Adverse Selection & Market Failure: Akerlof's Model of Asymmetric Information

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Introduction - Asymmetric Information

- Akerlof's Model of Adverse Selection
  - In 1970 George Akerlof wrote his famous "market for lemons" paper showing a model of asymmetric information resulting in the potential for market failure where a large proportion of low quality products can drive good quality products out of the market.
  - Akerlof, along with Michael Spence and Joseph Stiglitz, won the Nobel Prize in Economics in 2001.
  - The key feature of the model that enables potential failure of the market is the fact that sellers and buyers do not have the same information.

Theoretical Model - Akerlof's Market for Lemons

- Akerlof's Model of Adverse Selection - Abstract form:
  Consider a market where cars each have quality θ uniformly distributed on [0,1] and each car is owned by a type *s* "seller" person who knows its true quality. Type *s* people each own one car and can sell it to a type *b* "buyer" person. The value of a car of type θ is θ to a seller and $\beta\theta$ to a buyer, where β is a fixed "value parameter" which is the same for all buyers and greater than 1. There are B buyers and S sellers with $B > S$ and p denoting the competitive equilibrium price of a car in this market.

  - For what values of β is $p = 0$ an equilibrium price?
  - For what values of β is $p = 0.5$ an equilibrium price?
  - What is the cutoff level β^* such that there is a market equilibrium with $p > 0$ if and only if $\beta \geq \beta^*$?

Theoretical Model - Akerlof Adverse Selection

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- Note that $\beta > 1$ implies potential "gains from trade" since the buyers value cars more than sellers... a necessity for the market to function.

- $B > S$ means that there are more buyers than cars, so market clearing with a perfectly competitive market implies that buyers will have zero expected surplus.

- The expected value of quality for a car in the market with a uniform distribution of types $\theta \in [0, 1]$ is $\mathbb{E}[\theta] = \frac{1}{2}$

Solution - Theoretical Model: Market for Lemons

- Case 1: $p \geq 1$:

  With $\theta = \frac{1}{2}$ being the average quality in the market when all cars are sold, the buyer's expected surplus here is $0 = \beta(\frac{1}{2}) - p$, which means that $p_1 = \frac{\beta}{2}$. There is an equilibrium of $p_1 \geq 1$ where all cars are sold if and only if $\beta \geq 2$. This means for all cars to sell, the buyers must value them at least twice as much as sellers.

- Case 2: $0 \leq p \leq 1$:

  With $\frac{p}{2}$ being the average quality among cars that are sold, the buyer's expected surplus here is $0 = \beta(\frac{p}{2}) - p$. In this case, only cars of quality $\theta \leq p$ are sold, which occurs specifically when $\beta = 2$.

- Case 3: $p = 0$:

  No cars are sold (or only the worst quality car $\theta = 0$ is sold) in this market: with $\beta < 2$ there is a total market failure in this case.

Solution Summary - Theoretical Model: Market for Lemons

- Consider a market where used cars each have quality θ uniformly distributed on [0,1] and each car is owned by a type *s* "seller" person who knows its true quality. Type *s* people each own one car and can sell it to a type *b* "buyer" person. The value of a car of type θ is θ to a seller and $\beta\theta$ to a buyer, where β is a fixed "value parameter" which is the same for all buyers and greater than 1. There are B buyers and S sellers and $B > S$, with p denoting the competitive equilibrium price.

- Case 1: $p \geq 1$: All cars are sold: possible if $\beta \geq 2$

- Case 2: $0 \leq p \leq 1$: Only cars of quality $\theta \leq p$ are sold: $\beta^* = 2$

- Case 3: $p = 0$: No cars are sold: total market failure with $\beta < 2$.

Akerlof's Market for Lemons - Numerical Example

- Suppose there are two types of new cars available for sale: good cars and low quality "lemons", which account for proportion θ of all cars for sale. Sellers cannot effectively signal a car's type, buyers cannot ever determine anything about car type before purchase, there are more buyers than sellers, and the market proportion (θ) of lemons is always public knowledge. After buyers obtain a car they ascertain its true type. Assume the following: buyers have risk-neutral preferences, value good cars at $2000, value bad "lemons" at $1000 each, and no cars ever depreciate (lose value) over time.

◇ How do we determine the equilibrium price p^* for new cars?

→ We can create an equation for new car price as expected value:

$$p^* = (1-\theta) * 2000 + \theta * 1000 = 2000 - 1000 * \theta$$

Since there is no ability to signal type, sellers all charge the same price and risk-neutral buyers will pay the expected value - determined by θ.

Akerlof Model Application - Used Car Market

- Suppose car owners are each willing to sell their car at 20% below that car's value for buyers: $p^G = \$1600$ and $p^L = \$800$ are the values for potential sellers. (the buyer value multiplier here is fixed at $\beta = 1.25$)
- Since cars do not depreciate, car buyers will be willing to pay \$2000 for good cars and \$1000 for lemons. This means there is a surplus of either \$400 or \$200 from each sale... a gain from trade (and also a Pareto Improvement) if this market clears.

◇ What will be the used car equilibrium price?

- Buyers cannot distinguish between types but sellers know the true type. Assuming sellers wish to maximize revenue, for any $p \geq \$800$ the owners of lemons will benefit from selling. However, for $p < \$1600$ those who own good cars will not want to sell. This means the equilibrium used car market price will depend on θ.

Akerlof Model Application - Used Car Equilibrium

- If θ is too large then good quality cars cannot be sold on the market: if the market price is low enough then it is not "incentive compatible" for sellers of good cars since they would not benefit from selling.
- If $\theta = 0.5$ then the expected value of a used car is:

$$p^{\theta=0.5} = (1-\theta) * 2000 + \theta * 1000 = 2000 - 1000 * \theta = \$1500$$

- In this case, no owner of a good car would be willing to sell a good car, so the price cannot be \$1500... The market "unravels" as only lemons are for sale, with price $p = \$1000$ as the result.

- If $\theta = 0.2$ then the market price (EV for buyers) would be:

$$p^{\theta=0.2} = (1-0.2) * 2000 + 0.2 * 1000 = 2000 - 1000 * \theta = \$1800$$

- With the given values and assumptions in this problem, the maximum proportion of lemons in which the market does not unravel is $\theta = 0.4$ with a resulting price of $p^{min} = \$1600$: any price below this signals that all cars for sale must be "lemons" and the market fails...

Applied Akerlof Model - Three Types of Appliance Quality

Consider a market where identical risk-neutral buyers might or might not choose to purchase one household appliance. Appliances are one of three discrete quality types with the following values: Low (V_L), Medium (V_M), High (V_H). Sellers know the true type of the appliances for sale but consumers are unable to observe anything about quality. The "population" of appliances in the world consists of 25% high quality, 25% medium quality, 50% low quality: this fact and market price are public knowledge.

- Suppose the value to sellers is $V_H^S = \$50, V_M^S = \$30, V_L^S = \$10$.
- What multiplier level (β) on the buyers' value of products compared to sellers results in high quality products being driven out of the market?
- At what buyer value multiplier (β) will only low quality products be sold in this market?

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- What multiplier level (β) on the buyers' value of products compared to sellers results in high quality products being driven out of the market?

Solution: For all products to sell, the market price (which is the buyers' expected value of appliances in the market) must be greater than or equal to the sellers' value of the high quality appliance... or else they wouldn't be willing to sell it:

$$EV_{Buyers} = \mathbb{E}[V^B] \geq V_H^S = \$50, \quad \text{so} \quad 0.25(V_H^B) + 0.25(V_M^B) + 0.5(V_L^B) \geq 50$$

using the population proportions. Using the fact that $V^B = \beta(V^S)$, this becomes:

$$0.25\beta(V_H^S) + 0.25\beta(V_M^S) + 0.5\beta(V_L^S) \quad \geq 50.$$
$$0.25\beta(50) + 0.25\beta(30) + 0.5\beta(10) = 25\beta \geq 50$$

Therefore $\beta \geq 2$ for all appliances to be able to sell in this market.

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- At what buyer value multipliers (β) will only low quality products be sold?

With $\beta < 2$ everyone knows that sellers of high value appliances will no longer be able to get a price at which they are willing to sell, so now the market will only be comprised of 1/3 medium quality types and 2/3 low quality types:

$EV = \mathbb{E}[V^B] \geq V_M^S = \$30$, so using the population proportions:

$$\frac{1}{3}(V_M^B) + \frac{2}{3}(V_L^B) \geq 30 \quad \Leftrightarrow \quad \frac{1}{3}\beta(V_M^S) + \frac{2}{3}\beta(V_L^S) \geq 30$$

Plugging in values: $\frac{1}{3}\beta(30) + \frac{2}{3}\beta(10) = 16.67\beta \geq 30$ so $\beta \geq \frac{9}{5}$ for buyers' expected value to be high enough for sellers of medium quality appliances to remain in the market.

Discussion and Comments

- Which industries do you think face the largest issues with adverse selection / asymmetric information?
- What are some real-world cases where we see this harm markets?
- What solutions exist to mitigate the harmful effects of asymmetric information and adverse selection?
- How does this relate to US policies on car insurance and health insurance?

Discussion and Comments

- Which industries do you think face the largest issues with adverse selection / asymmetric information?
  - Insurance is probably the best example
  - Real authentic luxury goods vs. fake products
- What are some real-world cases where we see this harm markets?
  - Collateralized debt (think about packages of securities in the 2008 financial crisis: even the credit ratings agencies, which exist to improve market information, did not fully understand the risk composition)
- What solutions exist to mitigate the harmful effects of asymmetric information and adverse selection?
  - Consider US laws requiring the purchase of car insurance: the market could unravel if only poor drivers purchased insurance, as this would drive up cost and essentially defeat the whole purpose. Insurance costs do go up for accidents, etc, to address incentives.
  - Obamacare was designed according to similar logic.