

Lecture Note 22: Private Information, Adverse Selection and Market Failure

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Private Information, Adverse Selection and Market Failure

- In our discussion of signaling, we touched on the fact that sometimes certain actors in the market have information that their transaction partners do not have. Where there is this kind of private information, there is an incentive for both agents to engage in strategic behavior. George Akerlof won a Nobel prize for demonstrating how this behavior could alter or shut down markets that would otherwise work well.
- We will cover Akerlof's seminal 1970 paper on the topic, which sets up the following scenario: imagine that you are selling a product (e.g., used cars). Potential buyers that come onto your lot know the distribution of product quality (they know that some used cars work well, and others are "lemons," i.e. total garbage). How much should the buyer be willing to pay for a used car? The intuitive answer might be the *expected value* of the product.
- But this preliminary answer ignores an important consideration: you (the seller) get to choose which individual car you actually sell, and you may *know* which cars are valuable and which are lemons. So if the buyer offers a certain price, you might accept that price but sell her a lemon. Since the buyer knows this, she will offer a lower price in the expectation that she'll get a bad car. In which case, you certainly should not sell her one of your better cars. Knowing she will certainly get a worse car (because she has lowered her offer price), she lowers her offer price again...
- In equilibrium, you could face a scenario where both agents would be happy to make a deal on a given product. But one agent has private information about the product and the other player knows they might get ripped off, and nobody trades in the end. This same principle comes up in other important markets – most famously, health insurance – but we will get to that after establishing this theory formally.

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

1.1 The fundamental problem:

1. Goods of different quality exist in the marketplace.
 2. Sellers of goods *know more than potential buyers* about the quality of goods that they are selling.
 3. Akerlof's critical insight: *Potential buyers know that sellers know more about the quality of goods than they do.*
- This information asymmetry can substantially affect the market equilibrium. It is possible that there will be *no trade* whatsoever for a given good, even though:
 1. At any given price p_0 , there are traders willing to sell their products.
 2. At price p_0 , there are buyers willing to pay strictly above p_0 for the good that traders would like to sell.
 - Akerlof (1970) was the first economist to analyze this paradox rigorously. His 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?

1.2 A simple example: The market for used cars

- Setting
 - 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 publicly distinguish 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 $B_N^G = \$20,000$ to buyers and lemons are worth $B_N^L = \$10,000$ to buyers.
 - 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

$$P_N = (1 - \lambda) \cdot 20,000 + \lambda \cdot 10,000.$$

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

$$S_U^G = \$16,000 \text{ and } S_U^L = \$8,000.$$

- Since cars don't deteriorate, used car buyers will be willing to pay $B_U^G = \$20,000$ and $B_U^L = \$10,000$ respectively for used good cars and lemons. There the buyer and seller together gain a surplus of \$4,000 or \$2,000 from each sale. (Which actors actually gets the surplus may depend on bargaining power, but it isn't important for this model.) Selling either a good car or a lemon is potentially Pareto improving.
- Question: What will be the equilibrium price of used cars?
- Your initial answer might be

$$P_U = E[S_U] = (1 - \lambda) \cdot 16,000 + \lambda \cdot 8,000.$$

But this is not necessarily correct.

- Recall that buyers cannot distinguish good cars from lemons, while owners of used cars know which is which. Sellers will only part with their cars if offered a price that is greater than or equal to their reservation price. Recall that reservation selling prices $S_U^L = 8,000$, $S_U^G = 16,000$. So, for $P_U \geq 8,000$ owners of lemons will gladly sell their cars. However, for $P_U < 16,000$, owners of good cars would prefer to keep their cars.
- Given these reservation selling prices, the quality of cars available depends on the price. In particular, the share of Lemons is as follows:

$$Pr(Lemon|P_u) = \begin{cases} 1 & \text{if } P_U < 16,000 \\ \lambda & \text{if } P_U \geq 16,000 \end{cases}$$

- That is, quality is endogenous to price. More specifically, we can say that expected reservation selling price reflects quality of cars available for sale:

$$E[S_U|P_U] = \begin{cases} 8,000 & \text{if } P_U < 16,000 \\ 8,000 \cdot \lambda + (1 - \lambda) \cdot 16,000 & \text{if } P_U \geq 16,000 \end{cases}$$

- (Side Note: Recall that in recitation we discussed how, in markets with imperfect information, the composition of products in the market changes as the price changes. This happened in the Spence signaling model, where job offers that employers post changes whether high- and low-ability workers apply for the job. This also happens in the insurance market on Problem Set 6, where the price an insurer offers changes how sick the pool of buyers is on average. The exact same fundamental mechanism is happening here.)
- The value to buyers of cars for sale as a function of price is:

$$B_U(E[S_U|P_U]) = \begin{cases} 10,000 & \text{if } P_U < 16,000 \\ 10,000 \cdot \lambda + (1 - \lambda) \cdot 20,000 & \text{if } P_U \geq 16,000 \end{cases}$$

- The willingness of buyer's to pay for used cars also depends upon the market price (a result we have not previously seen in consumer theory).
- If there will be trade in equilibrium, buyers' willingness to pay must satisfy the following inequality: $B_U(E[S_U|P_U]) \geq P_U$. At the realized transaction price P_U , the quality of cars available for sale (as reflected in $E[S_u|P_u]$) must be worth at least that price to buyers.
- First, consider the case where $\lambda = 0.4$. Consider the price $P_U = 16,000$. 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

$$B_U(P_U = 16,000, \lambda = 0.4) = (1 - 0.4) \cdot 20,000 + 0.4 \cdot 10,000 = 16,000.$$

Here, used *good* 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 \$8,000 surplus. In math, this equation satisfies the condition $B_U(E[S_U|P_U]) \geq P_U$.

- But now take the case where $\lambda = 0.5$. At price $P_U = 16,000$, the expected value of a randomly chosen used car is:

$$B_U(P_U = 16,000, \lambda = 0.5) = (1 - 0.5) \cdot 20,000 + 0.5 \cdot 10,000 = 15,000.$$

Hence, $B_U(E[S_U|P_U]) < P_U$. Since owners of good used cars demand \$16,000, they will not sell their cars at \$15,000. Yet, $P_U = 15,000$ is the maximum price that buyers will be willing to pay for a used car, given that half of all cars are lemons. Consequently, good used cars will *not* be sold in equilibrium, despite the fact that they are worth more to buyers than to sellers. Thus, *only* lemons sell in equilibrium.

- More generally, if $\lambda > 0.4$, then good used cars are not sold and lemons sell for $P_u \in [8,000, 10,000]$.

- Bottom line: If the share of lemons in the overall car population is high enough, the bad cars will drive out the good ones. Although buyers would be willing to pay \$20,000 for a good used car, their inability to distinguish good cars from lemons means that they will not be willing to pay more than \$15,000 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.
- (Side Note: You may notice a parallel between this and our discussion about “Ban the Box.” Banning the box made it difficult for employers to distinguish between non-felons and felons, which then made them reluctant to interview minorities (who, in the United States, are more likely to be felons). Loosely speaking, by prohibiting employers from distinguishing among applicants who may be more or less desirable, “Ban the Box” generates an adverse selection problem: employers cannot tell felons from non-felons; and felons have no incentive to reveal this information once the “Box” is banned. Akerlof’s model shows that adverse selection can potentially ‘shut down’ a market, such as the market for used cars. Agan and Starr’s paper provides evidence that banning the box had the effect of ‘shutting down’—or at least substantially harming—the job market prospects of minority applicants.)

1.3 Summing up the Akerlof adverse selection model

- The key insight of Akerlof’s paper is that in markets with private information, the quality of goods sold in the market is *endogenous*: it depends on the market price. When sellers have private information about products’ intrinsic worth, they will only bring *good* products to market if 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, the average good 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.
- The underlying economics of adverse selection are very nicely explicated in the 2011 paper on your reading list, “Selection in Insurance Markets: Theory and Empirics in Pictures,” by Liran Einav and (our very own) Amy Finkelstein. The examples in their paper are geared towards the health insurance market, but they apply equally well to any market setting where adverse selection is present. (These figures recall Chapter 7 of Schelling’s book *Micromotives and Macrobehavior*, which we discussed in an earlier lecture.)
- Here’s a useful brief excerpt from their paper: “The link between the demand and cost curve is arguably the most important distinction of insurance markets (or selection markets more generally) from traditional product markets. The shape of the cost curve is driven by the demand-side customer selection. In most other contexts, the demand curve and cost curve are independent objects; demand is determined by preferences and costs by the production technology. The distinguishing feature of selection markets is that the demand and cost curves

are tightly linked, because the individual's risk type not only affects demand but also directly determines cost."

In this paragraph, the "demand side" of the market refers to consumers who differ in their expected health costs—i.e., some are sicker than others—and the "cost curve" refers to insurers' cost of providing health insurance to these consumers. Adverse selection arises because, in most realistic cases, consumers are better informed about their expected health costs than are insurers. The insight of the paragraph is that insurers' costs of providing policies depend on which consumers buy the policies, which is itself determined by what the policies cost. Specifically, the insurer's cost depends on the health of the consumers who choose to purchase the policy at a given price.

Figures 1, 2a and 2b of Einav-Finkelstein provide a nice graphical depiction of these insights. Figure 1 corresponds to a case where adverse selection causes an efficiency loss in an insurance market, but the market does not shut down entirely. Figure 2a corresponds to a case where adverse selection causes no efficiency loss (though it does transfer consumer surplus from low-risk consumers to high-risk consumers). Figure 2b depicts a case where adverse selection leads the insurance market to shut down: no one receives insurance even though all consumers are risk averse and hence willing to pay *more than* the actuarially fair cost of an insurance policy.

1.4 Keep in mind: Underneath the hood, we are invoking the Nash equilibrium

We implicitly invoked the Nash equilibrium concept in solving the used car example above. I'd like to take a few paragraphs to make this concept explicit, so that you can recognize a Nash equilibrium when you see one.

- We first worked out the strategies of used car sellers, taking as given the price offered by buyers. We concluded that if the offer price was less than 16,000, only lemons were sold. If the offer price was $\geq 16,000$, both lemons and good cars were sold.
- We observed that buyers have two primary strategies available: offering 8,000 and offering 16,000.
- We then asked which of these buyer strategies constituted a Nash equilibrium given the strategies of sellers.
- Offering 8,000 is always a Nash equilibrium. If a buyer offers 8,000, then sellers will offer only lemons. Since these cars are worth 8,000 to the seller and 10,000 to the buyer, the buyer and seller are both happy with this outcome and have no desire to change their behavior. These strategies therefore constitute a Nash equilibrium. Neither party wishes to deviate from their strategy (e.g., offer more, sell a good car) given the strategy of the other player.
- We next asked whether offering 16,000 could also be a Nash equilibrium. The answer, as we saw, depends upon λ , the population share of lemons. At offer price 16,000, both lemons and

good cars are sold (that's the sellers' strategy). For this to be a Nash equilibrium, buyers must be happy to pay a price of 16,000, given the sellers' strategies when facing this price. We calculated that the value to buyers of cars available at offer price 16,000 is:

$$E[S_U|P_U = 16,000] = (1 - \lambda) \cdot 20,000 + \lambda \cdot 10,000.$$

For $P_u = 16,000$ to be a Nash equilibrium, it must be the case that $B_U = 1.25 \times E[S_U|P_U = 16,000] \geq 16,000$, which requires that $\lambda \leq 0.4$. So if $\lambda \leq 0.4$, the pooling equilibrium where both cars are sold is indeed an equilibrium. If $\lambda > 0.4$, then the pooling equilibrium cannot hold, and only lemons are sold.

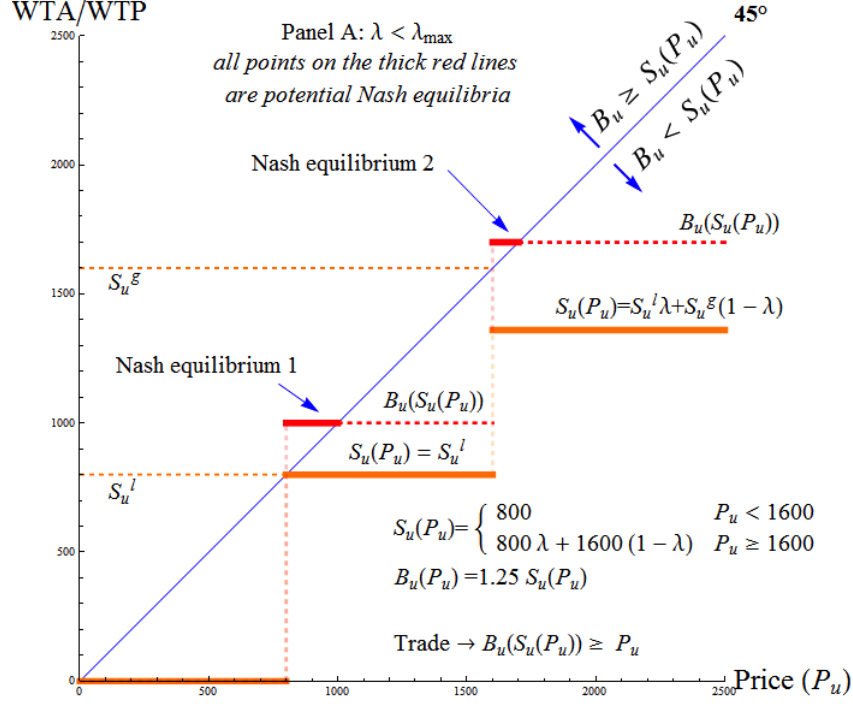
We can visualize the Nash equilibrium logic of the used car example above by plotting $S_U(P_U)$ and $B_U(S_U(P_U))$ for different values of λ , as in Figures 1 and 2 below. These figures plot $S_U(P_U)$ and $B_U(S_U(P_U))$ on the y -axis and P_U on the x -axis. Nash equilibria are visible as ranges (highlighted in dark red) where $B_U(S_U(P_U))$ lies above the 45° line, implying that $B_U(S_U(P_U)) \geq P_U$ at price P_U .¹

To match the following figure—generously donated by 14.03/003 alumnus Sergey Naumov—we will deflate all values used in this illustration by 10. Thus, good cars and bad cars are worth, respectively, 2,000 and 1,000 to buyers. Good and bad cars are worth, respectively, 1,600 and 800 to sellers.

In Figure 1, $\lambda = 0.3$, and there are two ranges of Nash equilibria: $P_U \in [800, 1000]$ and $P_U \in [1,600, 1,700]$. (Why is P_U capped at 1,700 not 1,800? Because $S_U(P_U \geq 1,600) = 0.3(800) + 0.7(1,600) = 1,360$ and $1,360 \times (1/0.8) = 1,700$. So $B_U(S_U(P_U(1,600))) = 1,700$.)

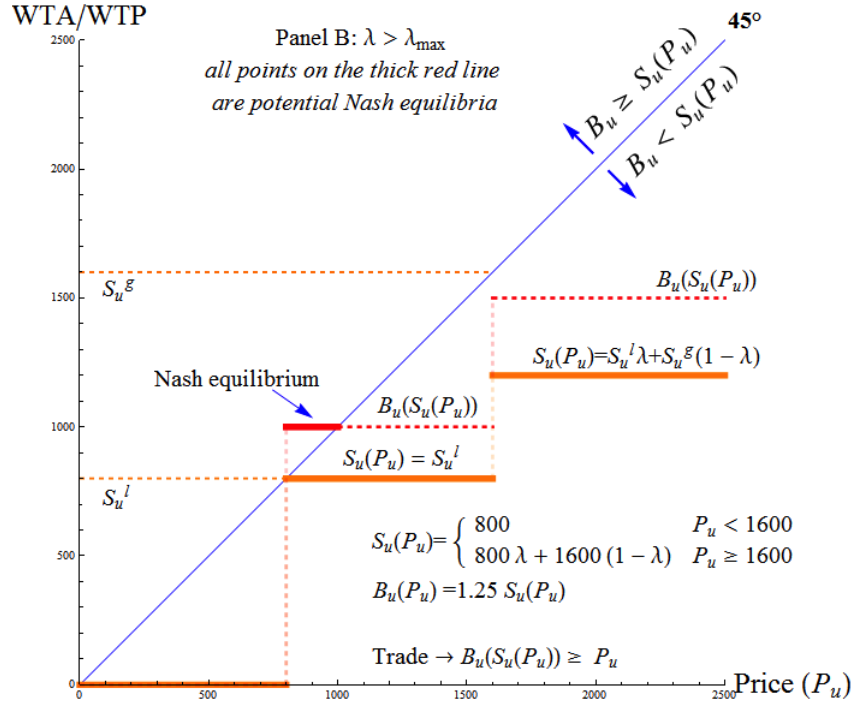
¹Many thanks to Sergey Naumov for these nice figures.

Figure 1: Potential Nash Equilibria of Used Car Market with $\lambda = 0.3$



In Figure 2, $\lambda = 0.5$, and there is only one range of Nash equilibria: $P_U \in [800, 1000]$. For $P_U \geq 1,600$ we have $S_U(P_U \geq 1,600) = 0.5(800) + 0.5(1,600) = 1,200$ and $B_U(S_U(P_U \geq 1,600)) = 1,500$, which is less than P_U . Thus, there is no Nash equilibrium above $P_U = 1,000$.

Figure 2: Potential Nash Equilibria of Used Car Market with $\lambda = 0.5$



2 Is Adverse Selection ‘a Thing?’

- If Lemons (adverse selection) hypothesis is correct, there should be some market mechanisms *already in place* to ameliorate the problem. After all, free markets often fix problems when extra surplus is available. Conversely, if no economic agent was observed attempting to solve the problem, we would have reason to doubt that the Lemons problem is relevant.
- 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 (or moral hazard)?

- Lifetime income insurance
- Why is health insurance so expensive for the unemployed?
- Why doesn't my life insurance policy cover suicide during the first five years after purchase?
- Why can't I buy insurance against getting a low GPA at MIT?
- Health insurance:
 - Health club benefits, maternity benefits—why are these offered?
 - Why do individual policies cost so much more than group policies?
- Auto insurance: You can choose your deductible, but your premium rises nonlinearly as you choose lower and lower deductibles. Why?
- What if MIT allowed new Economics professors to choose between two salary packages: low salary plus guaranteed tenure or high salary but no tenure guarantee. Assume there is no moral hazard problem (i.e., professors don't slack-off if tenured). Will this personnel policy yield a desirable faculty?

3 The Costs of Adverse Selection: A Simple Example of Public Insurance Provision

This example is inspired by the Einav-Finkelstein (2011) paper on your reading list. These section will re-iterate the mechanism behind the Lemons problem in the context of health insurance, and then will discuss the various ways in which markets and/or policies might ameliorate the issue.

Consider a unit mass of consumers i indexed from $i \in [0, 1]$, each of whom has a VNM expected utility function of the form $U(w_i) = \ln(w_i)$. Each consumer i has initial wealth $w_{0i} = 150$ and faces a 50% probability of suffering loss $L_i = i \times 100$ (e.g., by racking up large health care bills). Thus, for consumer $i = 0.60$:

$$E[w_i] = 150 - 0.5 \times 60 = \$120$$

$$U(E[w_i]) = \ln(120) = 4.79$$

$$E[U(w_i)] = 0.5 \times \ln(150) + 0.5 \ln(90) = 4.76$$

$$CE(E[U(w_i)]) = \exp(4.76) = \$116$$

Note that this CE calculation came from the equation $0.5 \times \ln(150) + 0.5 \ln(90) = \ln(x)$. Thus, $i = 0.60$ is willing to pay a \$4 risk premium ($\$120 - \116) to obtain full insurance.

Generalizing this calculation to any consumer i , we can write that i has the following wealth, expected utility, certainty equivalent income, etc.:

$$E[w_i] = 150 - 0.5 \times 100 \times i$$

$$U(E[w_i]) = \ln(150 - 0.5 \times 100 \times i)$$

$$\begin{aligned} E[U(w_i)] &= 0.5 \times \ln(150) + 0.5 \ln(150 - 100 \times i) \\ &= \ln\left(150^{0.5} \times (150 - 100 \times i)^{0.5}\right) \end{aligned}$$

$$CE(E[U(w_i)]) = \exp(E[U(w_i)]).$$

We can also calculate consumer i 's willingness to pay for insurance *in excess of* its actuarially fair value:

$$\begin{aligned} WTP_i &= \exp(\ln(150 - 0.5 \times 100 \times i)) - \exp(E[U(w_i)]) \\ &= (150 - 0.5 \times 100 \times i) - (150 \times (150 - 100 \times i))^{0.5} \end{aligned}$$

Assume that each consumer knows his or her type i but that insurers cannot distinguish individual types.

3.1 The naive policy

Consider a policy that pays each consumer L_i in the event of loss. That is, if i loses $L_i = 100 \times i$, the insurer pays L_i to i to compensate her for the loss. A naive insurer decides to offer this policy at the price of \$25 since the average expected loss across the full population is \$25 per consumer (since $L_i \sim U[0, 100]$, so $E[L_i] = 50$, and each consumer faces a 50% probability of loss). Which consumers will purchase insurance in this case, and what would be the expected profits or losses of the policy?

To solve this problem, you need to identify the consumer i' that is indifferent between buying this policy and having no insurance. Consumers who have greater expected losses than i' will buy the policy (since the premium is the same for all consumers) whereas consumers who lower expected losses than i' will not purchase the policy. Formally, we want to find i' such that:

$$E[U(w_{i'})] = 0.5 \times \ln(150) + 0.5 \ln(150 - 100 \times i') = \ln(150 - 25).$$

Notice that the lefthand side of this equation is the expected utility of i' if uninsured whereas the righthand side is wealth of i' if insured (in that case, i' pays the \$25 premium and so faces no risk of losing L_i).

$$\begin{aligned}
0.5 \times \ln(150) + 0.5 \ln(150 - 100 \times i') &= \ln(125) \\
\ln(150 - 100 \times i') &= (2 \times \ln(125) - \ln(150)) \\
150 - 100 \times i' &= \exp[2 \times \ln(125) - \ln(150)] \\
i' &= [\exp[2 \times \ln(125) - \ln(150)] - 150] / (-100) \\
i' &= 0.46
\end{aligned}$$

Thus consumers on the interval $i' \in [0.46, 1]$ will buy the policy. Notice that consumers with $i \in [0.46, 0.50)$ would expect to lose money on the policy—since their expected losses are *less than* \$25 whereas the policy cost is \$25. These consumers are buying the insurance despite it being actuarially unfair for them, because they are risk averse.

However, this policy will lose money on average. Expected costs per insured consumer on this policy are $E[L_i | i \geq 0.46] = 100 \times 0.5 \times \left(\frac{1+0.46}{2}\right) = \36.50 . But the proposed plan has the insurer selling insurance for \$25. So this “naive” policy cannot be an equilibrium policy.

The problem that the insurer is facing is adverse selection. At the actuarially fair average price for the *entire* market, only the highest risk 46% of consumers are buying the insurance policy. The remaining 54% are choosing to bear the risk on their own rather than paying a premium that far exceeds their expected losses.

3.2 The market-clearing (break-even) policy

The insurer has learned its lesson. It will charge a premium that breaks even *given* that the population that enrolls for the policy will be adversely selected—the higher the premium, the less healthy the set of consumers that chooses to ensure. How can we find that break-even free market policy?

Let i'' be the consumer who is just indifferent between the free market policy and no insurance. All consumers with greater expected losses than i'' will also buy the policy. Thus, the expected costs per insured of a policy sold to consumers with $i \geq i''$ is

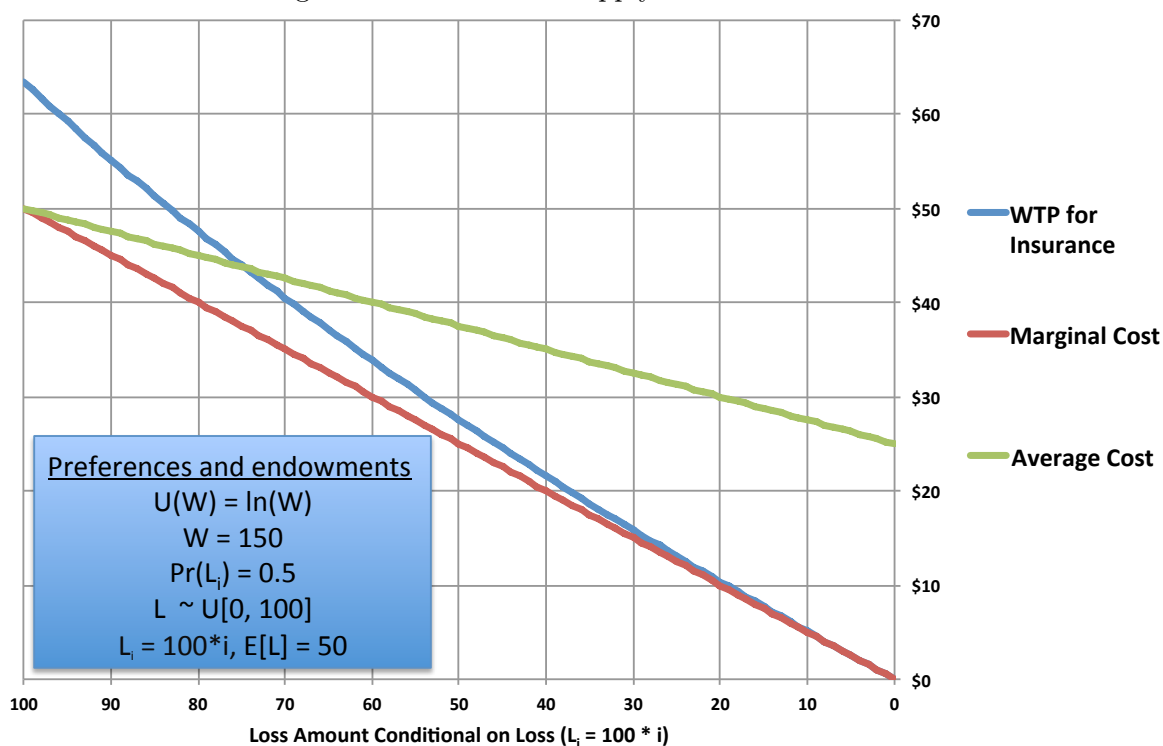
$$E[L_i | i \geq i''] = 100 \times 0.5 \times \left(\frac{1 + i''}{2}\right) = 25 \times (1 + i'').$$

Following the logic above, we can solve for i''

$$0.5 \times \ln(150) + 0.5 \ln(150 - 100 \times i'') = \ln(150 - 25 \times (1 + i'')).$$

After a bunch of algebra (or some spreadsheeting), the solution to this problem is $i'' = 0.75$. Thus, only one quarter of the population purchases insurance, and the premium for this policy is 43.75 (b/c $0.5 \times (100 + 75) / 2 = 43.75$). This low rate of insurance is again due to adverse selection. Those who have highest demand for insurance are those with the greatest expected losses. This means that the premium will typically be much higher than the expected loss in the full population (which is \$25).

Figure 3: Demand and Supply for Insurance



This high premium deters lower cost consumers from buying insurance, and hence only a subset of consumers insure, even though *all* are risk averse and would benefit from actuarially fair insurance. The high risk types impose a negative externality on the low risk types by driving up the cost of an insurance policy.

Quoting again from Einav-Finkelstein: “The fundamental inefficiency created by adverse selection arises because the efficient allocation is determined by the relationship between marginal cost and demand, but the equilibrium allocation is determined by the relationship between average cost and demand. Because of adverse selection (downward sloping MC curve), the marginal buyer is always associated with a lower expected cost than that of infra-marginal buyers.”

Given this inefficiency, why doesn't the market *completely* unravel—leading to no one buying insurance? The answer is risk aversion, as we saw in Problem Set #6. Consumers with highest likelihood of experiencing a loss are willing to pay a substantial premium in excess of their expected cost to obtain insurance. These consumers will prefer a policy that it is actuarially unfair for them (within limits) because they prefer a 'bad deal' on insurance to no insurance at all.

3.3 An efficient mandatory policy

What would be an efficient insurance solution in this case? Refer to the figure above. The key insight is that marginal social cost of providing insurance is below average cost for all but the riskiest consumer. And all consumers place positive value on insurance (except consumer $i = 0$, who

has zero risk). Therefore an efficient market solution involves all consumers obtaining insurance. Since the marginal cost of insuring each consumer is less than or equal to her willingness to pay for this insurance, all consumers should be insured. As with the naive policy, the efficient policy has a premium of \$25, but this policy is *mandatory*.

Notice that not every consumer is better off under the mandatory policy. As we saw with the naive policy, consumers with $i' < 0.46$ would prefer not to buy the \$25 policy. So, in what sense is it efficient to require them to do so? This is tricky. You should think of the mandatory policy as having two parts: an insurance value and a transfer value. The transfer is from low cost to high cost consumers. Consumers with $i < 0.50$ effectively subsidize consumers with $i > 0.50$. While the insurance component makes consumers better off, the transfer component makes consumers with $i < 0.50$ worse off (and for consumers with $i < 0.46$, the net effect of the insurance and transfer is to lower utility relative to a case with no insurance. But remember that this transfer is just that: a *transfer* to other consumers. So we view it as a wash. (Notice that in the mandatory insurance case, each consumer has the same wealth and hence the same marginal utility of wealth in equilibrium. Transfers at the margin therefore do not effect social welfare; one person's loss is exactly offset by another's gain.)

As is implied by this logic, some simple calculations (perhaps made using a spreadsheet) will demonstrate that average consumer welfare is higher under the *mandatory* insurance policy than either in the *no-insurance* or the *free market insurance* case.

3.4 Introducing free screening

Next, imagine that a free *voluntary* test is introduced that will reveal the risk type of each consumer i who takes the test. Once i is tested, insurers will offer i an actuarially fair insurance policy at cost $0.5L_i = 50 \times i$.

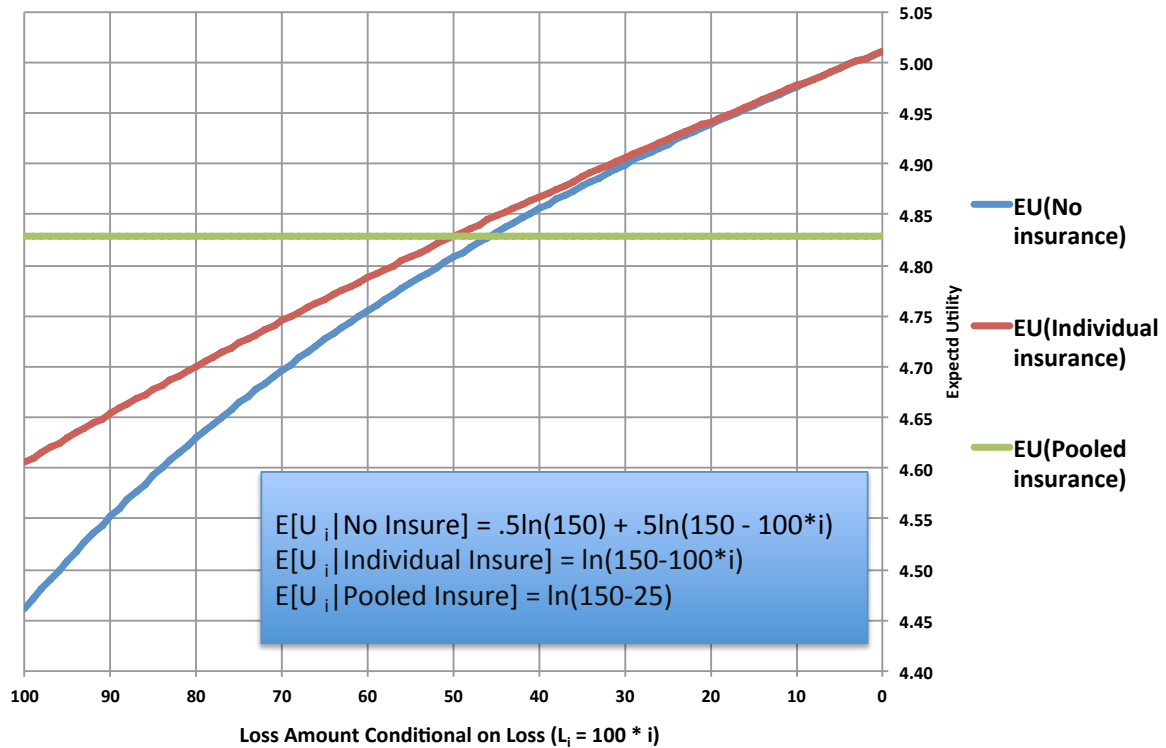
Which consumers will volunteer to take this free screening test? The answer will be *everyone*. This is the Full Disclosure principle at work—the opposite to the Lemons principle. The healthiest half of the population will first volunteer for the screening test. But then the healthiest half of the *remaining* untested population will volunteer for the test. And then the healthiest half of that remainder will volunteer for test. And so on. It's “turtles all the way down” as they say:² pretty soon, everyone is tested.

Now, insurers can offer each and every consumer a break-even policy with premium $50 \times i$. There is no more adverse selection in this Full Disclosure case, and each consumer is fully insured. Note that this equilibrium will *not* require an insurance mandate. The mandate was needed to resolve the adverse selection problem, which is no longer present because there is no remaining private information.

Here's an interesting question: Is average consumer welfare higher under the mandatory policy in part (3.3) or under the *new* free market policy where each consumer pays an individualized premium of $50 \times i$? Perhaps surprisingly, the answer is that average social welfare is *higher* under

²https://en.wikipedia.org/wiki/Turtles_all_the_way_down

Figure 4: Expected Utility Under Three Insurance Schemes



the mandatory policy. Why? Again, the mandatory policy does two things: it provides insurance *and* it transfers income from rich to poor (that is, from those with low expected losses to those with high expected losses; we know this because every policyholder i pays the same premium, and the policy breaks even). The mandatory policy provides both risk pooling *and* risk spreading. The break-even policy with testing provides risk pooling but not risk spreading. You can again quickly demonstrate this result to yourself (perhaps again using a spreadsheet). Average social welfare is lowest in this example with no insurance, highest with the *mandatory* \$25 policy, and somewhere in between with the free market policy with testing. (See Figure 4)

4 Summary

When information is private, the usual efficiency results for market outcomes may not hold. This simple insight is *highly* relevant to the operation of many markets, health insurance markets being the leading example. Unobservable quality heterogeneity creates important problems for market efficiency—market failures or incomplete markets quite likely.

The problem is not the uncertainty *per se*. As we demonstrated during previous lectures, there are market mechanisms for trading risk efficiently. But in those models, no agents were privy to special, private information. The fundamental problem in the adverse selection models above is that asymmetric information leads to a market equilibrium where sellers use their informational

advantage strategically. Buyers respond strategically to sellers' choices. This means that the pool of actors on the other side of the market responds ("is endogenous") to price, and the equilibrium of these strategic games are not likely to be first-best efficient.

5 [For self-study: Adverse selection — A richer example]

- Now that we have seen a stylized example, let's go through the same logic with a slightly richer example. We will consider a continuous distribution of product quality rather than just two types.
- Consider the market for 'fine' art. Imagine that sellers value paintings at between \$0 and \$100,000, denoted as V_s , and these values are uniformly distributed, so the average painting is worth \$50,000 to a seller.
- Assume that buyers value paintings at 50% above the seller's price. Denote this valuation as V_b . If a painting has $V_s = \$1,000$ then $V_b = \$1,500$.
- 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.
- 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: $V_b|E[V_s(P)] \geq P$.
- 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:

$$E[V_s|P] = \frac{0 + P}{2}.$$

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

$$E[V_b|E[V_s|P]] = 1.5 \cdot E[V_s|P] = 1.5 \left(\frac{0 + P}{2} \right) = \frac{3}{4}P.$$

Clearly $E[V_b|E[V_s|P]] < P$. No trade occurs

- Since that buyers' valuation of paintings lies strictly above sellers' valuations, this outcome is economically inefficient—that is, the gains from trade are unrealized. What's wrong?

- The sellers of low-quality goods generate a negative externality for sellers of high quality goods, since they are pooled together from the buyer’s perspective. For every \$1.00 the price rises, seller value only increases by \$0.50 because additional low-quality sellers crowd into the market $\left(\frac{\partial E[V_s|P_s]}{\partial P} = 0.5\right)$.
- Consequently, for every dollar that the price rises, buyers’ valuations only increases by \$0.75, $\left(\frac{\partial E[V_b|E[V_s|P]]}{\partial P} = 0.75\right)$. There is no equilibrium point where the market price ‘calls forth’ a set of products that buyers are willing to buy at that price.
- In this example, there is no trade.

5.1 Reversing the Lemons equilibrium: The Full Disclosure Principle

- Is there a way around this result? Intuition would suggest that the answer is yes. Sellers of *good* products have an incentive to demonstrate the quality of their products so that they can sell them at their true value. (Sellers of bad products have an incentive to not disclose quality, and this is what ‘spoils’ the market.)
- In the example above, sellers of good products do not disclose their art’s quality because we have stipulated that the value of a piece of art can only be assessed *ex-post* (by experience or appraisal). Sellers of good paintings therefore have no credible means to convey their products’ quality.
- What’s needed is a means to disclose information credibly. If there is an inexpensive (or free) means to credibly disclose the quality of paintings, you might expect that sellers of *above average* quality paintings will probably want to do this. In actuality, the result is much stronger: all sellers will choose to disclose. Let’s go through an example where this will take place.

5.2 Simplest case: Costless verification

- Imagine now that a seller of a product can get a free appraisal. This appraisal will credibly convey the true seller’s value of the painting (and of course the buyer’s willingness to pay will be 1.5 times this value). Who will choose to get their paintings appraised?
- Your first instinct 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—that is, an above-average painting—would choose to get an appraisal.
- This intuition is on the right track but incomplete. It neglects the fact that the decision by some sellers to have their paintings appraised affects buyers’ willingness to pay for non-appraised paintings.

- If only sellers with above average paintings had their paintings appraised, what would be the market price of non-appraised paintings?

$$1.5 \cdot E[V_s | V_s < 50,000] = 37,500.$$

- But if the market price is only \$37,500, then sellers with paintings at or above this price will also get them appraised. What is the new market price of non-appraised paintings?

$$1.5 \cdot E[V_s | V_s < 25,000] = 18,750.$$

- 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 seller is indifferent.
- This example demonstrates 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 are below the average, which will give them the incentive to disclose, and so on... If disclosure is costless, in equilibrium all parties 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 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 costs of disclosure are).

5.3 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 of a painting that the seller would obtain if the painting were appraised (net of the appraisal fee) ($A = 1$)
 2. The net price if not appraised ($A = 0$)
 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 (*IR*).

2. 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:

1. *IR* condition:

$$V_b(A = 1) \geq V_s + 5000$$

$$1.5V_s \geq V_s + 5000$$

$$V_s^{IR*} \geq 10,000$$

This condition says that sellers who value their painting at less than 10,000 will choose not to get them appraised. This is because the market price less the appraisal cost is less than their private value of the painting.

2. *SS* condition

This condition simply says that an individual seller must not be able to do better by switching their painting from appraised to non-appraised status or vice versa given the market equilibrium. Remember that the market value of a non-appraised painting is equal to 1.5 times their expected value to sellers. So, the self-selection constraint is:

$$V_b(V_s \geq V_s^{SS*}, A = 1) - 5,000 \geq 1.5 \times \frac{V_s^{SS*}}{2}$$

$$1.5 \times V_s^{SS*} - 5,000 \geq 0.75 \times V_s^{SS*}$$

$$0.75 \times V_s^{SS*} \geq 5,000$$

$$V_s^{SS*} \geq 6,666$$

and of course, the second inequality is also exactly satisfied at $V_s^{SS*} = 6,666$.

- Combining these results, we have

$$V_s^* = \max [V_s^{IR*}, V_s^{SS*}] = 10,000$$

Thus, the operative constraint is not that the *market price* for an non-appraised painting is higher than the *market price* for an appraised painting (which is *SS*) but that the *seller's own valuation* of an appraised painting net of appraisal cost must be greater than the *market price* of that painting when appraised (which is *IR*). Stated differently, when the *IR* constraint is satisfied, the *SS* constraint is also satisfied. But satisfaction of the *SS* constraint is necessary but not sufficient for satisfaction of the *IR* constraint. Hence, $V_s^* = V_s^{IR*} = 10,000$ is the threshold at which paintings are appraised.

- Meta-conclusion from this example:

If verification of information is costly, the market equilibrium will not be Pareto efficient. In particular, there are two distortions evident in this market equilibrium. First, most sellers are spending \$5,000 to appraise and sell their paintings, even though this investment does nothing to improve the painting (so, this is a deadweight loss). Second, paintings with $V_s < \$10,000$ are not sold, even though these paintings are worth $1.5 \cdot V_s$ to buyers.

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14.03 / 14.003 Microeconomic Theory and Public Policy
Fall 2016

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