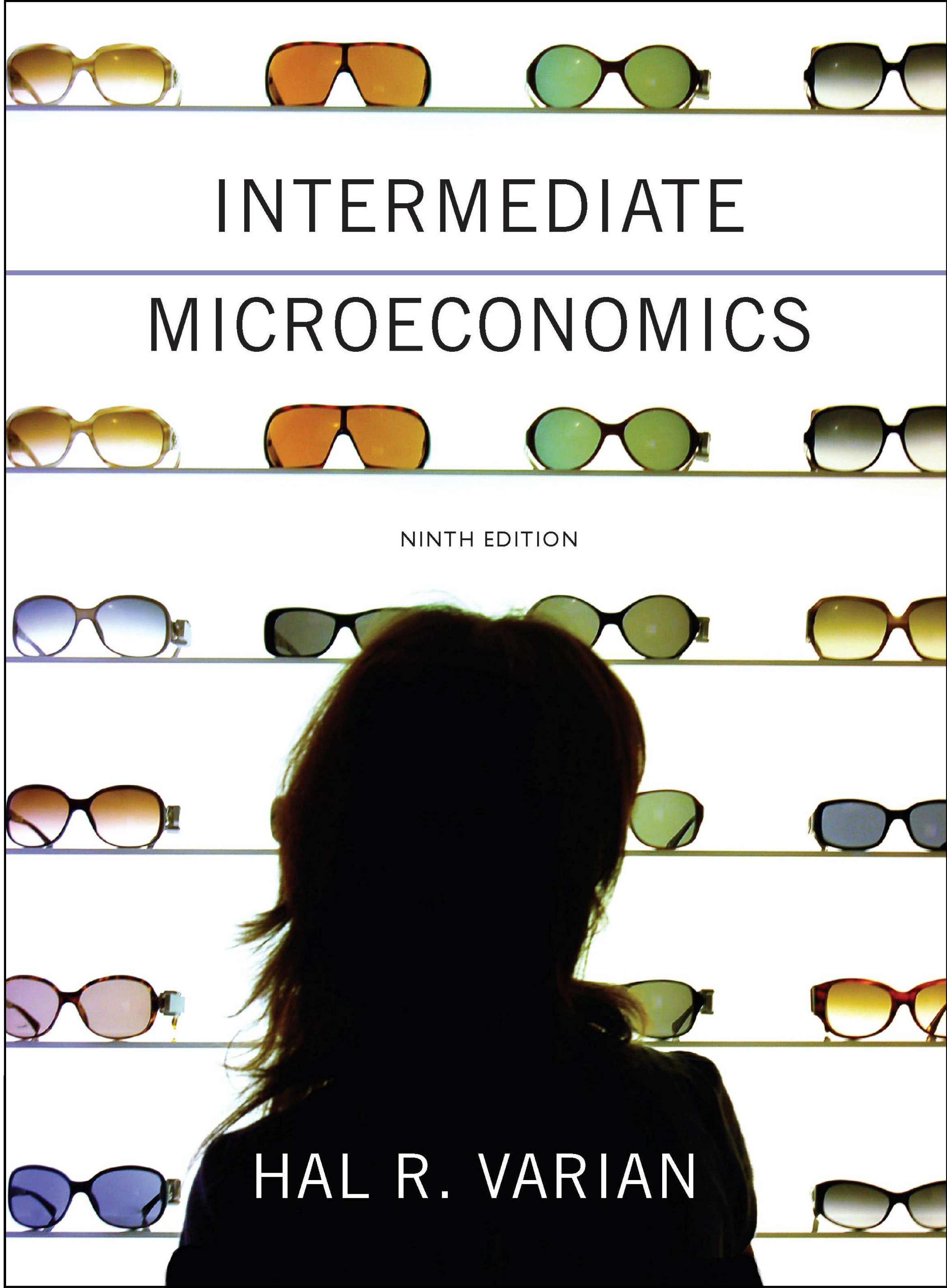


Chapter 38

Asymmetric Information

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 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?**
- **Four applications will be considered:**
  - **adverse selection**
  - **signaling**
  - **moral hazard**
  - **incentives contracting.**

Adverse Selection

- **Consider a used car market.**
- **Two types of cars; “lemons” and “peaches”.**
- **Each lemon seller will accept $1,000; a buyer will pay at most $1,200.**
- **Each peach seller will accept $2,000; a buyer will pay at most $2,400.**

Adverse Selection

- **If every buyer can tell a peach from a lemon, then lemons sell for between \$1,000 and \$1,200, and peaches sell for between \$2,000 and \$2,400.**
- **Gains-to-trade are generated when buyers are well informed.**

Adverse Selection

- Suppose no buyer can tell a peach from a lemon before buying.
- What is the most a buyer will pay for any car?

Adverse Selection

- Let *q* be the fraction of peaches.
- 1 - *q* is the fraction of lemons.
- Expected value to a buyer of any car is at most

$$EV = \$1200(1 - q) + \$2400q.$$

Adverse Selection

- Suppose EV > $2000.
- Every seller can negotiate a price between $2000 and $EV (no matter if the car is a lemon or a peach).
- All sellers gain from being in the market.

Adverse Selection

- **Suppose EV < $2000.**
- **A peach seller cannot negotiate a price above $2000 and will exit the market.**
- **So all buyers know that remaining sellers own lemons only.**
- **Buyers will pay at most $1200 and only lemons are sold.**

Adverse Selection

- Hence “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?
- Buyers will pay \$2000 for a car only if

$$EV = \$1200(1-q) + \$2400q \geq \$2000$$

Adverse Selection

- How many lemons can be in the market without crowding out the peaches?
- Buyers will pay \$2000 for a car only if

$$EV = \$1200(1-q) + \$2400q \geq \$2000$$

$$\Rightarrow q \geq \frac{2}{3}.$$

- So if over one-third of all cars are lemons, then only lemons are traded.

Adverse Selection

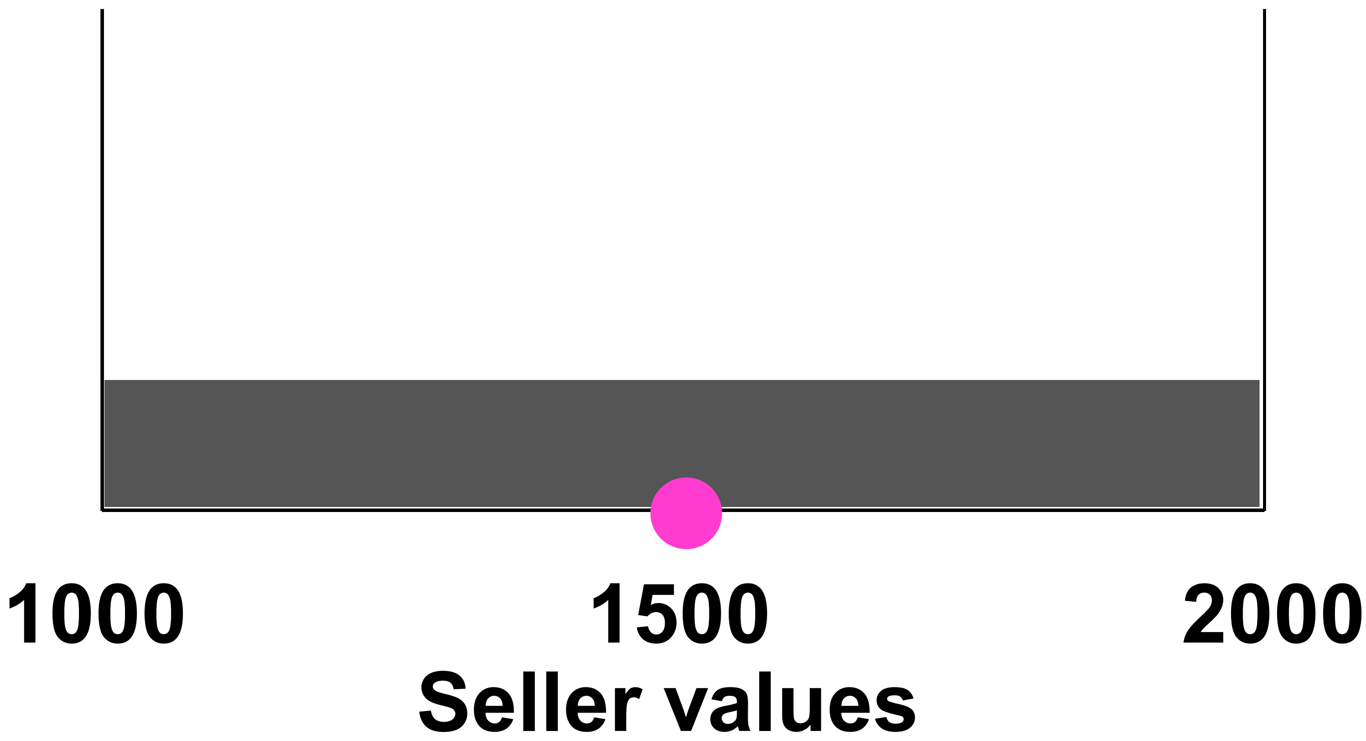
- **A market equilibrium in which both types of cars are traded and cannot be distinguished by the buyers is a pooling equilibrium.**
- **A market equilibrium in which only one of the two types of cars is traded, or both are traded but can be distinguished by the buyers, is a separating equilibrium.**

Adverse Selection

- **What if there is more than two types of cars?**
- **Suppose that**
  - **car quality is Uniformly distributed between \$1000 and \$2000**
  - **any car that a seller values at \$x is valued by a buyer at \$(x+300).**
- **Which cars will be traded?**

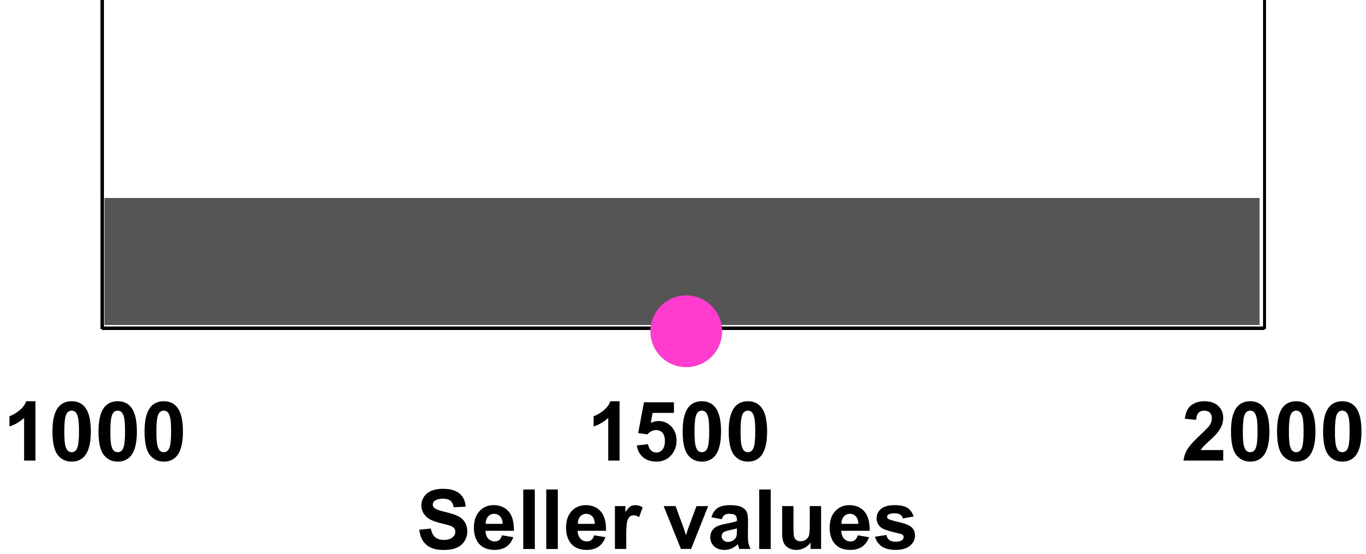
Adverse Selection

Adverse Selection



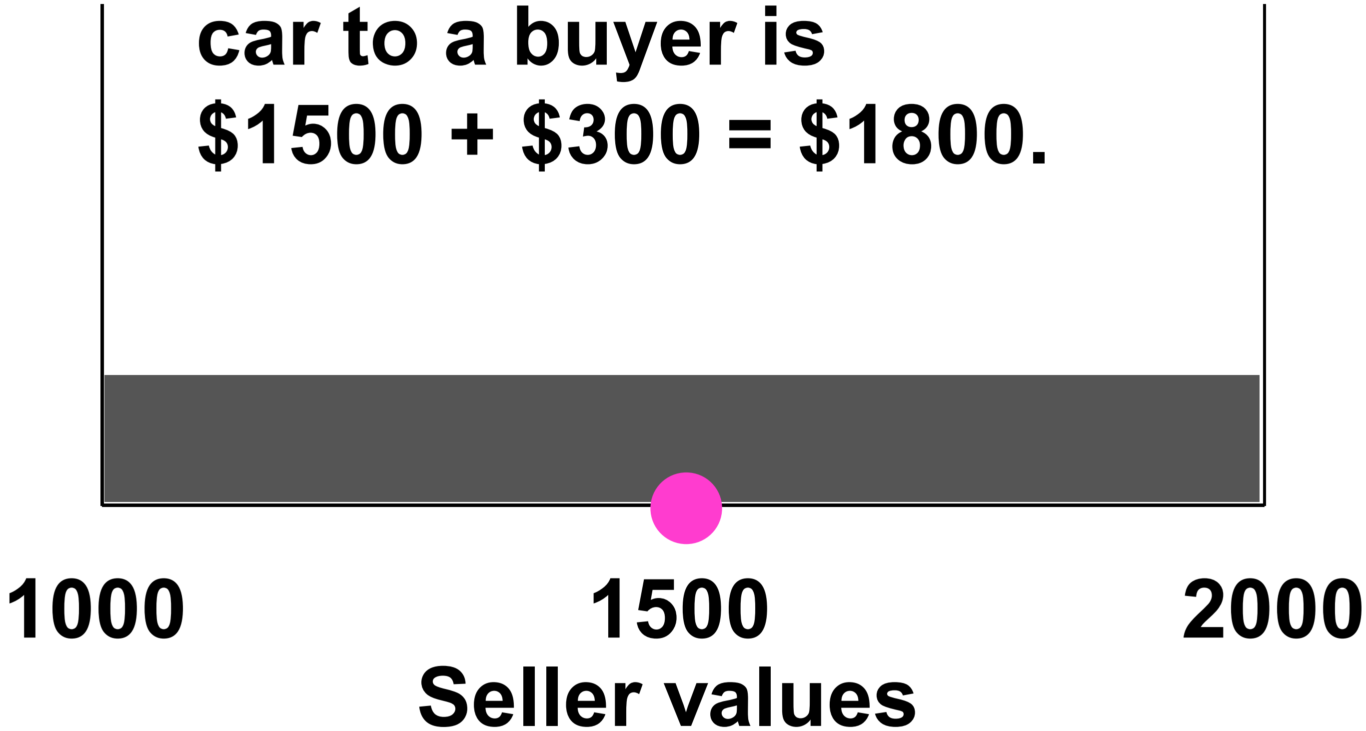
Adverse Selection

The expected value of any car to a buyer is $1500 + $300 = $1800.



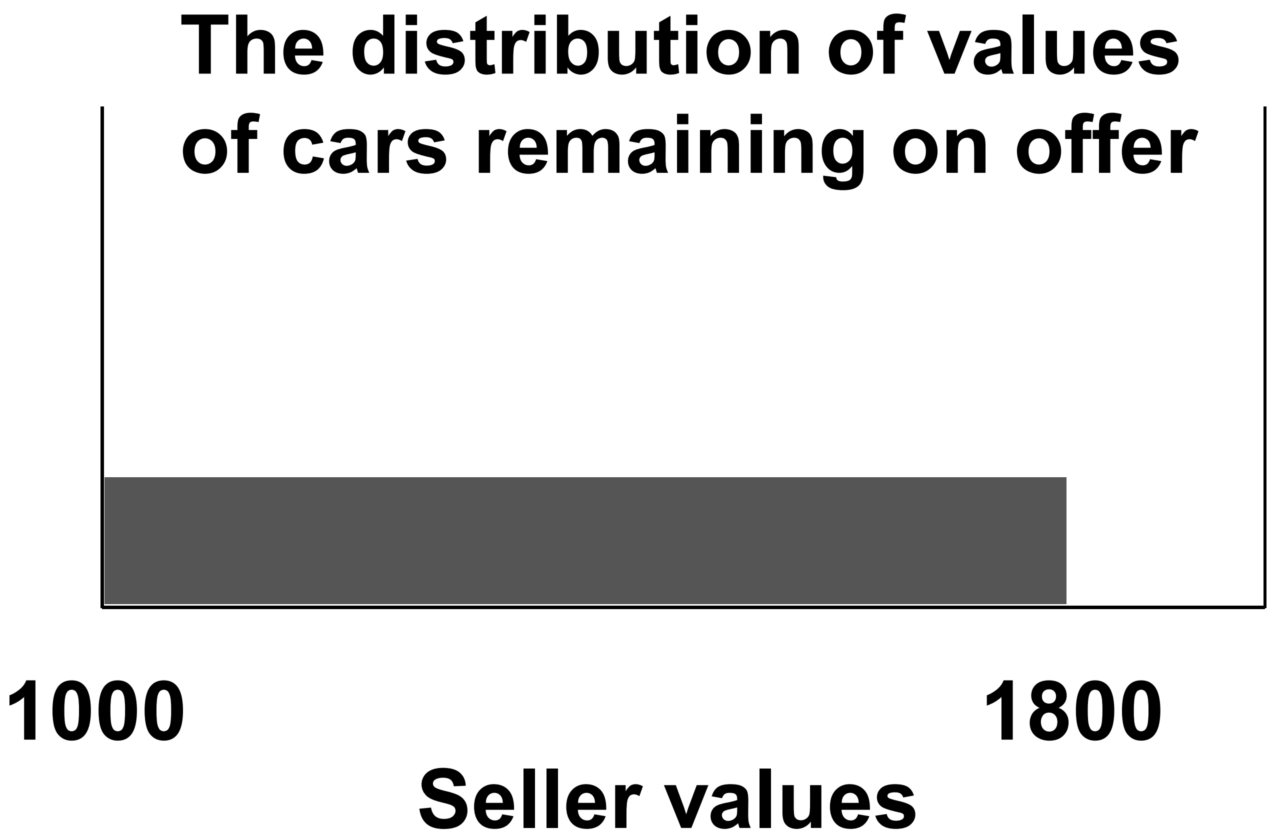
Adverse Selection

The expected value of any car to a buyer is $1500 + $300 = $1800.

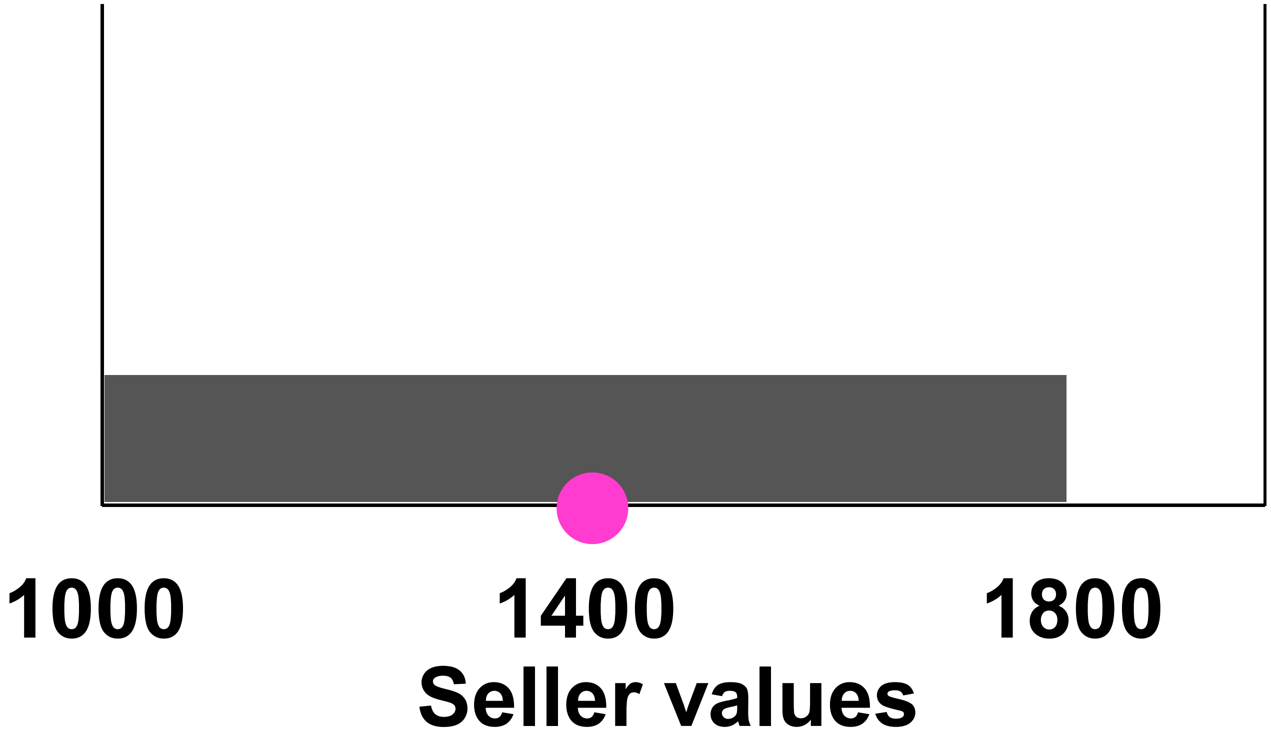


So sellers who value their cars at more than $1800 exit the market.

Adverse Selection

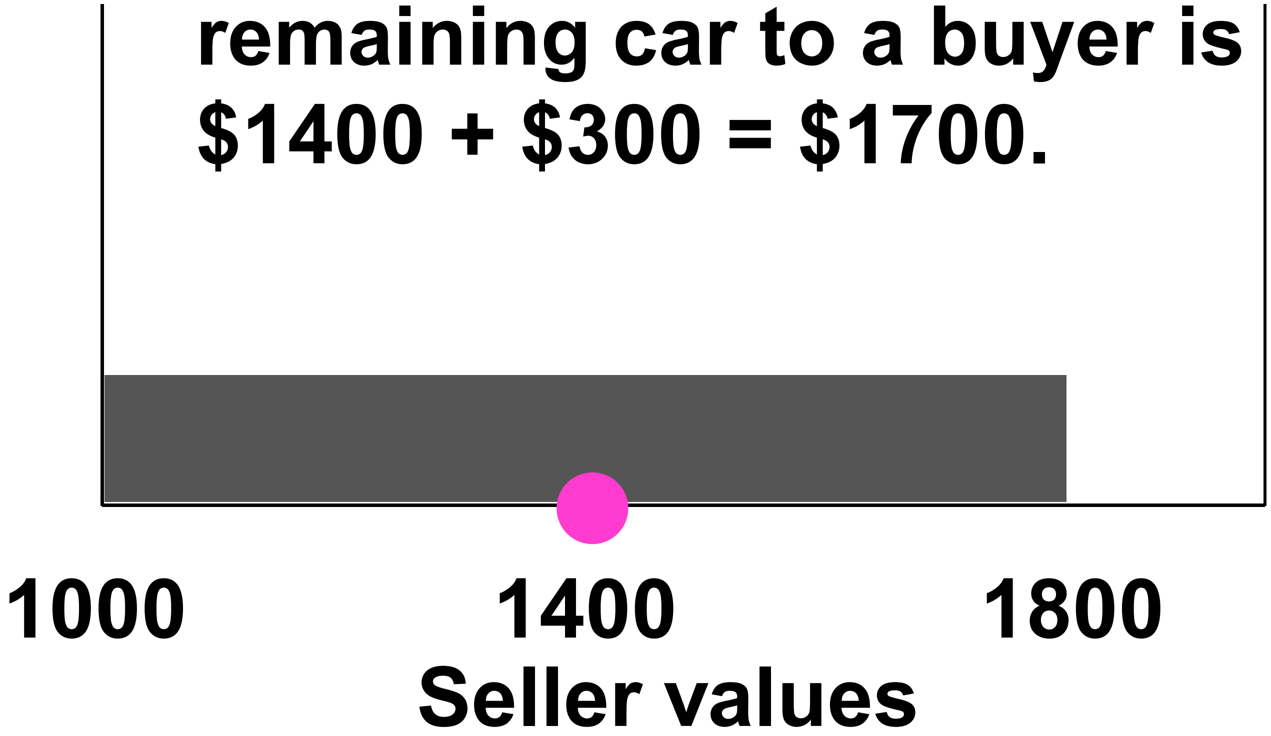


Adverse Selection



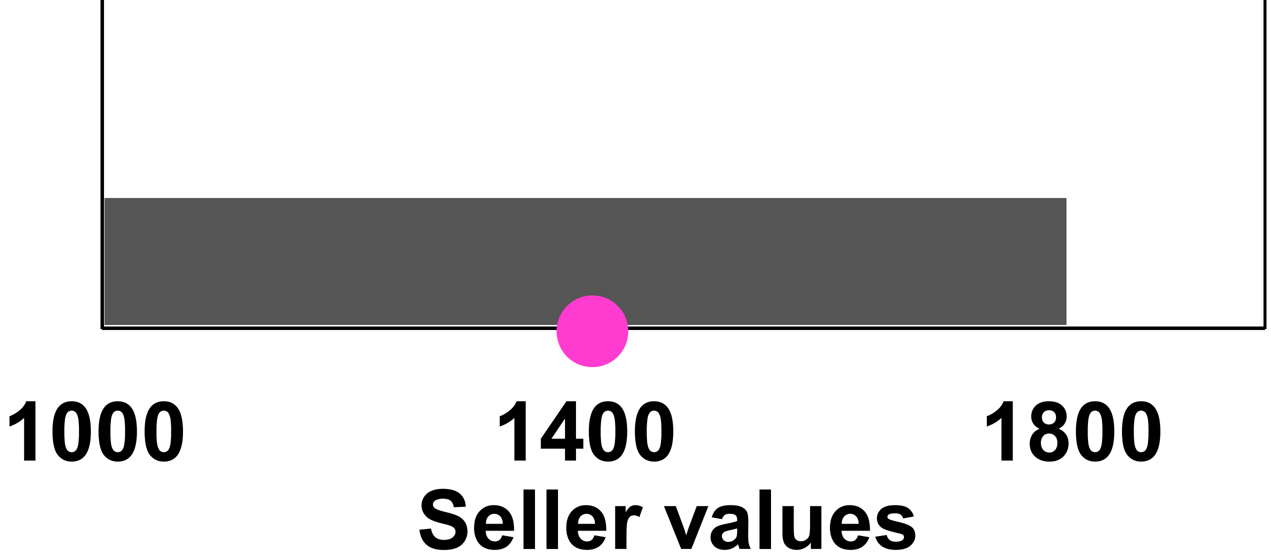
Adverse Selection

The expected value of any remaining car to a buyer is $1400 + $300 = $1700.



Adverse Selection

The expected value of any remaining car to a buyer is \$1400 + \$300 = \$1700.



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 is

$$\frac{1}{2} \times 1000 + \frac{1}{2} \times v_H .$$

Adverse Selection

- **So a buyer will pay at most**

$$\frac{1}{2} \times 1000 + \frac{1}{2} \times v_H + 300.$$

Adverse Selection

- So a buyer will pay at most

$$\frac{1}{2} \times 1000 + \frac{1}{2} \times v_H + 300.$$

- This must be the price which the seller of the highest value car remaining in the market will just accept; i.e.

$$\frac{1}{2} \times 1000 + \frac{1}{2} \times v_H + 300 = v_H.$$

Adverse Selection

$$\frac{1}{2} \times 1000 + \frac{1}{2} \times v_H + 300 = v_H$$

$$\Rightarrow \quad v_H = \$1600.$$

Adverse selection drives out all cars valued by sellers at more than $1600.

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 value a high-quality umbrella at $14 and a low-quality umbrella at $8.**
- **Before buying, no buyer can tell quality.**
- **Marginal production cost of a high-quality umbrella is $11.**
- **Marginal production cost of a low-quality umbrella is $10.**

Adverse Selection with Quality Choice

- **Suppose every seller makes only high-quality umbrellas.**
- **Every buyer pays \$14 and sellers' profit per umbrella is \$14 - \$11 = \$3.**
- **But then a seller can make low-quality umbrellas for which buyers still pay \$14, so increasing profit to \$14 - \$10 = \$4.**

Adverse Selection with Quality Choice

- **There is no market equilibrium in which only high-quality umbrellas are traded.**
- **Is there a market equilibrium in which only low-quality umbrellas are traded?**

Adverse Selection with Quality Choice

- **All sellers make only low-quality umbrellas.**
- **Buyers pay at most $8 for an umbrella, while marginal production cost is $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**

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

- **High-quality manufacturers must recover the manufacturing cost,**

$$EV = 8 + 6q \geq 11 \Rightarrow q \geq 1/2.$$

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.**

Adverse Selection with Quality Choice

- **Since all sellers reason this way, the fraction of high-quality sellers will shrink towards 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**

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 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!

Signaling

- 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?
- E.g. warranties, professional credentials, references from previous clients etc.

Signaling

- **A labor market has two types of workers; high-ability and low-ability.**
- **A high-ability worker's marginal product is a_H.**
- **A low-ability worker's marginal product is a_L.**
- **$a_L < a_H$.**

Signaling

- **A fraction *h* of all workers are high-ability.**
- **1 - *h* is the fraction of low-ability workers.**

Signaling

- **Each worker is paid his expected marginal product.**
- **If firms knew each worker's type they would**
  - **pay each high-ability worker $w_H = a_H$**
  - **pay each low-ability worker $w_L = a_L$.**

Signaling

- If firms cannot tell workers' types then every worker is paid the (pooling) wage rate; i.e. the expected marginal product

$$w_P = (1 - h)a_L + ha_H.$$

Signaling

- $w_P = (1 - h)a_L + ha_H < a_H$, **the wage rate paid when the firm knows a worker really is high-ability.**
- **So high-ability workers have an incentive to find a credible signal.**

Signaling

- **Workers can acquire "education".**
- **Education costs a high-ability worker c_H per unit**
- **and costs a low-ability worker c_L per unit.**
- **$c_L > c_H$.**

Signaling

- **Suppose that education has no effect on workers' productivities; i.e., the cost of education is a deadweight loss.**

Signaling

- **High-ability workers will acquire e_H education units if**
  (i) $w_H - w_L = a_H - a_L > c_H e_H$, and
  (ii) $w_H - w_L = a_H - a_L < c_L e_H$.

Signaling

- **High-ability workers will acquire e_H education units if**
  (i) $w_H - w_L = a_H - a_L > c_H e_H$, and
  (ii) $w_H - w_L = a_H - a_L < c_L e_H$.
- **(i) says acquiring e_H units of education benefits high-ability workers.**

Signaling

- **High-ability workers will acquire e_H education units if**
  (i) $w_H - w_L = a_H - a_L > c_H e_H$, and
  (ii) $w_H - w_L = a_H - a_L < c_L e_H$.
- **(i) says acquiring e_H units of education benefits high-ability workers.**
- **(ii) says acquiring e_H education units hurts low-ability workers.**

Signaling

$a_H - a_L > c_H e_H$ **and** $a_H - a_L < c_L e_H$

together require

$$\frac{a_H - a_L}{c_L} < e_H < \frac{a_H - a_L}{c_H}.$$

Acquiring such an education level credibly signals high-ability, allowing high-ability workers to separate themselves from low-ability workers.

Signaling

- **Q: Given that high-ability workers acquire e_H units of education, how much education should low-ability workers acquire?**

Signaling

- **Q: Given that high-ability workers acquire e_H units of education, how much education should low-ability workers acquire?**
- **A: Zero. Low-ability workers will be paid $w_L = a_L$ so long as they do not have e_H units of education and they are still worse off if they do.**

Signaling

- **Signaling can improve information in the market.**
- **But, total output did not change and education was costly so signaling worsened the market’s efficiency.**
- **So improved information need not improve gains-to-trade.**

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.**

Incentives Contracting

- A worker is hired by a principal to do a task.
- Only the worker knows the effort she exerts (asymmetric information).
- The effort exerted affects the principal's payoff.

Incentives Contracting

- **The principal's problem: design an incentives contract that induces the worker to exert the amount of effort that maximizes the principal's payoff.**

Incentives Contracting

- ***e* is the agent's effort.**
- **Principal's reward is** $y = f(e).$
- **An incentive contract is a function *s*(*y*) specifying the worker's payment when the principal's reward is *y*. The principal's profit is thus**

$$\Pi_p = y - s(y) = f(e) - s(f(e)).$$

Incentives Contracting

- **Let $\tilde{u}$ be the worker's (reservation) utility of not working.**
- **To get the worker's participation, the contract must offer the worker a utility of at least $\tilde{u}$.**
- **The worker's utility cost of an effort level *e* is *c*(*e*).**

Incentives Contracting

So the principal's problem is choose e to

$$\max \Pi_p = f(e) - s(f(e))$$

subject to $s(f(e)) - c(e) \geq \tilde{u}$. **(participation constraint)**

To maximize his profit the principal designs the contract to provide the worker with her reservation utility level. That is, ...

Incentives Contracting

the principal's problem is to

$$\max \Pi_p = f(e) - s(f(e))$$

subject to $s(f(e)) - c(e) = \tilde{u}$. **(participation constraint)**

Incentives Contracting

the principal's problem is to

$$\max \Pi_p = f(e) - s(f(e))$$

subject to $s(f(e)) - c(e) = \tilde{u}$. **(participation constraint)**

Substitute for $s(f(e))$ **and solve**

$$\max \Pi_p = f(e) - c(e) - \tilde{u}.$$

Incentives Contracting

the principal's problem is to

$$\max \Pi_p = f(e) - s(f(e))$$

subject to $s(f(e)) - c(e) = \tilde{u}$. **(participation constraint)**

Substitute for $s(f(e))$ **and solve**

$$\max \Pi_p = f(e) - c(e) - \tilde{u}.$$

The principal's profit is maximized when

$$f'(e) = c'(e).$$

Incentives Contracting

$$f'(e) = c'(e) \Rightarrow e = e^*.$$

The contract that maximizes the principal's profit insists upon the worker effort level *e that equalizes the worker's marginal effort cost to the principal's marginal payoff from worker effort.**

Incentives Contracting

$$f'(e) = c'(e) \Rightarrow \; e = e^* .$$

The contract that maximizes the principal's profit insists upon the worker effort level *e that equalizes the worker's marginal effort cost to the principal's marginal payoff from worker effort.**

How can the principal induce the worker to choose e = e*?

Incentives Contracting

- $e = e^*$ must be most preferred by the worker.

Incentives Contracting

- **e = e* must be most preferred by the worker.**
- **So the contract *s*(*y*) must satisfy the incentive-compatibility constraint;**

$$s(f(e^*)) - c(e^*) \geq s(f(e)) - c(e), \text{ for all } e \geq 0.$$

Rental Contracting

- **Examples of incentives contracts: (i) Rental contracts: The principal keeps a lump-sum R for himself and the worker gets all profit above R; i.e.**

$$s(f(e)) = f(e) - R.$$

- **Why does this contract maximize the principal's profit?**

Rental Contracting

- **Given the contract** $s(f(e)) = f(e) - R$ **the worker's payoff is**

$$s(f(e)) - c(e) = f(e) - R - c(e)$$

and to maximize this the worker should choose the effort level for which $f'(e) = c'(e)$; that is, $e = e^*$.

Rental Contracting

- **How large should be the principal's rental fee R?**
- **The principal should extract as much rent as possible without causing the worker not to participate, so R should satisfy** $s(f(e^*)) - c(e^*) - R = \tilde{u}$; **i.e.** $R = s(f(e^*)) - c(e^*) - \tilde{u}$.

Other Incentives Contracts

- **(ii) Wages contracts: In a wages contract the payment to the worker is**

  $$s(e) = we + K.$$

  ***w* is the wage per unit of effort.**
  ***K* is a lump-sum payment.**
- $w = f'(e^*)$ **and *K* makes the worker just indifferent between participating and not participating.**

Other Incentives Contracts

- **(iii) Take-it-or-leave-it: Choose $e = e^*$ and be paid a lump-sum L, or choose $e \neq e^*$ and be paid zero.**
- **The worker's utility from choosing $e \neq e^*$ is $- c(e)$, so the worker will choose $e = e^*$.**
- **L is chosen to make the worker indifferent between participating and not participating.**

Incentives Contracts in General

- **The common feature of all efficient incentive contracts is that they make the worker the full residual claimant on profits.**
- **I.e. the last part of profit earned must accrue entirely to the worker.**