distribution of car qualities in *market*) can arise *in equilibrium*?

- Recall: Uniform prices since cars are indistinguishable
- Sellers who find it profitable to sell at price p **depends** on p
- Price p that buyers are willing to offer depends on which sellers sell!

Self-fulfilling expectations equilibrium: A distribution of qualities (here h) such that:

- If buyers 'expect' this distribution (here, fraction h of cars for sale that are good), then the offered (*i.e.*, market-clearing) price *induces* that distribution of sellers in market (here, a fraction h of cars offered for sale will indeed be good)

Equilibrium outcomes

- When is h a self-fulfilling expectations equilibrium (SFEE)?
- h is an SFEE if there is a (market-clearing) price p^* 'supporting' fraction h, *i.e.*, p^* is such that
  - Sellers willing to sell at p^*, *i.e.*, with $v_s \leq p^*$, is such that fraction h of cars for sale are good
  - Expected value of cars to buyers *with 'distribution' h* is no smaller than price:

$$h \cdot b_H + (1 - h) \cdot b_L \geq p^*$$

- To put it another way:
  - Buyers do not want to change decision (price offered) given sellers' decisions
  - No seller wants to change decision—*either to sell* **or** *not sell*—given buyers' decision

Equilibrium outcomes in the used car market

- Recall: With complete information, efficient outcome with all cars sold is realized
  - What 'should happen' happens: $h = g$
- Our question: 'What does happen' with information asymmetry?
  - **Distribution** of qualities of cars on market is *endogenously* determined by strategic choices of traders
  - How does asymmetry affect efficiency:What is extent of trade h with asymmetry?
  - To find out: Solve for SFEE (self-fulfilling expectations equilibrium)!

Understanding equilibrium outcomes in the used-car market

- Consider market M with n buyers and m sellers, $n > m$ and asymmetric information
  - Seller values for good and bad cars: s_H, s_L $(s_H > s_L)$
  - Buyer values for good and bad cars: b_H, b_L $(b_H > b_L)$
  - Fraction of good car sellers in population $g < 1$
  - Recall: h is fraction of cars in *market* that are good

- ([A] True [B] False) There can be equilibria where only good cars are for sale (*i.e.*, $h = 1$) for some market M

  - No: This is precisely the 'adverse selection' idea!
  - Asymmetric information: Uniform price p for all cars
  - If good sellers are willing to sell, $p \geq s_H$ must hold
  - $s_H > s_L \Rightarrow p > s_L$: Bad sellers also willing to sell!
  - So h *cannot* be greater than g in any equilibrium

Identifying SFEE: An example

- Consider market with n buyers and m sellers, $n > m$
  - Seller values: $s_H = 10$, $s_L = 4$
  - Buyer values: $b_H = 12$, $b_L = 6$
  - Fraction of good car sellers in population $g = \frac{4}{5}$
- Which of the following is true?
  (Recall: h is fraction of cars for sale that are good)
  - $h = \frac{4}{5}$ is an SFEE
  - $h = \frac{3}{4}$ is an SFEE
  - Both $h = \frac{4}{5}$ and $h = \frac{3}{4}$ are SFEE
  - None of the above