ECO421: Adverse selection

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Plan

Introduction

Market for lemons

Insurance
- Flood insurance
- Obamacare

Screening with menus
- Monopolist with price-quality choice
- Adverse selection
- Menu

Conclusions

Introduction

- Last time, we learned how to model asymmetric information.
- Does asymmetric information affect behavior?
- One of the simplest cases is *adverse selection:*
  - one agent has a private information,
  - depending on the information, the agent may choose whether to trade with another agent,
  - the self-selection may hurt the other agent.

Introduction

- One of the simplest cases is *adverse selection:*
  - two players, Ann and Bob
  - Ann knows the state of the world (Ann's type),
  - Bob does not, but his payoffs depend on it.
  - Bob offers Ann a contract. Ann accepts it or rejects it depending on her type.
  - Bob's payoff from the contract depends on which type of Ann accept it.

    Bob needs to take it into account when choosing the contract.

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Market for lemons

Example

Used car market:

- two types of used cars: good (with probability λ) and bad (i.e. "lemon", with prob. $1 - \lambda$)
- sellers (current owners know the type of the used car)
- buyers do not (you can only learn the type after you use it for some time).

Example

Simple example:

- The value of the car for the buyers is $V_G = \$2000$ and $V_B = \$1000$.
- The value for the sellers is $U_G = \$1500$ and $U_B = \$750$. So, there are gains from trade.

Market for lemons

All-types trade

- All-type trade
  - Suppose that $\lambda = \frac{2}{3}$. Then, the market can operate at price $P = \$1600$.
  - Indeed, $P > U_B, U_G$ so both car owners are happy to trade.
  - Also, $P < \lambda V_G + (1 - \lambda) V_B = \frac{2}{3}2000 + \frac{1}{3}1000 = 1666$, so the buyers are happy to trade as well.
- Suppose that $\lambda = \frac{1}{3}$.
  - Then, $P < \lambda V_G + (1 - \lambda) V_B = \$1333$ for the buyer to be happy trading.
    For instance $P = 1300$.
  - But then, the good car owner does not want to trade!
  - If the good cars are not on the market, the value of the cars on the market for the buyer is equal to V_B.
  - But then, the buyers do not want to buy at $P > V_B$.

Market for lemons

All-types trade

- For what values of λ there is an all-type trade?
  - For all type trade, there must be a price P such that

$$P \geq \max\left(U_B, U_G\right) = U_G$$
$$P \leq \lambda V_G + \left(1-\lambda\right) V_B,$$

    which implies that

$$\lambda V_G + \left(1-\lambda\right) V_B \geq \max\left(U_B, U_G\right) = U_G.$$

  - In our example, it is $\lambda \geq \frac{1}{2}$.

Market for lemons

Some (but not all) types trade

- There is always price P such that only bad cars trade on the market: $P \in (U_B, V_B)$.
  - the buyer knows that the car is bad, so the price must be smaller than V_B,
  - the bad seller sells the car at any price above U_B.
- There is no price such that only good cars trade.
  - Why?

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Insurance markets

- Adverse selection is major issue in the insurance markets.
- Insurance companies charge fees and pay out compensation in case of damage.
- The fees are small if the overall probability of the damage is small.
- The problem is when only the risky individuals choose to insure themselves.
- Two examples:
  - flood insurance,
  - individual mandate in health insurance markets.

Insurance markets

Flood insurance

Example

Flood insurance pays out a compensation to homeowners in case of flooding.
Most insurance companies do not offer flood insurance. Or they offer, but as an add-on, at significantly higher cost. Why?

Insurance markets

Flood insurance

- Suppose that insurance charges fee p and pays out compensation C in case of damage.
- Homeowner buys insurance if

$$-p - \pi\left(D - C\right) + \Delta > -\pi D,$$

where
  - π is the probability of the damage,
  - D is the size of the damage,
  - and Δ is the risk premium (a value of peace of mind due to insurance).
- Thus, homeowner buys insurance if

$$p < \pi C + \Delta,$$

or

$$\pi > \frac{1}{C}\left(p - \Delta\right).$$

Insurance markets

Flood insurance: Identical homeowners

- First, suppose that all homeowners have the same probability of damage π. Then, they will buy insurance if

$$p < \pi C + \Delta.$$

- Insurance companies make profits if

$$p \geq \pi C.$$

  - law of large numbers.
- For the market to function, we need

$$p_{\text{both}} \in (\pi C, \pi C + \Delta).$$

Insurance markets

Flood insurance: Two types of homeowners

- Suppose that there are two types of homeowners $\pi_h > \pi_l$ and such that
$$\pi = \lambda \pi_h + (1 - \lambda)\, \pi_l .$$
  - high and low risk types: some homes are simply badly located, or badly graded,
  - we assume that the difference is significant:
  $$\pi_h - \pi_l > \frac{1}{\lambda} \frac{\Delta}{C},$$
  which means
  $$\Delta < \lambda \left(\pi_h - \pi_l \right) C .$$
- Each homeowner knows its type. λ
- Insurance companies do not.

Insurance markets

Flood insurance: Two types of homeowners

- If both types buy insurance, then

$$p \geq \pi C.$$

- Further

$$\begin{aligned} p \geq \pi C &= (\lambda \pi_h + (1 - \lambda) \pi_l) C \\ &= \lambda \pi_l C + \lambda (\pi_h - \pi_l) C \\ &> \lambda \pi_l C + \Delta! \end{aligned}$$

(we are using the fact that differences are significant)

- The last inequality means that the price is too high for the low-risk types.
- Market unraveling: Types l won't buy insurance.
- What happens to the price of insurance?

Insurance markets

Flood insurance: Two types of homeowners

- TBA
- If only high risk types buy the insurance, for the insurers to make profit, we need

$$p_{\text{only }h} \geq \pi_h C.$$

- Notice that

$$\begin{aligned}\frac{p_{\text{only }h}}{p_{\text{both}}} &\geq \frac{\pi_h C}{\pi C + \Delta} \\ &\geq \frac{\pi_h C}{\pi C + \lambda\left(\pi_h - \pi_l\right) C} \\ &= \frac{\pi_h}{2\lambda\left(\pi_h - \pi_l\right) + \pi_l} \\ &= \frac{1}{2\lambda\left(1 - \frac{\pi_l}{\pi_h}\right) + \frac{\pi_l}{\pi_h}}.\end{aligned}$$

- If $\frac{\pi_l}{\pi_h}$ and λ is very small (there are few very high risk types), the price on the "only *h*" market is much higher than on the "both" market.

Insurance markets

Flood insurance: Two types of homeowners

- With adverse selection, the low-risk types may stop buying insurance.
- That leaves the insurers with only high risk types.
  - market unraveling.
- Insurers need to jack-up prices.
- Result: flood insurance is rare and expensive.

Insurance markets

- How to deal with adverse selection?
- One way is to mandate that everybody buys insurance.
  - auto insurance (third party liability)
- Universal health coverage in almost all developed countries.
- One exception: US.

Insurance markets

- One of the major political debates in US over the last 10 years is about the ACA law, more commonly known as Obamacare.
- Prior to Obamacare, about 80% of adults 18-65 had medical insurance.
  - mostly people whose employers provided coverage for them and their families,
  - but, large number of employers did not provide insurance,
  - if you lost your job, and/or got employed by one of the no-insurance employers, it was difficult to find an affordable insurance
  - it was impossible, if you or your family had a pre-existing condition.
- Obamacare intended to change it.

Insurance markets

- Three major elements of Obamacare:
  - insurance companies cannot discriminate with respect to pre-existing condition,
  - subsidies for low-income people,
  - individual mandate: everybody has to buy coverage.
- The last requirement is least popular politically.
- But, without it, Obamacare may fall into so-called "death spiral".
  - In Canada, the "individual mandate" is known as the "universal coverage." It plays exactly the same role.

Insurance markets

Death spiral on Obamacare exchanges

- Why the mandate is important?
- Without it - market unraveling. Also, known as "death spiral":
  - the healthiest people withdraw from the market →
  - →prices go up→
  - →less healthy people withdraw from the market→
  - →prices go up even higher→
  - →even less healthy people stay on the market→
  - →....
  - →only the most sick people remain on the market.

Insurance markets

Death spiral on Obamacare exchanges

- The adverse selection story explains the form of the insurance market prior to Obamacare.
- The insurers could keep prices low
  - either by refusing to insure folks with pre-existing condition,
  - or by making sure that both healthy and sick people join the market
    - group insurance by employers creates a mini local individual mandate.

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Screening with menus

- Recall that we consider adverse selection with
  - two players, Ann and Bob
  - Ann knows the state of the world (Ann's type),
  - Bob does not, but his payoffs depend on it.
  - Bob offers Ann a contract. Ann accepts it or rejects it depending on her type.
  - Bob's payoff from the contract depends on which type of Ann accept it.
  - *Bob needs to take it into account when choosing the contract.*
- Can Bob do anything else?

Screening with menus

- Can Bob do anything else?
- Yes.
- Bob can try offer a different contract for each of the types.
  - menu of contracts,
- When would it work?

Screening with menus

Menus of contracts

- Airline tickets:
  - economy and first class.
- Health insurance:
  - low fee-high copay vs high fee-low copay,
- Car rentals:
  - fill the gas and penalty if not vs prepay gas.
- Phone companies.

Price-quality discrimination

Example

A monopolist sells good at price p and quality q. The cost of quality is $c(q) = \frac{1}{2}q^2$.
Two types of consumers: θ_h (with prob. λ) and $\theta_l < \theta_h$. A consumer has taste for quality θ and buys the good if only if

$$\theta q - p \geq 0.$$

Price-quality discrimination

No adverse selection

- First, suppose that there is no adverse selection, perhaps because the monopolist can distinguish between consumers.
- Then for each type θ, the monopolist chooses (p, q) that maximizes profits $p - c(q)$ st.

$$p \leq \theta q.$$

  - monopolist will choose $p = \theta q$.
  - profits

$$\max_q \theta q - \frac{1}{2} q^2.$$

  - FOC imply

$$q^* (\theta) = \theta.$$

Price-quality discrimination

No adverse selection

- With no adverse selection

$$p^*(\theta) = \theta^2,$$
$$q^*(\theta) = \theta.$$

- Consumer's utility

$$\theta^* q(\theta) - p^*(\theta) = 0!$$

  - monopolist gets all the consumer's utility.

Price-quality discrimination

- With adverse selection, there are many possibilities for the monopolist:
  - design good (p, q) so that both types will buy,
  - only h types buy,
  - only l types buy,
  - nobody buys.
  - menu: design two goods (p_l, q_l) and (p_h, q_h) so that the each type buys a different good.

Price-quality discrimination

Both types buy

- If both types buy, it must be that

$$p \leq \theta_h q, \text{ and } p \leq \theta_l q.$$

- Because the monopolist maximizes profits, it will choose $p^{both} = \theta_l q$.
- Profits

$$p - c(q) = \theta_l q - \frac{1}{2} q^2.$$

FOC imply that $q^{both} = \theta_l$, and the profits are equal to

$$\theta_l \theta_l - \frac{1}{2} (\theta_l)^2 = \frac{1}{2} \theta_l^2.$$

- Consumer l gets 0 utility, but consumer h is better off!

$$\theta_h q^{both} - p^{both} = \theta_h \theta_l - \theta_l^2 = (\theta_h - \theta_l)\, \theta_l > 0.$$

Price-quality discrimination

Only type h

- Only type h buys:
$$p \leq \theta_h q.$$
- Because the monopolist maximizes profits, it will choose $p = \theta_h q$.
- Profits
$$\lambda (p - c(q)) = \lambda \left(\theta_h q - \frac{1}{2} q^2 \right).$$
  - notice that the monopolist only serves fraction λ of the market.
- Similar calculations imply that the optimal profits are equal to
$$\lambda \frac{1}{2} \theta_h^2.$$

Price-quality discrimination

Only type l

- If type l buys, then
$$p \leq \theta_l q.$$
- But then, also
$$p \leq \theta_l q,$$
so type h buys as well.
- We have already considered this case.

Price-quality discrimination

Menu: Individual rationality

- Two goods (p_l, q_l) and (p_h, q_h).
- We must have

$$p_h \leq \theta_h q_h, \quad (IR_h)$$
$$p_l \leq \theta_l q_l \quad (IR_l)$$

  - these conditions are called *individual rationality*.

Price-quality discrimination

Menu: Incentive compatibility

- But also, it's better be the case that individuals want to buy the goods designed for them, and not the others.

$$\theta_h q_h - p_h \geq \theta_h q_l - p_l, \quad (IC_h)$$
$$\theta_l q_l - p_l \geq \theta_l q_h - p_h. \quad (IC_l)$$

  - it's called *incentive compatibility* (IC).
- If IC is violated, then
  - either we will be in the case where both types buy the same good,
  - or the individuals switch.

Price-quality discrimination

Menu: Incentive compatibility

- IC conditions:

$$\theta_h q_h - p_h \geq \theta_h q_l - p_l \text{ (IC}_h\text{)},$$
$$\theta_l q_l - p_l \geq \theta_l q_h - p_h \text{ (IC}_l\text{)}.$$

- Some algebra shows that

$$\theta_h (q_h - q_l) \geq p_h - p_l \geq \theta_l (q_h - q_l).$$

- By eliminating the term in the middle, we get

$$\theta_h (q_h - q_l) \geq \theta_l (q_h - q_l), \text{ or}$$
$$(\theta_h - \theta_l)(q_h - q_l) \geq 0.$$

Price-quality discrimination

Menu: Incentive compatibility

- Two inequalities:

$$\theta_h (q_h - q_l) \geq p_h - p_l \geq \theta_l (q_h - q_l),$$
$$(\theta_h - \theta_l)(q_h - q_l) \geq 0.$$

- Because the $\theta_h > \theta_l$, the second inequality implies that

$$q_h \geq q_l.$$

Because $\theta_l \geq 0$, the first inequalities imply that

$$p_h \geq p_l.$$

Lemma

If menu satisfies IC, then types h pay more and get higher quality goods.

Price-quality discrimination

Menu

- Because the monopolist charges the highest possible price, it must be that
$$p_h = p_l + \theta_h (q_h - q_l).$$
- Because IR_l condition must hold, we can take
$$p_l = \theta_l q_l.$$
  - notice that IR_h will always hold as $p_h = \theta_l q_l + \theta_h (q_h - q_l) = \theta_h q_h - (\theta_h - \theta_l) q_l < \theta_h q_h$!
- Profits:
$$\begin{aligned} &\lambda (p_h - c(q_h)) + (1-\lambda)(p_l - c(q_l)) \\ =&\lambda \left(\theta_l q_l + \theta_h (q_h - q_l) - \frac{1}{2} q_h^2\right) + (1-\lambda)\left(\theta_l q_l - \frac{1}{2} q_l^2\right). \end{aligned}$$

- Monopolist problem

$$\max_{q_h, q_l} \lambda \left(\theta_l q_l + \theta_h (q_h - q_l) - \frac{1}{2} q_h^2 \right) + (1 - \lambda) \left(\theta_l q_l - \frac{1}{2} q_l^2 \right).$$

- FOC wrt q_l:

$$\theta_l - \lambda \theta_h = (1 - \lambda) q_l, \text{ or}$$
$$q_l^* = \frac{\theta_l - \lambda \theta_h}{1 - \lambda}.$$

FOC wrt. q_h:

$$\lambda \theta_h = \lambda q_h, \text{ or}$$
$$q_h = \theta_h.$$

Price-quality discrimination

Optimal menu

- To summarize:
  - consumer l gets

$$q_l^{menu} = \theta_h, p_l^{menu} = p_l^{menu} + \theta_h \left(q_h^{menu} - q_l^{menu} \right),$$

$$q_l^{menu} = \frac{\theta_l - \lambda \theta_h}{1 - \lambda}, p_l^{menu} = \theta_l q_l^{menu}.$$

- Compare it to the menu from no adverse selection:

$$q_h^* = \theta_h, p_h^* = \theta_h q_h^*$$

$$q_l^* = \theta_l, p_l^* = \theta_l q_l^*.$$

Price-quality discrimination

Optimal menu

Lemma

IN optimal menu,

- *consumer l gets 0 utility and a good of worse quality than under no adverse selection.*
- *consumer h gets >0 utility and the same quality good as under no adverse selection.*

- World

Price-quality discrimination

Optimal menu

- To see it in another way, notice that the no adverse selection menu

$$q_h^* = \theta_h, p_h^* = \theta_h q_h^*$$
$$q_l^* = \theta_l, p_l^* = \theta_l q_l^*$$

  is no incentive compatible
  - there is no problem with IR.
- To see why, notice that if type h chooses (q_h^*, p_h^*), he gets 0 utility.
- But if type h chooses (q_l^*, p_l^*), he gets positive utility:

$$\theta_h q_l^* - p_l^* = \theta_h q_l^* - \theta_l q_l^* = (\theta_h - \theta_l)\, q_l^* > 0!$$

- To make sure that h type does not choose the good for type l, quality of type l good is reduced.

Price-quality discrimination

Menu: Incentive compatibility

- Airline will on purpose reduce the legroom to incentivize some of us to buy first-class ticket.
- Apple will on purpose put small HD into the Ipad, so that those of us who care strongly enough pay higher price for the larger drives.
- Etc. etc.

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What did we learn - concepts

- Adervse selection in lemons market and insurance
  - market unraveling.
- Screening with menus.
  - individual rationality and incentive compatibility
  - optimal menus

Conclusions

What did we learn - skills

- Find conditions for market unravelling due to adverse selection
- Check whether a menu is incentive compatible and indivdually rational.
- Find optimal menus.

Conclusions

Further reading

- Market for lemons
  - Akerlof, G. (1970), "The market for "lemons": Quality uncertainty and the market mechanism," Quarterly Journal of Economics, 84, 488-500.
- Competitive insurance market
  - Rothschild, M. and J. Stiglitz (1976), "Equilibrium in competitive insurance markets: An essay on the economics of imperfect information," Quarterly Journal of Economics, 90, 629-649.