Lecture – Private Information, Adverse Selection and Market Failure

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1 Private Information, Adverse Selection and Market Failure

- It used to be thought that markets for information are well-behaved, like markets for other goods and services. One could optimally decide how much information to buy, and hence equate the marginal returns to information purchases with the marginal returns to all other goods.
- In the 1970s, this unexamined belief was undermined by a set of seminal papers by Akerlof, Stiglitz, and Spence, all of whom went on to share the 2001 Nobel for their work on information economics.
- Information is not a standard market good:
  - Non-rivalrous (no marginal cost to each person knowing it)
  - Extremely durable (not consumed)
  - Not a typical experience good where you can 'try before you buy.' Cannot readily allow you to 'sample' information without actually giving you information.
  - Unlike other goods (or their attributes), information is extremely difficult to measure, observe, verify.
- This combination of odd properties often gives rise to settings where information is – at least potentially – *asymmetric*. That is, some agents in a market are better informed than others about the attributes of a product or transaction.
- The most natural (and surely ubiquitous) way in which this occurs is that buyers may have general information about the 'average' characteristics of a product they wish to buy whereas sellers will have specific information about the individual specimen of the product they are selling.

- A general point: when buyers and sellers have asymmetric information about market transactions, the trades actually completed may be biased to favor the actor with better information.

- Equally critically, many potentially Pareto-improving trades will not be completed due to informational asymmetries (that is, trades that would voluntarily occur if all parties had full information will not take place).

- Economic models of information are often about the information environment–who knows what when. Specifying these features carefully in the model is critical to understanding what follows.

- This lecture will cover two key results:

  1. The "Lemons Principle"
  2. The"Full Disclosure Principle"

- It turns out that these principles are roughly inverses.

2 Adverse Selection: The Market for Lemons (Akerlof, 1970)

- The fundamental problem:

  1. Goods of different quality exist in the marketplace.
  2. Owners/sellers of goods know more about their goods' quality than do buyers.
  3. Critical insight of Akerlof: *Potential buyers know that sellers know more about the quality of goods than they do.*

- This information asymmetry dramatically changes the market.

- It can easily be the case that there is *no trade* whatsoever for a given good even though:

  1. At any given price, there are traders willing to sell their products.
  2. At this price, there are buyers willing to buy the product.

- Akerlof (1970) was the first economist to analyze this paradox rigorously.

- Akerlof's paper was nominally about the market for used cars. It's always been folk wisdom that it's a bad idea to buy used cars–that 'you are buying someone else's problem.' But why should this be true? If used cars are just like new cars only a few years older, why should someone else's used car be any more problematic than your new car after it ages a few years?

- Let's take a simple example.
  - There are 2 types of *new* cars available at dealerships: good cars and lemons (which break down often).
  - The fraction of lemons at a dealership is λ.
  - Dealers do not distinguish (perhaps by law) between good cars versus lemons; they sell what's on the lot at the sticker price.
  - Buyers cannot tell apart good cars and lemons. But they know that some fraction $\lambda \in [0, 1]$ of cars are lemons.
  - After buyers have owned the car for any period of time, they also can tell whether or not they have bought a lemon.
  - Assume that good cars are worth \$2,000 to buyers and lemons are worth \$1,000 to buyers.
  - Finally, for simplicity (and without loss of generality), assume that cars do not deteriorate and that buyers are risk neutral.
- What is the equilibrium price for new cars? This will be

$$P^N = (1 - \lambda) \cdot 2,000 + \lambda \cdot 1,000.$$

- Since dealers sell all cars at the same price, buyers pay the expected value of a new car.
- Now, consider the used car market. Assume that used car sellers are willing to part with their cars at 20 percent below their new value. So,

$$S_G^U = \$1,600 \text{ and } S_L^U = \$800.$$

- Since cars don't deteriorate, used car buyers will be willing to pay \$2,000 and \$1,000 respectively for used good cars and lemons. Hence, there is a surplus of \$400 or \$200 gain from trade from each sale. Selling either a good car or a lemon yields a Pareto improvement.
- Question: What will be the equilibrium price of used cars?
- The natural answer is

$$P^U = (1 - \lambda) \cdot 1,600 + \lambda \cdot 800,$$

but this is not necessarily correct.

- Recall that buyers cannot distinguish good cars from lemons whereas owners of used cars know which is which. Assuming sellers are profit maximizing, this means that at any $P^U \geq 800$, owners of lemons will gladly sell them. But at $P^U < 1,600$, owners of good cars will *keep* their cars.

- Denote buyers' willingness to pay for a used car as B^U.

- If there will be trade in equilibrium, buyers' willingness to pay must satisfy the following inequality: $B^U\left(E\left(S^U\left(P\right)\right)\right) \geq P$. That is, at price P, the quality of cars available for sale, $S^U\left(P\right)$, must be worth at least that price to buyers.

- The quality of cars available depends on the price. In particular, the share of Lemons is as follows:

$$\Pr\left(\text{Lemon}|P\right) = \begin{cases} 1 & \text{if } P < 1,600 \\ (1-\lambda) & \text{if } P \geq 1,600 \end{cases}.$$

  That is, quality is *endogenous* to price. More specifically:

$$E\left(S^U\left(P\right)\right) = \begin{cases} 800 & \text{if } P < 1,600 \\ 800 \cdot \lambda + (1-\lambda) \cdot 1,600 & \text{if } P \geq 1,600 \end{cases}$$

- What is $B^U\left(E\left(S^U\left(P\right)\right)\right)$? The value to buyers of cars for sale as a function of price is:

$$B^U\left(P\right) = \begin{cases} 1000 & \text{if } P < 1,600 \\ \lambda \cdot 1000 + (1-\lambda) \cdot 2000 & \text{if } P \geq 1,600 \end{cases}$$

- The willingness of buyer's to pay for used cars depends upon the market price (a result we have not previously seen in consumer theory).

- Take the case where $\lambda = 0.4$. Consider the price $P = 1,600$. At this price, the expected value (to a buyer) of a randomly chosen used car–assuming both good cars and lemons are sold–would be

$$B^U\left(P = 1,600, \lambda = 0.4\right) = (1-0.4) \cdot 2000 + 0.4 \cdot 1000 = 1,600.$$

  Here, used cars sell at exactly the average price at which potential sellers value them. Owners of good cars are indifferent and owners of lemons get a \$800 surplus. This equation therefore satisfies the condition that $B^U\left(S^U\left(P\right)\right) \geq P$.

- But now take the case where $\lambda = 0.5$. At price $P = 1,600$, the expected value of a randomly chosen used car is:

$$B^U\left(P = 1,600, \lambda = 0.5\right) = (1-.5) \cdot 2000 + .5 \cdot 1000 = 1,500.$$

- $B^U\left(S^U(P)\right) < P$. This cannot be an equilibrium. Since owners of good used cars demand $\$1,600$, then they will not sell them at $\$1,500$. But $P = 1,500$ is the maximum price that buyers would be willing to pay given that half of the used cars are lemons. Hence, good used cars will not be sold in equilibrium.

- If $\lambda > 0.4$, then good used cars are not sold and $P \in [800, 1000]$. In this price range, $B^U\left(S^U(P)\right) \geq P$.

- Main point: if the share of lemons in the overall car population is high enough, the bad products drive out the good ones. Although buyers would be willing to pay $\$2,000$ for a good used car, their inability to distinguish good cars from lemons means that they are not willing to pay more than $\$1,500$ for *any* used car. With λ high enough, no good cars are sold, and the equilibrium price must fall to exclusively reflect the value of lemons.

2.1 Summing up the Akerlof adverse selection model

- The key insight of Akerlof's paper is that market quality is *endogenous,* it depends on price. When sellers have private information about products' intrinsic worth, they will only bring *good* products to market when prices are high.

- Buyers understand this, and so must adjust the price they are willing to pay to reflect the quality of the goods they expect to buy at that price.

- *In equilibrium, goods available at a given price must be worth that price.* If they are not, then there will be no equilibrium price and it's possible that no trade will occur (which is the case in the lemons model in the Akerlof paper.)

3 A richer example

- Now that we have seen a stylized example, let's go through the same logic with a richer example. We will consider a continuous distribution of product quality (rather than just two types: good cars and lemons).

- Consider the market for 'fine' art. Imagine that paintings are worth between $\$0$ and $\$100,000$ dollars to sellers (denote this as V_s), and that they are uniformly distributed between these two values, so the average painting is worth $\$50,000$ to a seller.

- The only way to know the value of a painting is to buy it and have it appraised. Buyers cannot tell masterpieces from junk. Sellers can.

- Assume that buyers value paintings at 50% above the seller's price (denote this as V_b). If a painting has $V_s = \$1,000$ then $V_b = \$1,500$.

- What is the equilibrium price of paintings in this market? An equilibrium price must satisfy the condition that the goods that sellers are willing to sell at this price are worth that price to buyers: $V_b\left(E\left(V_s\left(P\right)\right)\right) \geq P$.

- Take the sellers' side first. A seller will sell a painting if $P \geq V_s$.

- There is a range of sellers, each of whom will put their painting on the market if $P \geq V_s$.

- What is the *expected* seller's value of paintings for sale as a function of P? Given that paintings are distributed uniformly, it is:
$$E(V_s\left(P\right)) = \frac{0+P}{2}.$$
So, if $P = 100,000$ then *all* paintings are available for sale and their expected value to sellers is $\$50,000$. If $P = 50,000$, the expected seller value of paintings for sale is $\$25,000$.

- Now take the buyer's side. Since the $V_b = 1.5 \cdot V_s$, buyers' willingness to pay for paintings as a function of their price is
$$V_b\left(E\left(V_s\left(P\right)\right)\right) = 1.5 \cdot E(V_s\left(P\right)) = 1.5\left(\frac{0+P}{2}\right) = \frac{3}{4}P.$$
Clearly $V_b\left(E\left(V_s\left(P\right)\right)\right) < P$. No trade occurs

- Given that buyers value paintings strictly above the seller's price, this result is ironic. What's wrong?

- The sellers of low-quality goods generate a negative externality for sellers of high quality goods. For every \$1.00 the price rises, seller value only increases by \$0.50 because additional low-quality sellers crowd into the market $\left(\frac{\partial E(V_s|P\geq V_s)}{\partial P} = 0.5\right)$.

- And for every dollar that the price rises, buyer value only increases by \$0.75 $\left(\frac{\partial E(V_b|P)}{\partial P} = 0.75\right)$. And so the twain do not meet.

- This is in effect the "Lemons Principle" – The goods available at a given price are worth less than or equal to that price (to sellers).

- In this example, there is no trade.

4 Reversing the Lemons equilibrium

- Is there a way around this result? Intuition should suggest that the answer is yes. Sellers of good products have an incentive to prove their products' quality so they can sell at their true value. (Otherwise, they may not sell at all.)

- This type of disclosure not occur in the example above because I have stipulated that the value of a piece of art can only be assessed by appraisal *ex-post*. Sellers of good paintings have no credible means to convey this information b/c sellers of low-quality goods will also claim that they have high quality paintings.

- Needed: a means to disclose information credibly. If there is an inexpensive (or free) means to credibly disclose the quality of paintings, sellers of above average paintings will probably want to do this. In fact, the result is much stronger than this.

4.1 Simplest case: Costless verification

- Imagine now that a seller of a painting can get a free appraisal. This appraisal will credibly convey the true seller's value of the painting (and so the buyer's willingness to pay will be 1.5 times this value). Who will pay to get this appraisal?

- Your first guess might be that since buyers are willing to pay $\$75,000$ for a painting of average quality, any seller with a painting that would sell for at least $\$75,000$ if appraised would choose to get an appraisal. This is on the right track but incomplete.

- The reason it is incomplete is that the decisions of some sellers to appraise their paintings affects buyers' willingness to pay for non-appraised paintings.

- If only sellers with $V_s \geq 75,000$ had their paintings appraised, what would be the market price of non-appraised paintings?

$$1.5 \cdot E\left(V_s | V_s < 75,000\right) = 56,250.$$

- But if the market price is only $56.250, then sellers with paintings at or above this price will also get them appraised. What is the new market price of non-appraised paintings?

$$1.5 \cdot E\left(V_s | V_s < 56,250\right) = 42,888.$$

- And so on...

- You can keep working through this example until you eventually conclude that *all* sellers will wish to have their paintings appraised. Why? Because each successive seller who has his painting appraised devalues the paintings of those who do not. This in turn causes additional sellers to wish to have their paintings appraised. In the limit, the only seller who doesn't have an incentive to obtain an appraisal is the seller with $V_s = 0$. This sellers is indifferent.

- What is operative here is the **Full-Disclosure Principle.** Roughly stated: If there is a credible means for an individual to disclose that he is above the average of a group, she will do so. This disclosure will implicitly reveal that other non-disclosers were below the average, which will give them the incentive to disclose, and so on... In equilibrium, everyone will explicitly or implicitly disclose their private information. (If there is a cost to disclosure, there will typically be a subset of sellers who do not find it worthwhile to disclose.)

- The Full Disclosure Principle is essentially the inverse of the Lemons Principle. In the Lemons case, the bad products drive down the price of the good ones. In the Full Disclosure case, the good products drive down the price of the bad ones. What distinguishes these cases is simply whether or not there is a credible disclosure mechanism (and what the direct disclosure costs are).

4.2 A simpler example of the full-disclosure principle

- Consider the following simple case.

- 100 bullfrogs are arrayed around a pond on a moonless night. Females choose mates according to their croaks. The frog with the deepest croak attracts the best mate, and so on... Each of the male frogs has a different croaking depth, and they all know where they stand in the ranking. If a frog doesn't croak, females take their best guess at his croaking depth (i.e., the expected value). The question: Which frog(s) croak, thereby revealing their type?

- Consider the decision of the frog with the 49th deepest croak (i.e., the frog just above average). Clearly, he should croak since females will otherwise assume that he is only as good as the average frog. Similarly, frogs 1 - 48 should croak since they are all above average too.

- What about the below average frogs? Now that the first 51 frogs have croaked, females should assume that the silent frogs are all below the average of the croaking frogs. Recognizing this, all of the frogs that are above the average of the previously silent group should now croak. So frogs 51 - 74 should also croak.

- Since frogs 75 - 100 are clearly below the average of the frogs that have croaked, frogs numbered 76 - 83 should now croak to show that they are above the average of the previously silent group...

- In the end, all of the frogs will croak, except perhaps for the highest pitched frog, who needn't bother since his type is implicitly revealed.

4.3 More complex case: Costly verification

- Imagine now that a seller of a painting must pay $\$5,000$ for a appraisal. Which paintings will be appraised? If there are non-appraised paintings, will they be sold and at what price?

- We now need to consider three factors simultaneously:

  1. The net price a painting would get if appraised (net of the appraisal fee)
  2. The price a painting would get if not appraised
  3. The value of the painting to the seller (remember that sellers won't sell for a net price less than V_s).

- The following conditions must be satisfied in equilibrium:

  1. Buyer's willingness to pay for an appraised painting is greater than or equal to seller's value of painting:
  $$V_b\,(A=1) \geq V_s + 5000,$$
  We will refer to this as Individual Rationality Constraint 1 ($IR1$).
  2. Buyer's willingness to pay for a non-appraised painting is greater than or equal to seller's value of painting:
  $$V_b\,(A=0) \geq V_s$$
  We will refer to this as Individual Rationality Constraint 2 ($IR2$).
  3. Seller cannot do better by appraising a non-appraised painting or v.v. We will refer to this as the Self-Selection Constraint (SS). Consider a cutoff value V_s^*. In equilibrium Paintings with $V_s \geq V_s^*$ are appraised and paintings with $V_s < V_s^*$ are not:
  $$V_b\,(V_s \geq V_s^*, A=1) - 5,000 \geq V_b\,(V_s \geq V_s^*, A=0)$$
  and
  $$V_b\,(V_s < V_s^*, A=1) - 5,000 \leq V_b\,(V_s < V_s^*, A=0)\,.$$

- Let's go through these one at a time.

1. Rewriting $IR1$, we have:

$$\begin{aligned} V_b (A = 1) &\geq V_s + 5000, \\ 1.5V_s &\geq V_s + 5000. \end{aligned}$$

2. Rewriting $IR2$, we have:

$$\begin{aligned} V_b (A = 0) &\geq V_s, \\ 1.5 \cdot E (V_s \leq V_s^*) &\geq V_s, \\ 1.5 \cdot E (V_s \leq V_s^*) &\geq V_s^*. \end{aligned}$$

3. Rewriting SS, to solve for the critical value of V_s^*:

$$\begin{aligned} V_b (V_s = V_s^*, A = 1) &= V_b (V_s = V_s^*, A = 0), \\ 1.5V_s^* - 5,000 &= \frac{1.5V_s^*}{2}. \end{aligned}$$

(This implicitly satisfies the second inequality in SS as well: $V_b (V_s < V_s^*, A = 1) \leq V_b (V_s < V_s^*, A = 0)$.)

- Let's solve these out of order.

   1. Solving $IR1: \; 1.5V_s \geq V_s + 5000 \Rightarrow V_s \geq 10,000$. That is, no painting under \$10,000 would be appraised because the purchase price at the appraised value would not compensate the seller for his reservation price.
   2. Solving $IR2 : 1.5 \cdot E (V_s \leq V_s^*) \geq V_s^* \Rightarrow \frac{3}{4}V_s^* \geq V_s^* \Rightarrow V_s^* = 0$. $IR2$ can only be satisfied with $V_s^* = 0$. That is, as in the pure adverse selection case above, non-appraised paintings cannot be sold. There is no market in non-appraised paintings because buyers willingness to pay for them in lower than sellers' than willingness to accept.
   3. Solving SS for V_s^* gives $\frac{3}{4}V_s^* \geq 5,000 \Rightarrow V_s^* = \$6,666$.

- Combining these results, we have

$$\begin{aligned} V_s^* &= 10,000, \\ P (A = 1) &\geq \max [V_s^* + 5,000, 15,000] \leq 1.5 \cdot V_s^*, \\ P (A = 0) &= \emptyset, \end{aligned}$$

That is, paintings with $V_s \geq 10,000$ are appraised and sold at $\leq 1.5 \cdot V_s^*$ but with a minimum price of $15,000$ (the lowest price that a seller of an appraised painting with $V_s = 10,000$ would accept).

- Paintings that are not appraised are not sold because buyers would be willing to pay no more than $\$7,500$ for them if all were sold. But at that price, only paintings worth up to $\$7,500$ would be sold, meaning that buyers would only be willing to pay $\$5,625$, and so on...

5 Conclusions

- Unobservable quality heterogeneity creates important problems for market efficiency – market failures or incomplete markets quite likely.
- If Lemons hypothesis is correct, there should be some market mechanisms *already in place* to partly solve the problem. If no one was trying to solve the problem, we would have reason to doubt that Lemons problem exists.
- What are some of these mechanisms?
  - Private mechanisms: Information provision, warranties, brand names, specialists and testers.
  - Licensing.
  - Mandated information provision.
  - Legal liability.
  - Regulation.
  - Example: Health insurance 'open enrollment' periods. Life insurance applications.
  - Lemon laws.
- Are there any markets that simply don't exist because of adverse selection (and possibly moral hazard)?
  - Lifetime income insurance
  - Others?