INTERMEDIATE MICROECONOMICS

ASYMMETRIC INFORMATION

SPRING 2019, PROFESSOR ANH NGUYEN

Information in Competitive Markets

- In purely competitive markets all agents are fully informed about traded commodities and other aspects of the market.
- What about markets for medical services, or insurance, or used cars?

Asymmetric Information in Markets

- A doctor knows more about medical services than does the buyer.
- An insurance buyer knows more about his riskiness than does the seller.
- A used car's owner knows more about it than does a potential buyer.

Asymmetric Information in Markets

- Markets with one side or the other or both imperfectly informed are markets with **imperfect information**.
- Imperfectly informed markets with one side better informed than the other are markets with **asymmetric information**.

Asymmetric Information in Markets

- In what ways can asymmetric information affect the functioning of a market?
- Examples:
  - **adverse selection**
  - signaling
  - moral hazard
  - incentives contracting.

Adverse Selection

Akerlof's 1970 paper

- Consider a used car market.
- Two types of cars; "lemons" and "peaches."
- People's valuations of lemons
  - Each lemon seller will accept $1,000 or more
  - A buyer will pay at most $1,200
- People's valuations of peaches
  - Each peach seller will accept $2,000 or more
  - A buyer will pay at most $2,400.

Adverse Selection

- Suppose everyone can see each car's quality (peach or lemon)
- How much will lemons sell for?
  - Any price above the seller's reservation ($1,000)
  - Any price below the buyer's reservation ($1,200)
  - Thus, prices range from $1,000 to $1,200 for lemons
- How much will peaches sell for?
  - Any price above the seller's reservation ($2,000)
  - Any price below the buyer's reservation ($2,400)
  - Thus, prices range from $2,000 to $2,400 for peaches
- Gains-to-trade are generated when buyers are well informed

Adverse Selection

- Suppose each seller knows their car’s quality
- BUT no buyer can tell a peach from a lemon before buying
- What is the most a buyer will pay for any car?
- We’ll assume:
  - Buyers are risk neutral
  - Hence, buyers will pay (at most) the expected value of a car

Adverse Selection

- Let q be the fraction of peaches.
- $1 - q$ is the fraction of lemons.
- What's the expected value of a random car of unknown quality?

$$
\begin{aligned}
EV &= \$1{,}200 \times (1 - q) + \$2{,}400 \times q \\
&= \$1{,}200 \times (1 + q)
\end{aligned}
$$

For example: 50% that it's a good car
50% bad car
$q = 0.5$

$\rightarrow$ EV = 50% × 12,00 + 50% × 2400

= 1800

Adverse Selection

- A buyer's reservation price is $EV = \$1{,}200 \times (1 + q)$
- Recall the seller's reservations price is:
  - \$1,000 for a lemon
  - \$2,000 for a peach
- Suppose $EV > \$2{,}000$
- Will lemon owners be willing to sell their cars?
  - Yes! Trade will occur at any price between \$1,000 and EV
- Will peach owners be willing to sell their cars?
  - Yes! Trade will occur at any price between \$2,000 and EV
- All sellers—peach or lemon—gain from being in the market

Adverse Selection

- Now, suppose $EV < \$2{,}000$ Assume EV = 1800
- Will anyone ever buy or sell a peach?
  - The maximum anyone will pay for a car is $EV < \$2{,}000$
  - The minimum a peach owner will accept is $2,000
  - No price will induce a trade!
- What about the cars that do get sold?
  - They're not peaches, so they must be lemons
  - What's the expected value of the cars in the market? $1,200
  - The price paid is between $1,000 and $1,200

Adverse Selection

- What changed between the two examples?
  - Constant fundamentals, i.e., the valuations of lemons and peaches
  - Changes in people’s expectations!
- Expectations can be self-fulfilling:
  - People expect only lemons →
  - buyers won’t pay high prices →
  - peach owners won’t sell at low prices →
  - only lemons go up for sale

  - People expect mixed quality →
  - buyers pay higher prices →
  - peach owners willing to sell →
  - both peaches & lemons go up for sale

Adverse Selection

- “Too many” lemons “crowd out” the peaches from the market.
- Gains-to-trade are reduced since no peaches are traded.
- The presence of the lemons inflicts an external cost on buyers and peach owners.

Adverse Selection

- How many lemons can be in the market without crowding out the peaches?
- For peach owners to sell, the price must exceed \$2,000
- For people to buy, the price must be less than the expected value
- Buyers will pay \$2,000 for a car only if

$$EV = \underbrace{\$1{,}200\times(1-q) + \$2{,}400\times q}_{1200\times(1+q)} \geq \$2{,}000$$

$1200 \times (1+q) \geq 2000 \rightarrow q \geq \frac{2000}{1200} - 1 = 2/3$

- That is, $q \geq 2/3$
- If more than $1/3$ of cars traded are lemons, then *only* lemons are traded

Adverse Selection

- A market equilibrium in which both types of cars are traded and cannot be distinguished by the buyers is a **pooling equilibrium**.

- A market equilibrium in which only one of the two types of cars is traded, or both are traded but can be distinguished by the buyers, is a **separating equilibrium**.

Example 1

- The figure on the left depicts the market for used cars.
- Buyers cannot tell whether any given car is a lemon.
- Ten percent (10%) of all cars are lemons.

Which of the following statements is true?

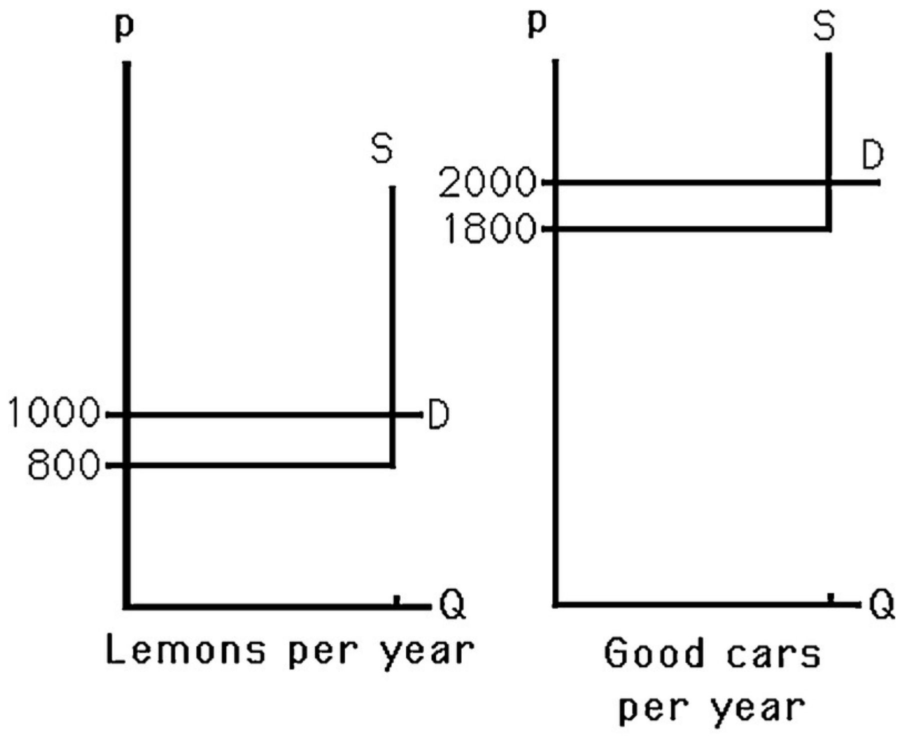
A) All of the cars will be sold.

B) No cars will be sold.

C) Only lemons will be sold

D) Only good cars, peaches, will be sold.

Is this pooling or separating equilibrium?



Example 1: Answer

Expected value of a car (of unknown quality) to the buyer:

$$EV = 10\% \times 1000 + 90\% \times 2000$$
$$= 1900$$

At $p = EV = 1900 \rightarrow$ both peach sellers & lemon seller will sell

$$(1900 > 1800$$
$$1900 > 800)$$

$\rightarrow$ Equilibrium: $p = 1900$

All cars will be sold

} Pooling Equilibrium

Example 2

- The figure on the left depicts the market for used cars.
- Buyers cannot tell whether any given car is a lemon.
- Now 40% of all cars are lemons.

Which of the following statements is is true?

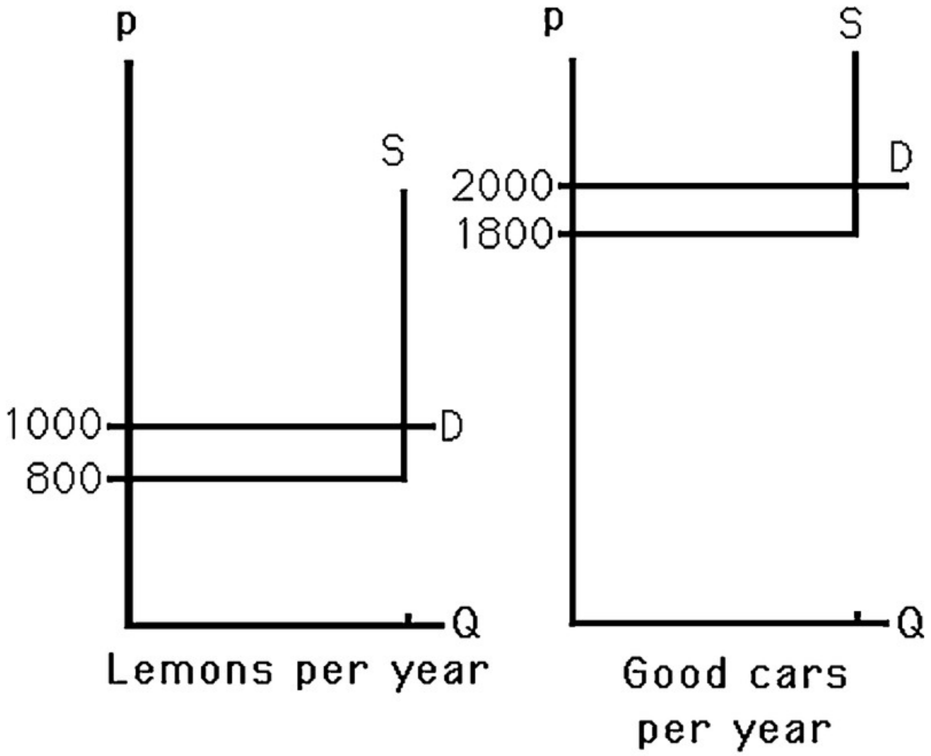
A) All of the cars will be sold.

B) No cars will be sold

C) Only lemons will be sold

D) Only good cars will be sold.

Is this pooling or Separating equilibrium?



Example 2: Answer

Buyer's WTP (EV) for a car of unknown quality:

$EV = 40\% \times 1000 + 60\% \times 2000$

$= 1600$

At $p = 1600 \rightarrow$ Only lemons are going to be sold at this price.

Conclude that $p = 1600$ & only lemons are sold are the eq.?

Incorrect!

Consumers, knowing that only lemons are being sold, will pay at most 1000.

$\rightarrow$ Eq: $800 \leq p \leq 1000$; only lemons are being sold.

Adverse selection

- One party knows its type while the other does not have that information
- Examples?
  - Used car markets
  - Insurance markets
  - Labor market: we don't know workers' quality.

Adverse Selection

- What if there is more than two types of cars?
- Let v be the value of a car to a seller
  - The seller is willing to accept any price greater than $\$v$
  - Assume the buyer is willing to pay any price less than $\boxed{\$(v+300)}$

buyers always value cars $300 more than sellers.

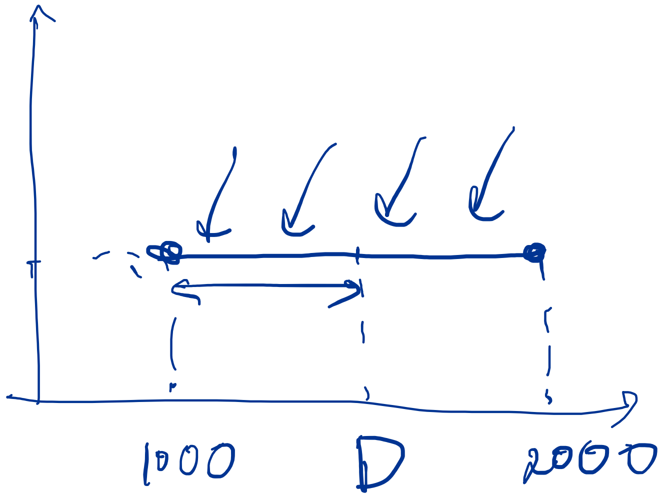
- Suppose that v is uniformly distributed between \$1000 and \$2000

Cumulative distribution of a uniform distribution.

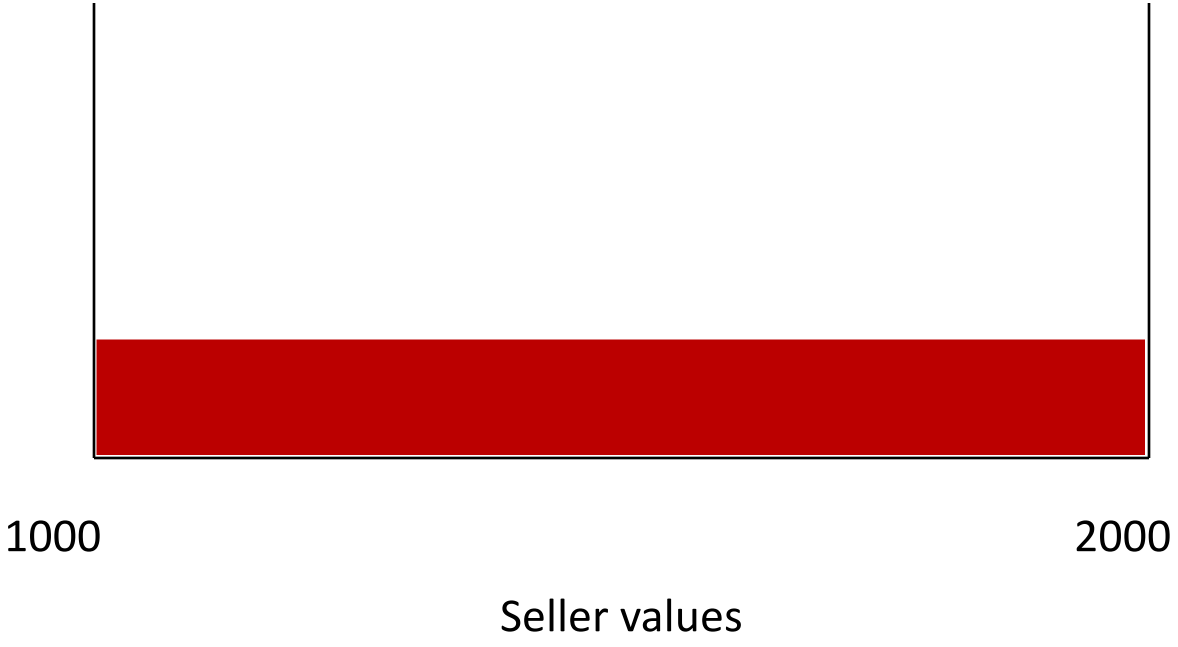
$$P[v \le \$D] = \frac{\$D - \$1{,}000}{\$1{,}000}$$

probability that seller has valuation ≤ D

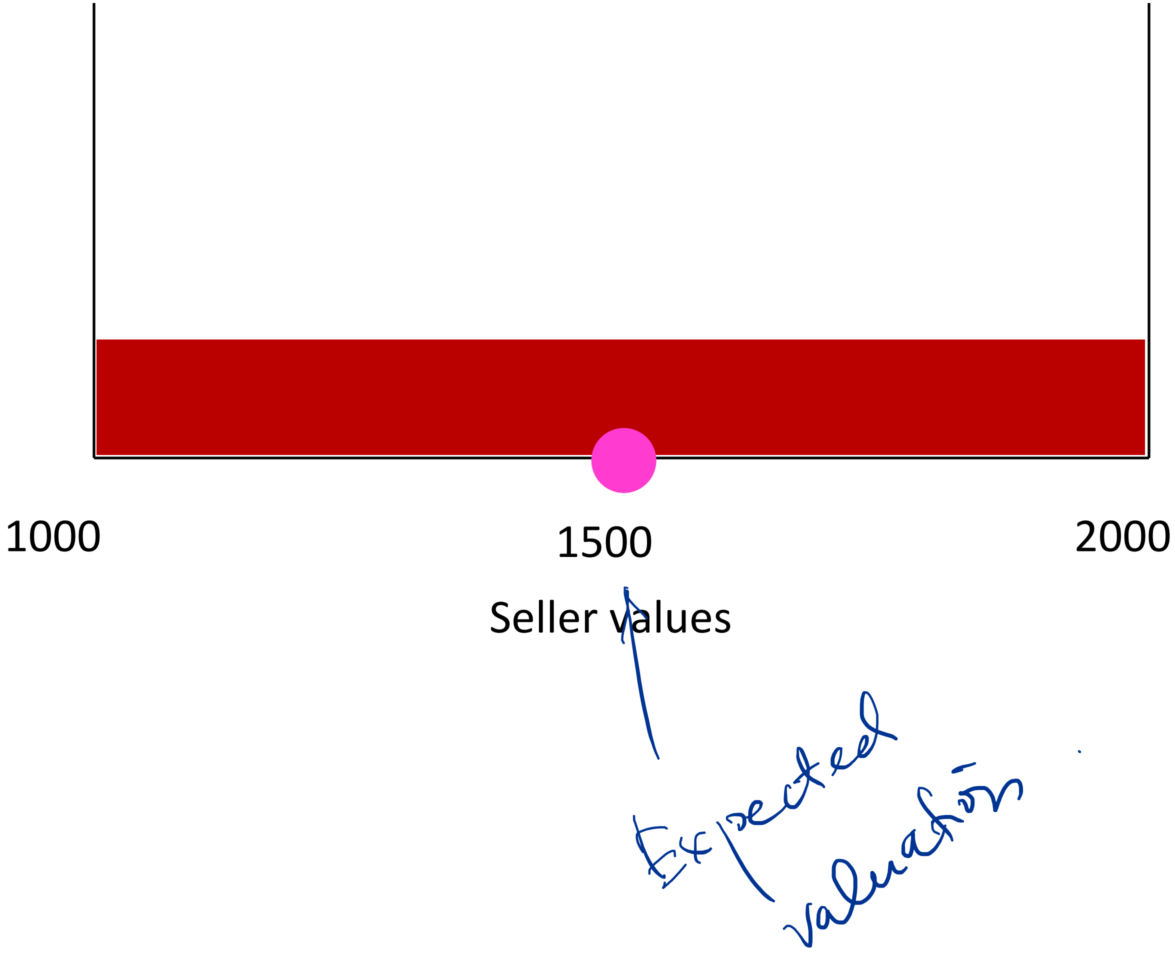
- Which cars will be traded?



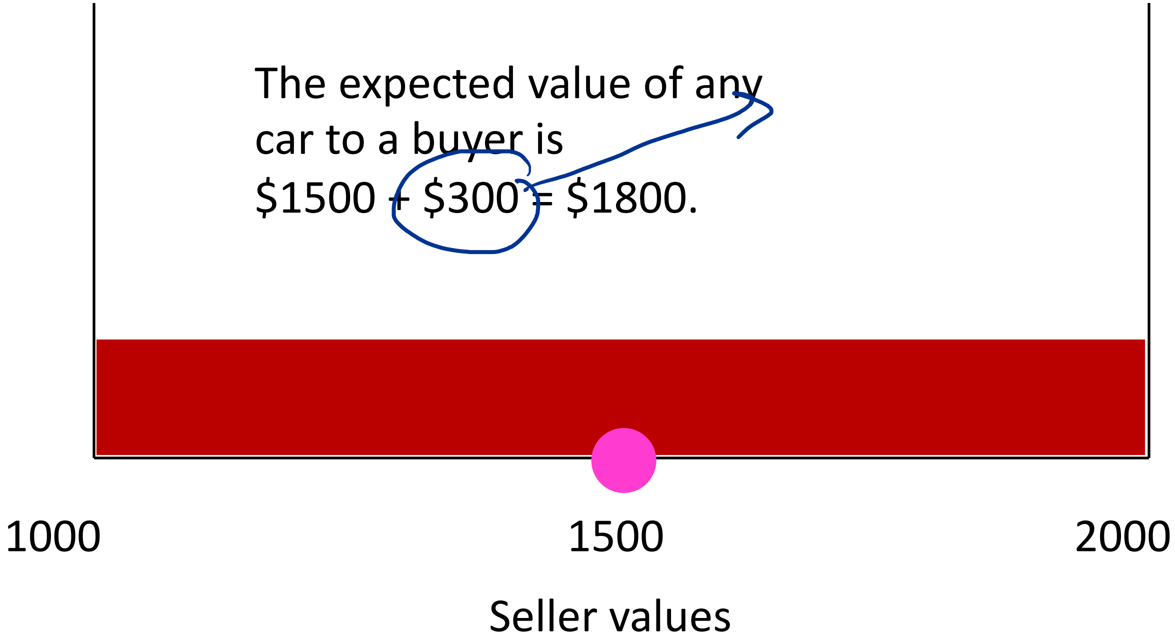
Adverse Selection



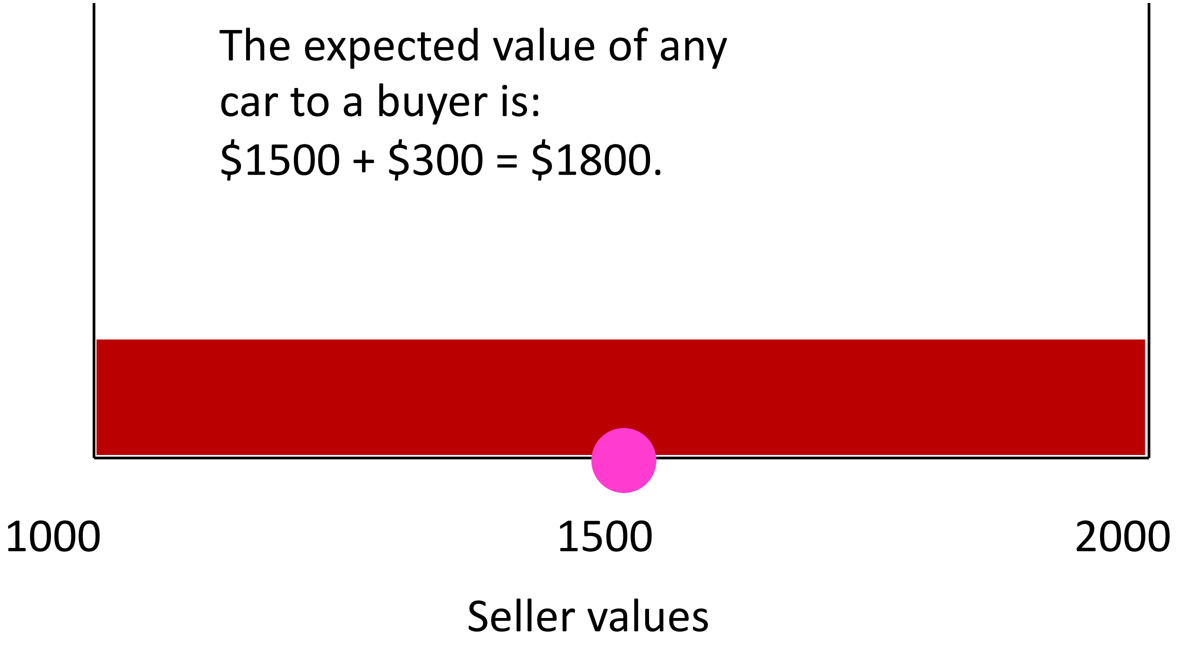
Adverse Selection



Adverse Selection

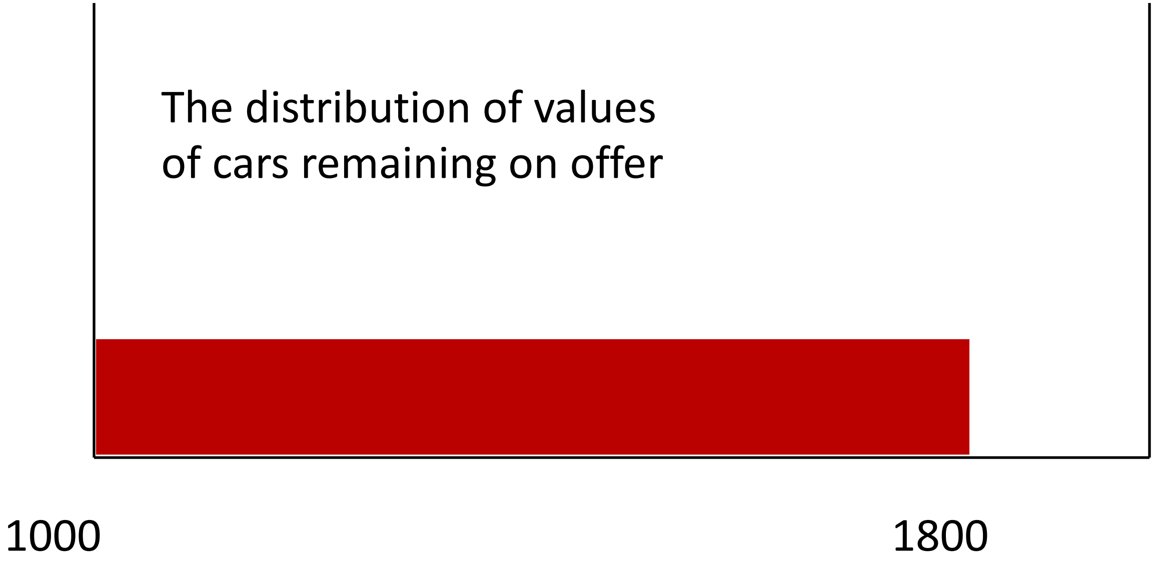


Adverse Selection



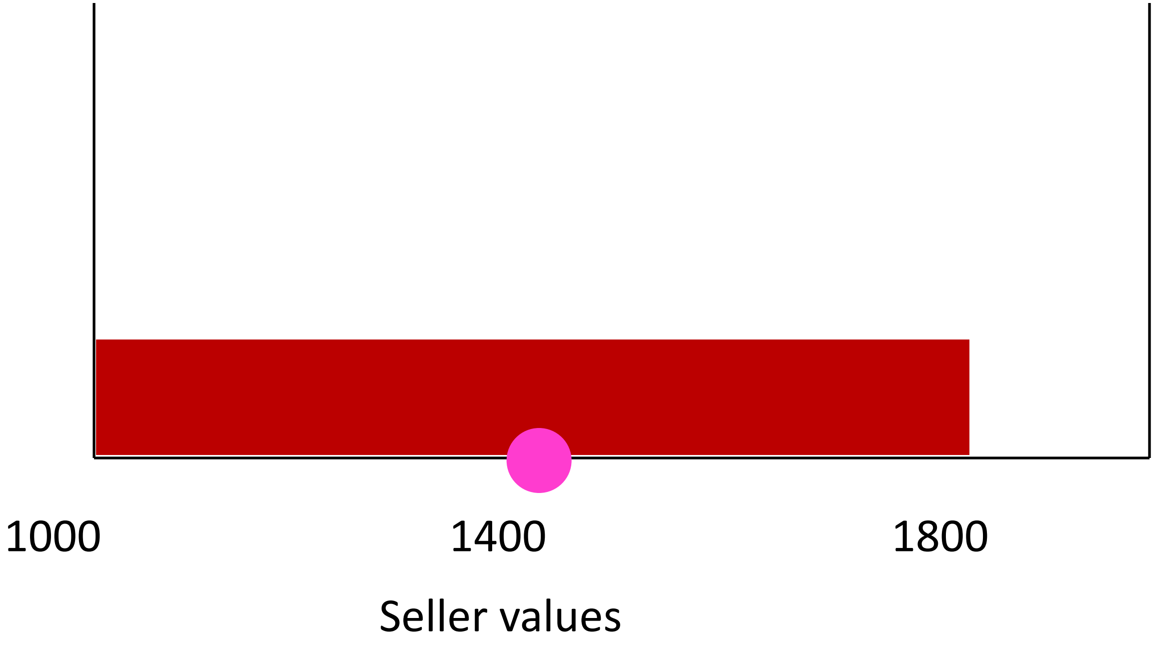
So sellers who value their cars at more than $1800 exit the market.

Adverse Selection

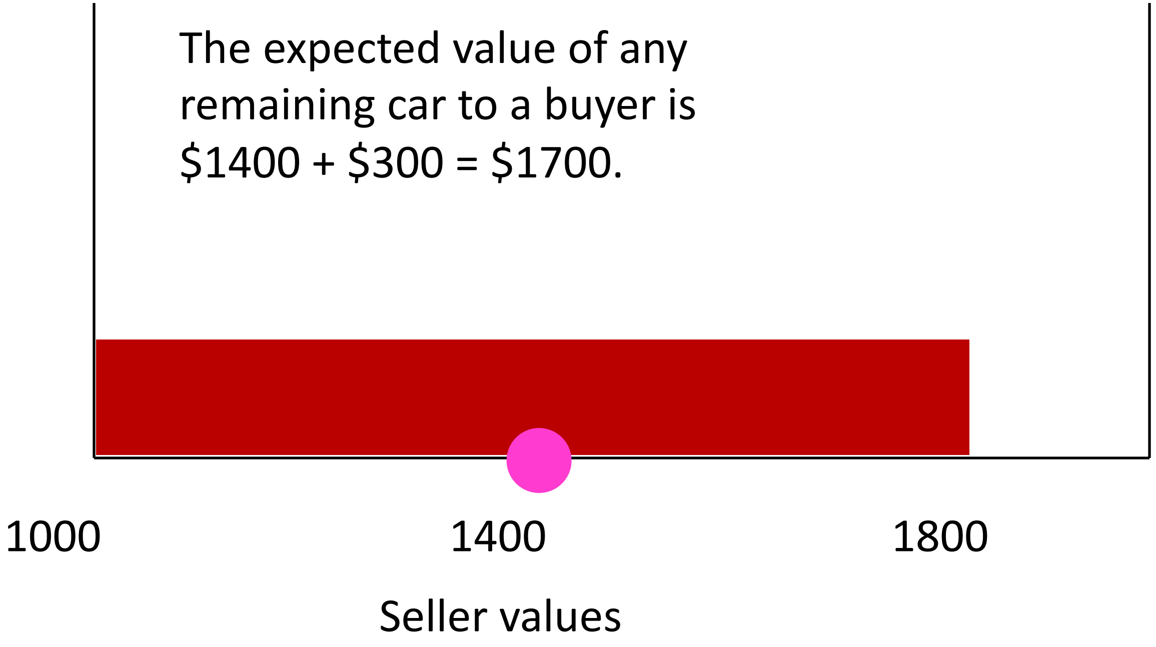


Seller values

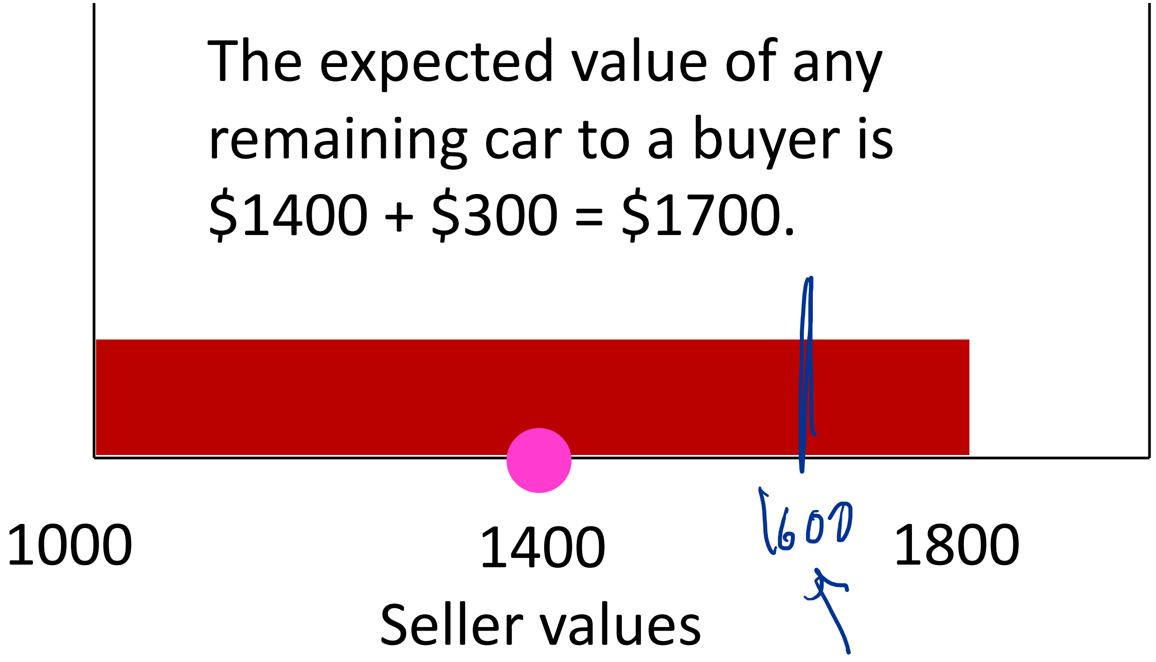
Adverse Selection



Adverse Selection



Adverse Selection



So now sellers who value their cars between $1700 and $1800 exit the market.

Adverse Selection

- Where does this unraveling of the market end?
- Let v_H be the highest seller value of any car remaining in the market.
- The expected seller value of a car remaining in the market is:

mean $= \frac{1}{2}(1000 + v_H)$

1000 $\quad$ v_H

$$E[v] = \frac{1}{2} \times \$1{,}000 + \frac{1}{2} \times \$v_H$$

- What's the most any buyer will be willing to pay? $E[v] + \$300$
- What's most a seller will value their car and still be willing to sell?

$$v_H = E[v] + \$300$$

→ This ensures that no more seller will exit the market

- Combining these expressions: $v_H = \$1{,}600$.
- Adverse selection drives out all cars valued by sellers at more than \$1600.

$$v_H = \underbrace{\left(500 + \frac{1}{2} v_H\right)}_{E[v]} + 300 \rightarrow \frac{1}{2} v_H = 800 \rightarrow v_H = 1600$$

Adverse selection

- So in equilibrium:
- Cars of value between \$1000 and \$1600 for the sellers are sold.
- The value of these cars are \$1300 to \$1900 for buyers
- Or on average: $\frac{\$1,300+\$1,900}{2} = \$1600$
- So they are willing to pay at most \$1600. (Remember that the buyers were risk neutral.)
- At price \$1600:
  - Sellers of car value of \$1000 and \$1600 sell
  - Sellers of car value of above \$1600 are not willing to sell
  - Buyers are willing to buy knowing who is willing to sell, on average they are paying equal to their expected value.

Adverse Selection with Quality Choice

- Now each seller can choose the quality, or value, of her product.
- Two umbrellas: high-quality and low-quality.
- Which will be manufactured and sold?

Adverse Selection with Quality Choice

- Buyers' valuations of umbrellas:
  - Buyers value a high-quality umbrella at $14
  - Buyers value a low-quality umbrella at $8

- Before buying, no buyer can observe quality → adverse selection

- The seller's cost of producing umbrellas:
  - Production cost of a high-quality umbrella is $11
  - Production cost of a low-quality umbrella is $10

[socially efficient outcome should not have any low quality umbrella]

[8 < 10]

Adverse Selection with Quality Choice

- Suppose every seller makes only high-quality umbrellas.
- Suppose further that every buyer pays \$14
- Sellers' profit per umbrella: \$14 - \$11 = \$3
- How can any one seller make more money?
  - A seller can make low-quality umbrellas, and no one will know
  - This seller's profit per umbrella: \$14 - \$10 = \$4
  - Selling low-cost umbrellas is more profitable

Adverse Selection with Quality Choice

- There is no market equilibrium in which only high-quality umbrellas are traded. (Why?)

- Is there a market equilibrium in which only low-quality umbrellas are traded?

Adverse Selection with Quality Choice

- Suppose all sellers make only low-quality umbrellas.
- What's the maximum buyers are willing to pay? $8
- What's the lowest price that lets producers to break even? $10.
- There is no market equilibrium in which only low-quality umbrellas are traded.

Adverse Selection with Quality Choice

- Now we know there is no market equilibrium in which only one type of umbrella is manufactured.
- Is there an equilibrium in which both types of umbrella are manufactured?

Adverse Selection with Quality Choice

- A fraction q of sellers make high-quality umbrellas: 0 < q < 1.
- Buyers' expected value of an umbrella is:

Prob of good   Prob of bad

$$EV = \$14 \times q + \$8 \times (1 - q) = 8 + 6q$$

- High-quality manufacturers must recover the manufacturing cost:

$$EV \geq \$11$$

→ cost of producing a good um.

- Hence: $q \geq 1/2$

$8 + 6q \geq 11$

$\rightarrow 6q \geq 3 \rightarrow q \geq \frac{1}{2}$

Adverse Selection with Quality Choice

- So at least half of the sellers must make high-quality umbrellas for there to be a pooling market equilibrium.
- But then a high-quality seller can switch to making low-quality and increase profit by $1 on each umbrella sold.
- Since all sellers reason this way, the fraction of high-quality sellers will shrink to zero — but then buyers will pay only $8.
- So there is no equilibrium in which both umbrella types are traded.

Adverse Selection with Quality Choice

- The market has no equilibrium
  - with just one umbrella type traded
  - with both umbrella types traded
- So **the market has no equilibrium** at all.
- Adverse selection has destroyed the entire market!

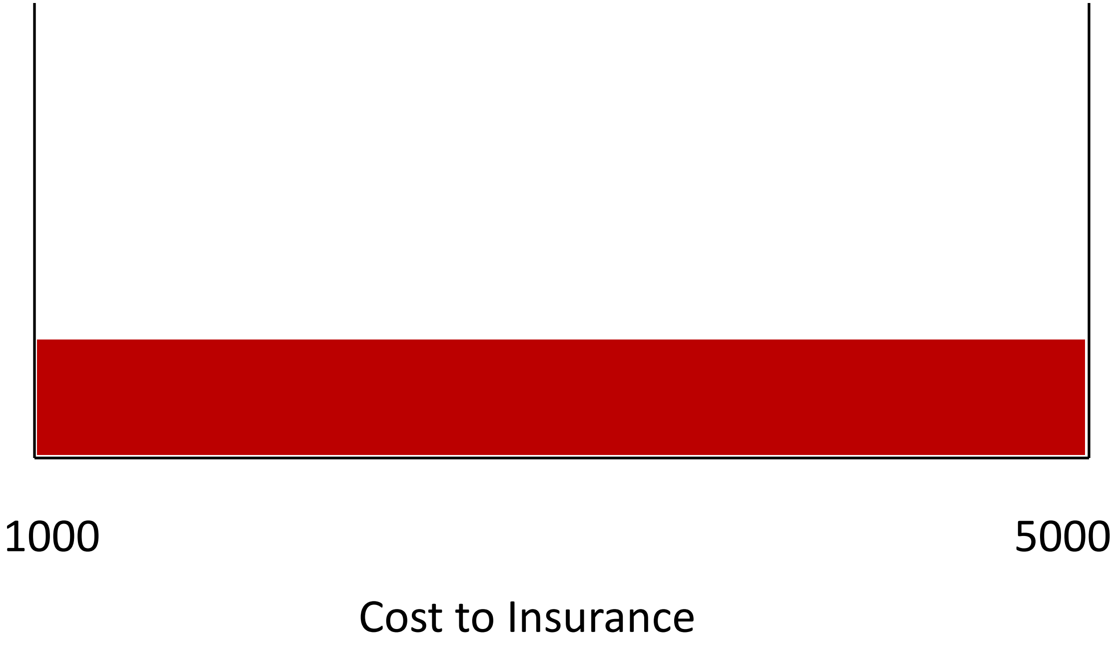
→ Rothschild & Stiglitz

Example: Adverse Selection – Insurance Market

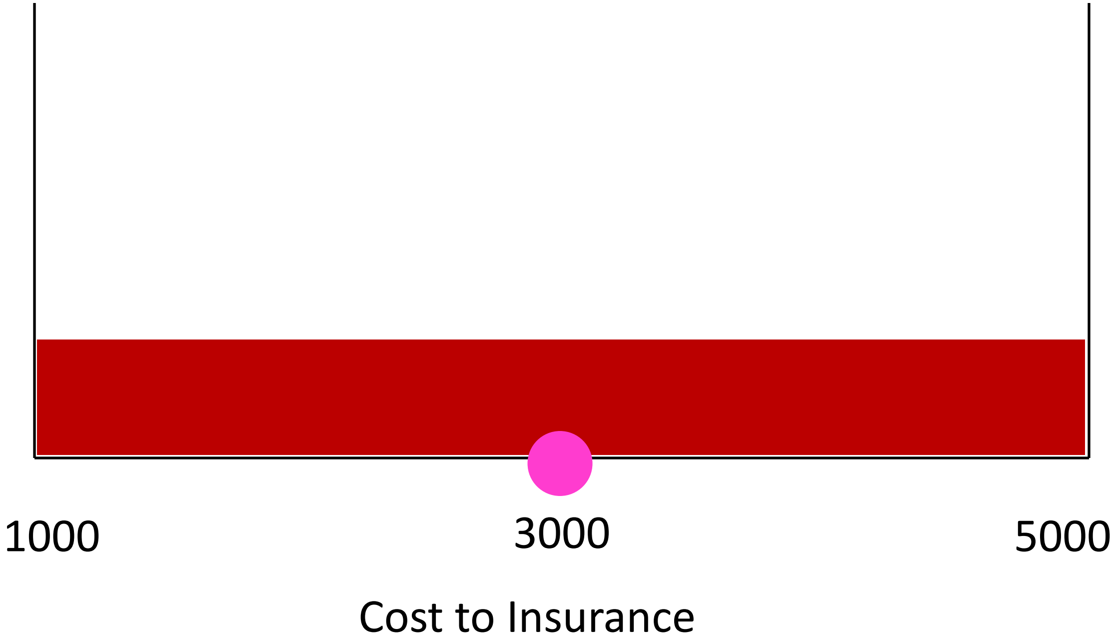
- Suppose that
  - Patients have different levels of riskiness, which is known to them
  - The cost of insuring patients varies between $1000 and $5000, depending on their risk factor.
  - Patients value insurance $1000 above the average cost to the insurance company. Therefore ranging between $2000 and $6000. [Consumers are risk averse]
  - Assume that insurance market is perfectly competitive:
    - Zero profit
    - Price = expected cost.

- Who gets insurance and what will be the price of insurance?

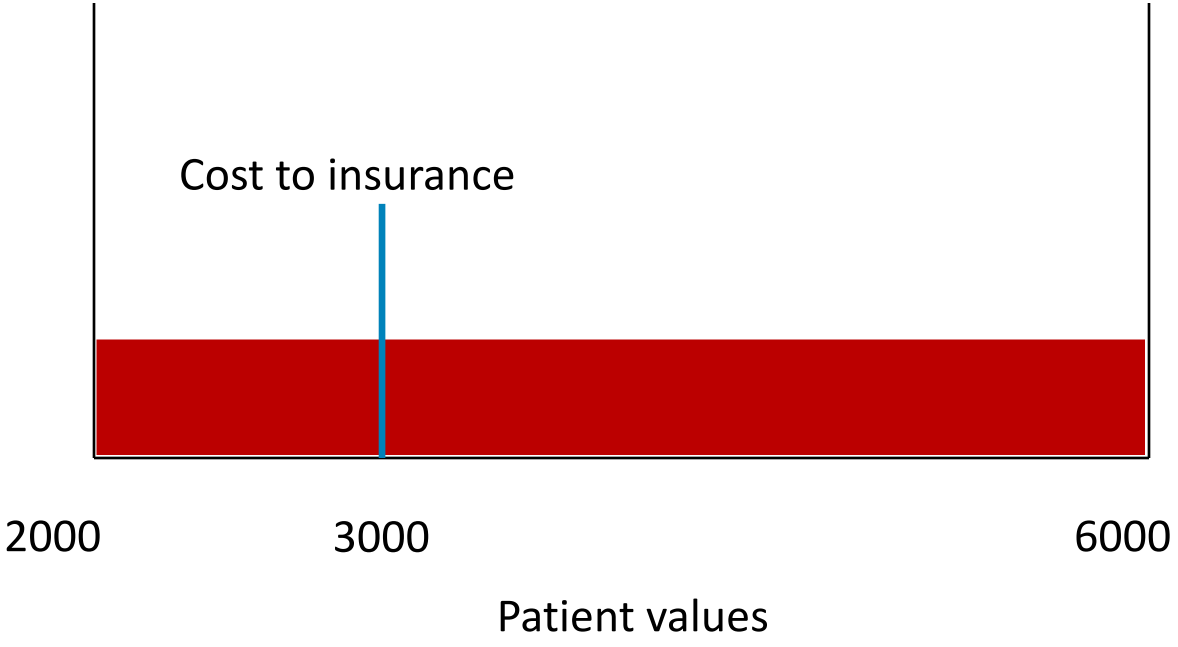
Example: Adverse Selection in Insurance



Example: Adverse Selection in Insurance



Example: Adverse Selection in Insurance



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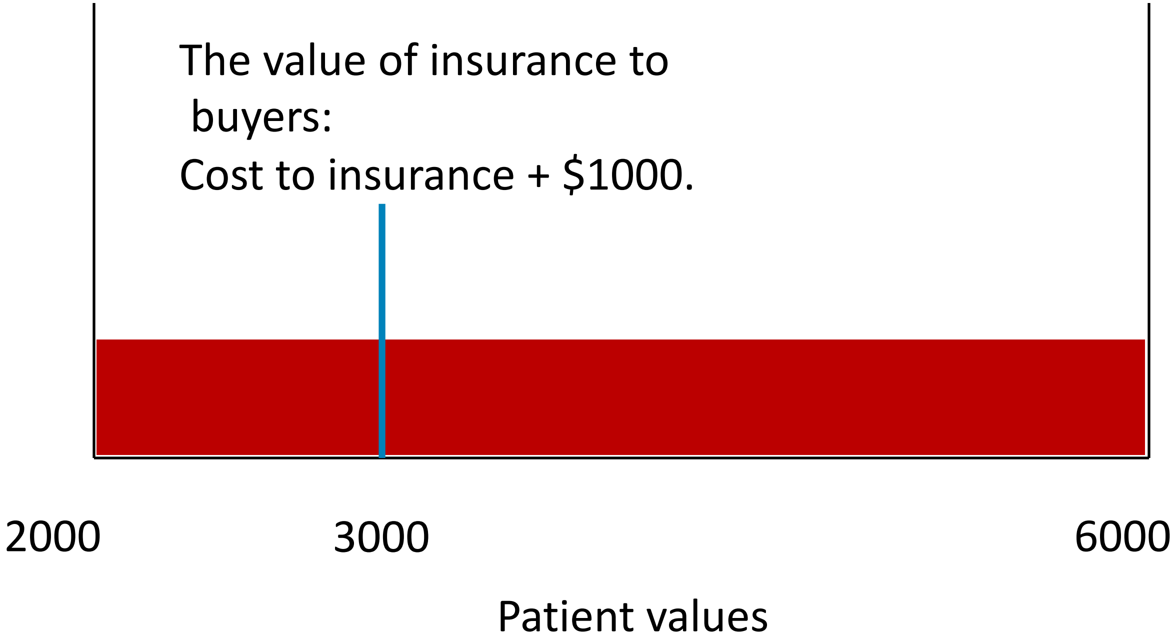

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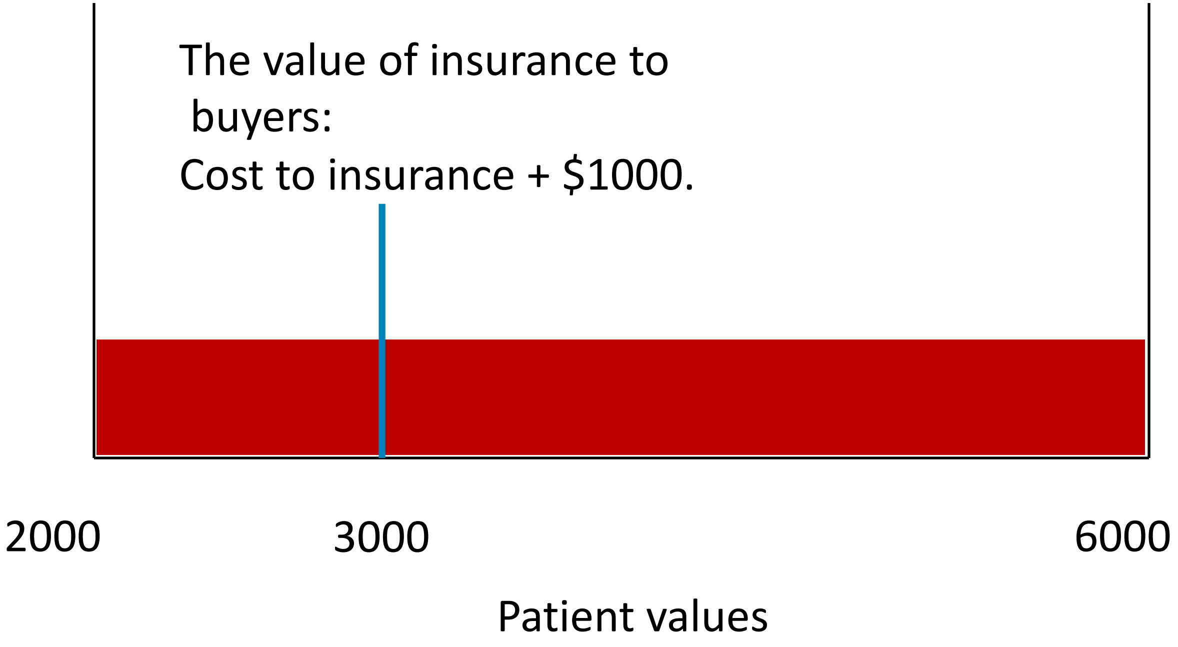
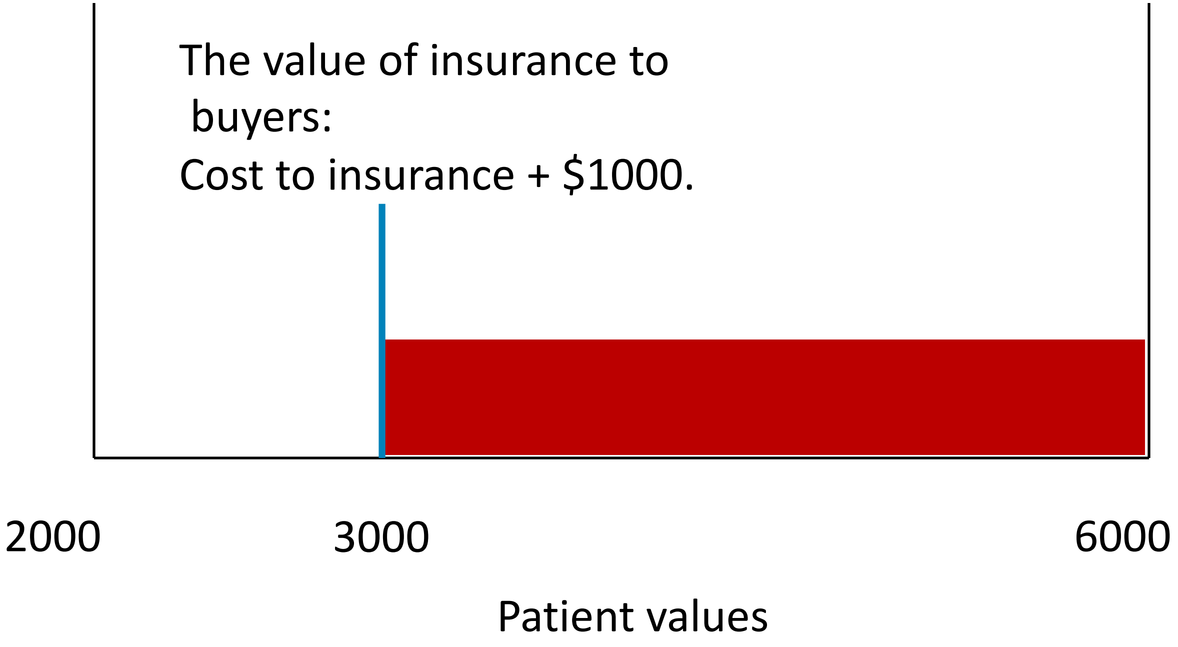


At price= $3000, patients with value lower than $3000 will not buy.

Example: Adverse Selection in Insurance



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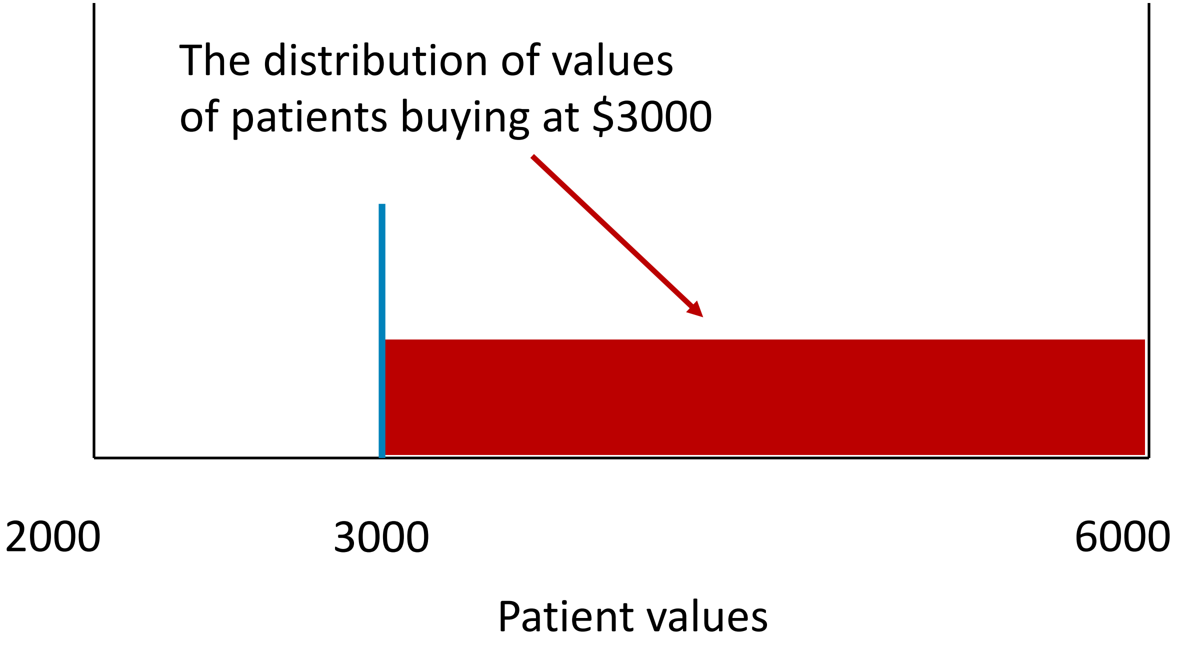
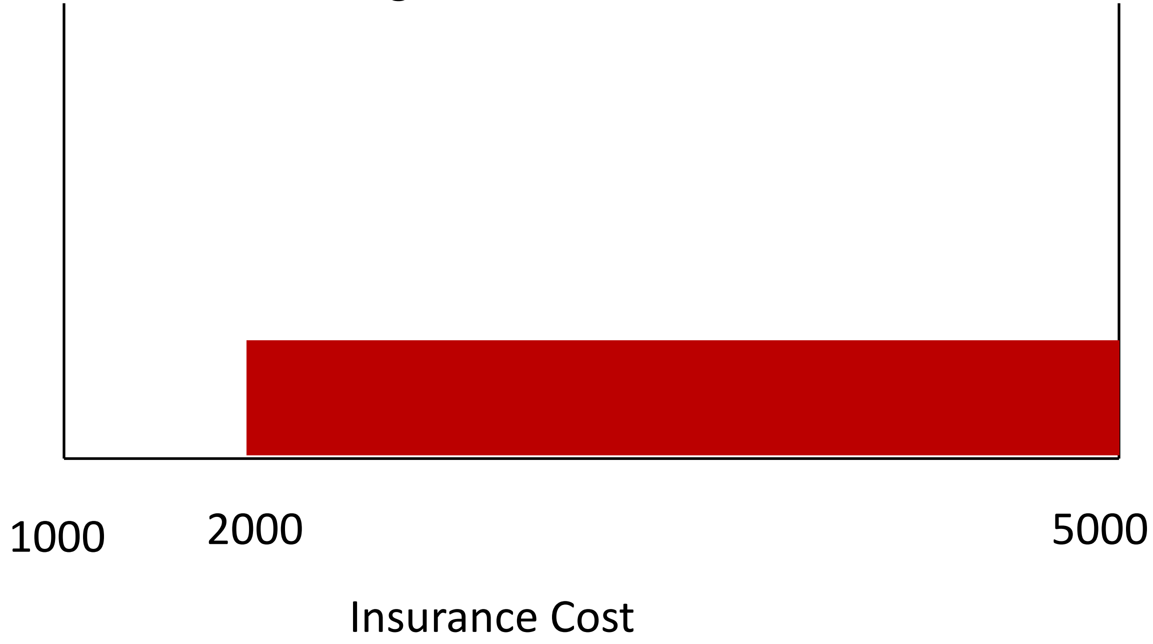


At price= $3000, patients with value lower than $3000 will not buy.

Example: Adverse Selection in Insurance

When the price is $3000:

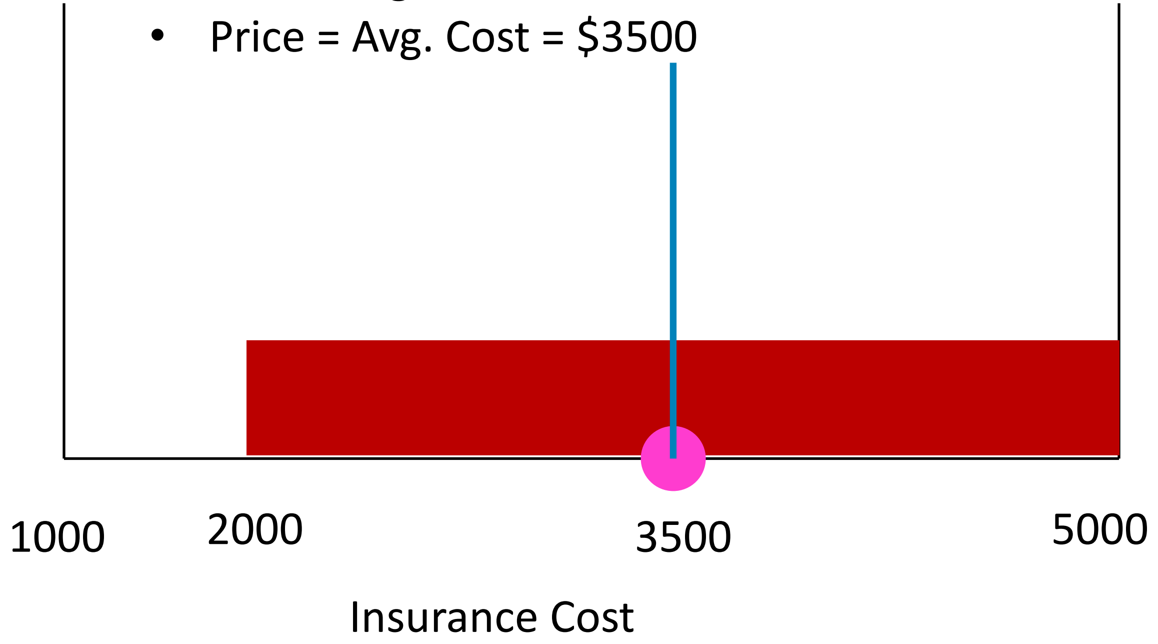
- Patient values range from $3000 to $6000
- Costs range from $2000 to $5000



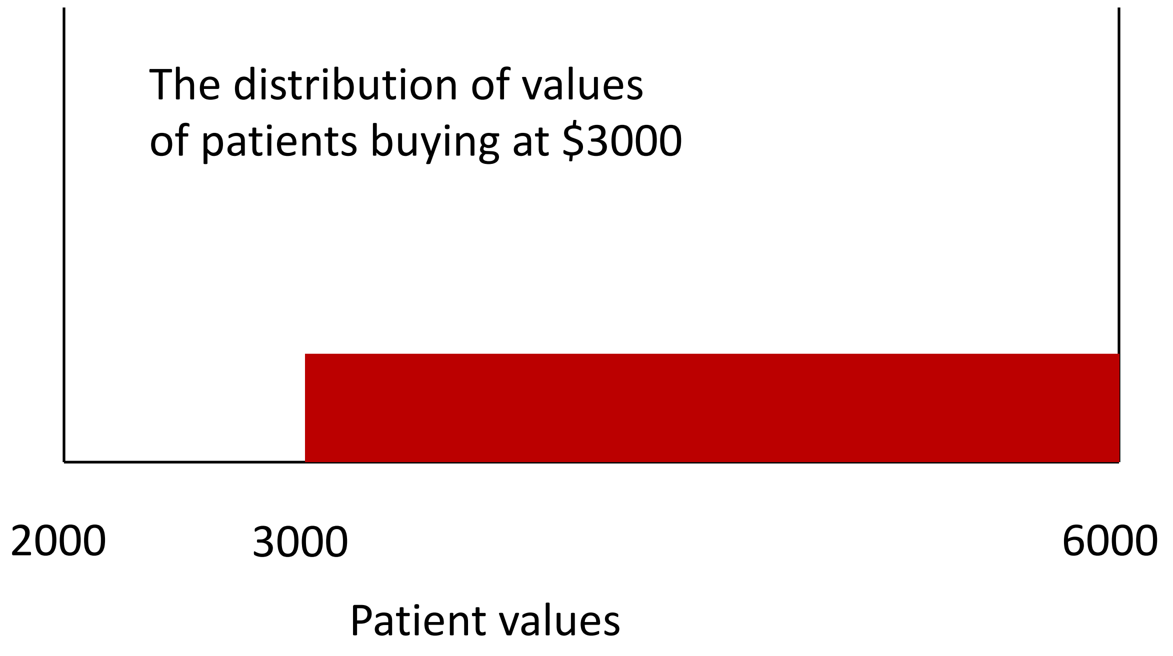
Example: Adverse Selection in Insurance

When the price is $3000:

- Patient values range from $3000 to $6000
- Costs range from $2000 to $5000
- Price = Avg. Cost = $3500



Example: Adverse Selection in Insurance



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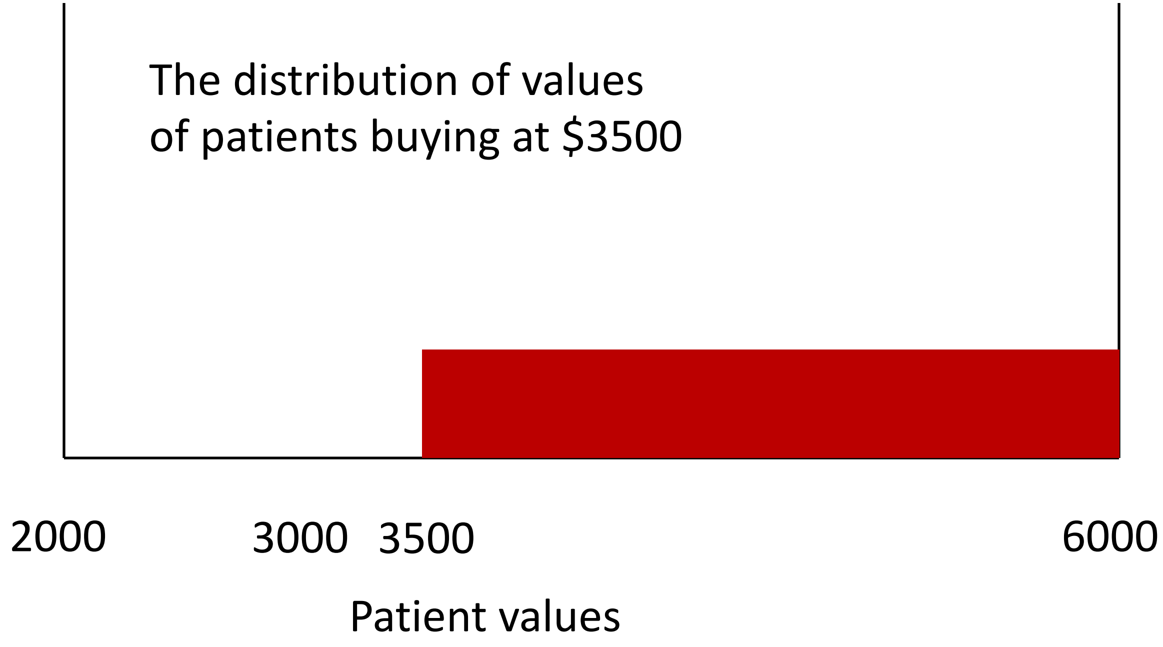

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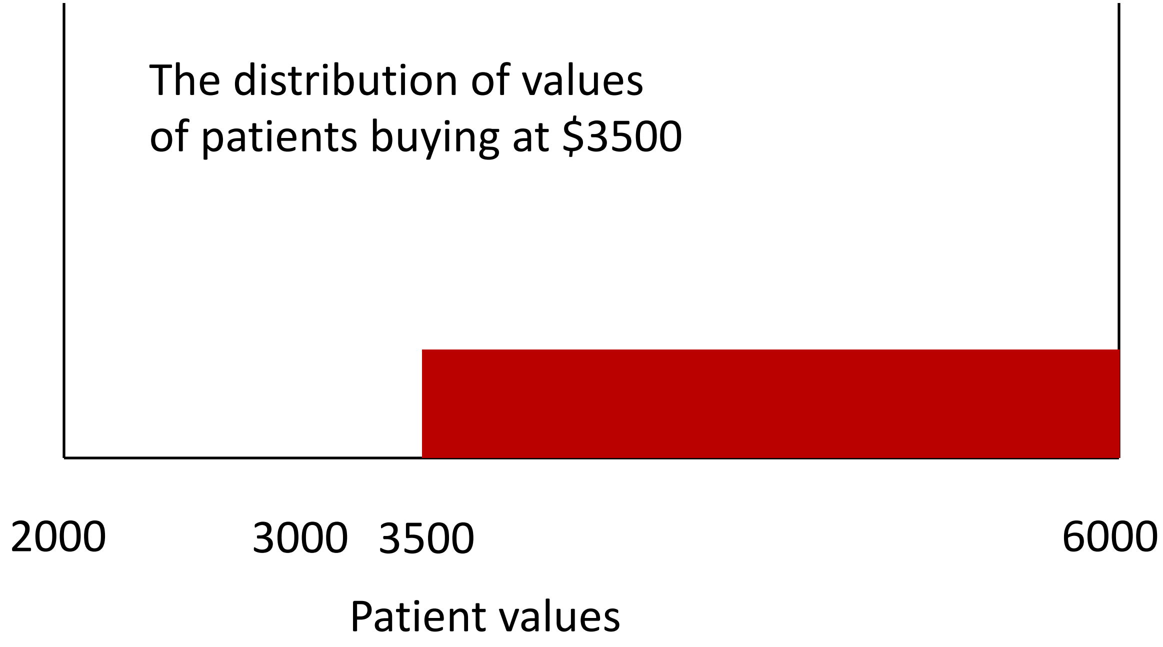
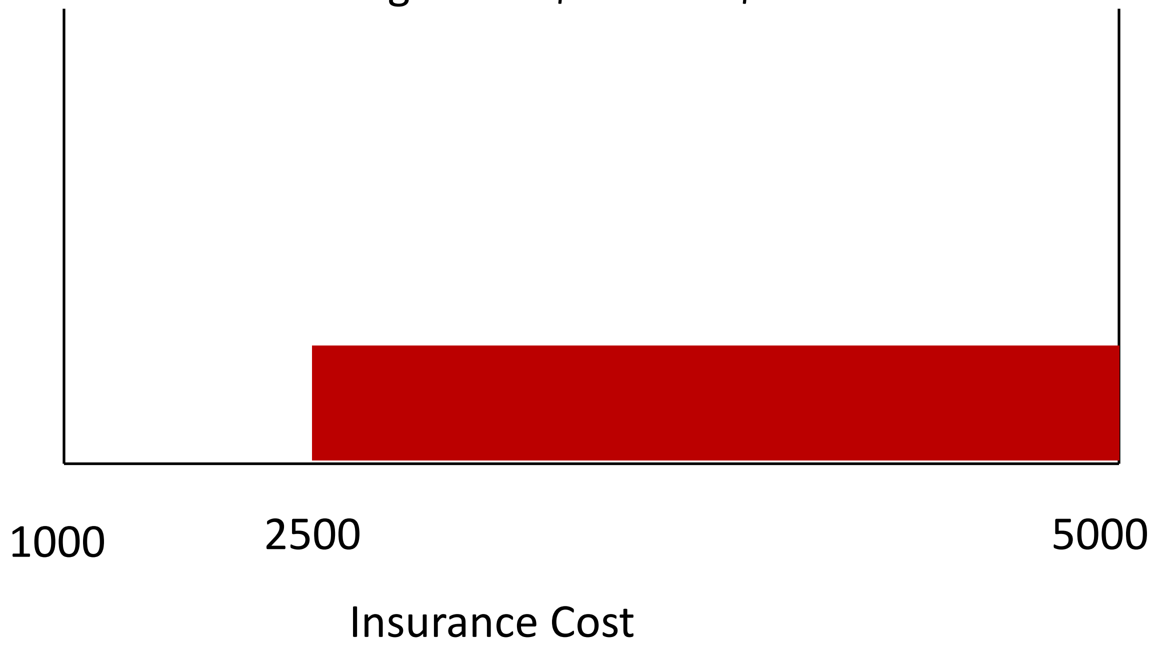


Increasing the price changes the distribution of patients who buy Insurance.

Example: Adverse Selection in Insurance

When the price is $3500:

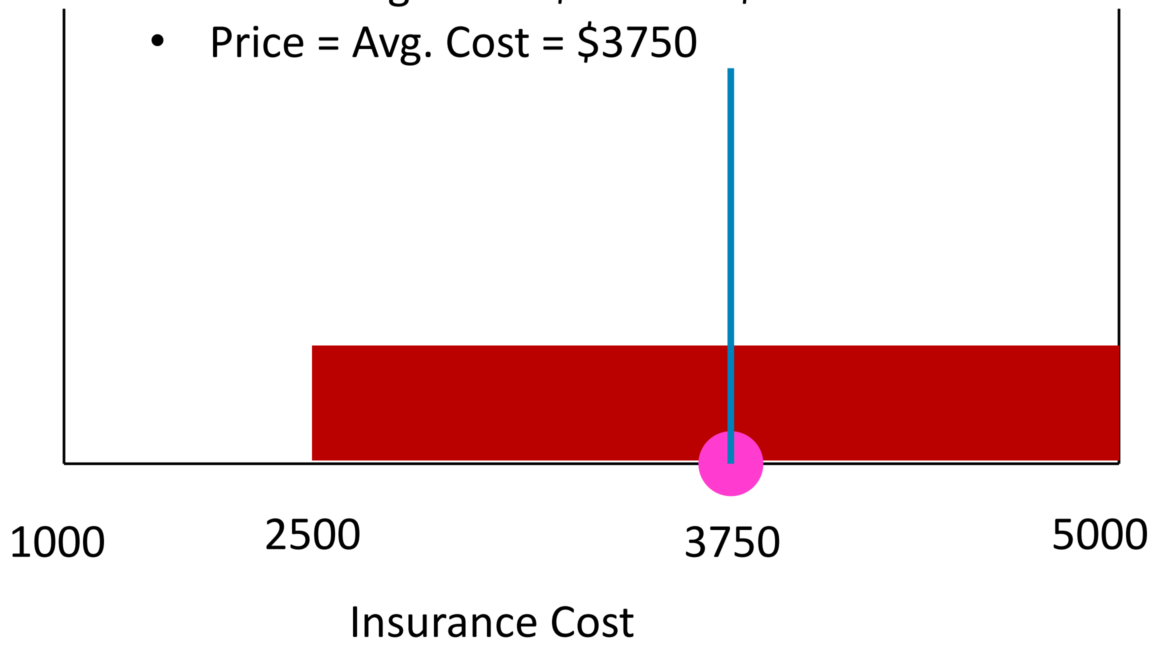
- Patient values range from $3500 to $6000
- Costs range from $2500 to $5000



Example: Adverse Selection in Insurance

When the price is $3500:

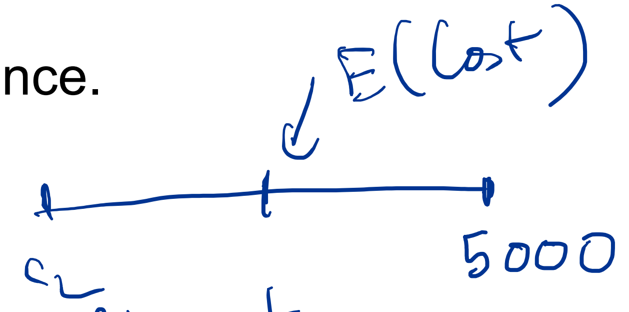
- Patient values range from $3500 to $6000
- Costs range from $2500 to $5000
- Price = Avg. Cost = $3750



Example: Adverse Selection in Insurance

death spiral

- Where does this unraveling of the market end?
- Let c_L be the patient with lowest cost that is willing to buy insurance.
- The expected cost of insurance for insurance company is:



$$E[Cost] = \frac{1}{2}\times c_L + \frac{1}{2}\times 5000 = p$$

(healthiest patient)

- Price = Expected cost

Example: Adverse Selection in Insurance

- Moreover the patient with cost c_L is willing to pay at most:
$$c_L + 1000$$
- Are patients with costs higher than c_L willing to buy at this price?
- The marginal patient will buy insurance at price c_L if:
$$c_L + 1000 = p$$
- We reasoned that price equals expected cost: $p = \frac{1}{2}c_L + \frac{1}{2}5000$
- Combining the two equations: $c_L + 1000 = \frac{1}{2}c_L + \frac{1}{2}5000$ $\rightarrow$
- Thus, in an equilibrium: $c_L = \$3000$ and $p = \$4000$

Example: Adverse Selection in Insurance

- Now consider the mandate: The uninsured must pay a $500 fine.
- In this case if the cost of insurance is c, the patient is willing to pay $c + 1000 + 500$
- Like before, let c_L be the lowest-cost patient who gets insurance
- What price will make this patient willing to buy?

$$p = \underbrace{c_L + 1500}$$

- What's the expected cost to the insurance company?

$$p = \underbrace{\frac{1}{2}c_L + \frac{1}{2}5000} = c_L + 1500$$

- Thus: $c_L = \$2000$ and $\underbrace{p = \$3500}$

Example: Adverse Selection in Insurance

- What happens if we increase the fine from \$500 to \$1000?
- In this case if the cost of insurance is c, the patient is willing to pay $c + 1000 + 1000$
- The price/expected cost still satisfies: $p = \frac{1}{2}c_L + \frac{1}{2}5000$
- The lowest-cost patient buys insurance when: $p = c_L + 2000$
- Thus: $c_L = \$1000$ and $p = \$3000$

$\rightarrow \frac{1}{2}c_L + \frac{1}{2}5000 = c_L + 2000$

Adverse Selection

- Who benefits from mandate?
  - Consider someone with cost $c = \$5000$
  - How much do they value the insurance? $\$6000$
  - Without the mandate, they would be paying \$4000
  - With the mandate, they pay only \$3000

- Who suffers from mandate?
  - Consider someone with cost $c_L = 1000$
  - How much do they value the insurance? $c_L + 1000 = 2000$
  - How much are they paying? $p = 3000$

Moral Hazard

- If you have full car insurance are you more likely to leave your car unlocked?
- Moral hazard is a reaction to incentives to increase the risk of a loss
- and is a consequence of asymmetric information.

Moral Hazard

- If an insurer knows the exact risk from insuring an individual, then a contract specific to that person can be written.

- If all people look alike to the insurer, then one contract will be offered to all insurees; high-risk and low-risk types are then pooled, causing low-risks to subsidize high-risks.

Moral Hazard

- Examples of efforts to avoid moral hazard by using signals are:
  - higher life and medical insurance premiums for smokers or heavy drinkers of alcohol
  - lower car insurance premiums for contracts with higher deductibles or for drivers with histories of safe driving.

Signaling

(Spence 1989)

- Adverse selection is an outcome of an informational deficiency.
- What if information can be improved by high-quality sellers signaling credibly that they are high-quality?
- Examples: Warranties, professional credentials, references from previous clients