

Chapter 6: Asymmetric Information

Ch 37 in H. Varian 8th Ed.

Slides by [Mariona Segú](#), CYU Cergy Paris Université

Inspired by [Michael D. Robinson](#), Mount Holyoke College

Information in Competitive Markets

So far...

→ We have assumed that all agents are fully informed about traded commodities and other aspects of the market.

But... This might not be true in some cases:

→ Quality is hard to tell. Ex: labor market

→ What about markets for medical services, or insurance, or used cars?

Asymmetric Information in Markets

Examples:

- 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**.
- In what ways can asymmetric information affect the functioning of a market?
- Two applications will be considered:
 - 1. Adverse Selection**
 - 1. Solved with **signaling**
 - 2. Moral Hazard**
 - 1. Solved with **incentives** contracting.

Outline

1. The Lemons market
2. Adverse selection with quality choice
3. Signaling
4. Moral Hazard
5. Incentives contracting

1. The Lemons market

- 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.

The Lemons market

Perfect information

- 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.

The Lemons market

Asymmetric information

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

The Lemons market

- 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

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

The Lemons market

- 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.

The Lemons market

- 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.

The Lemons market

- 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.
- Market failure: there is an externality
 - when an individual decides to try to sell a bad car, he affects the purchasers’ perceptions of the quality of the average car on the market

The Lemons market

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

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

$$\Rightarrow q = \frac{2}{3}$$

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

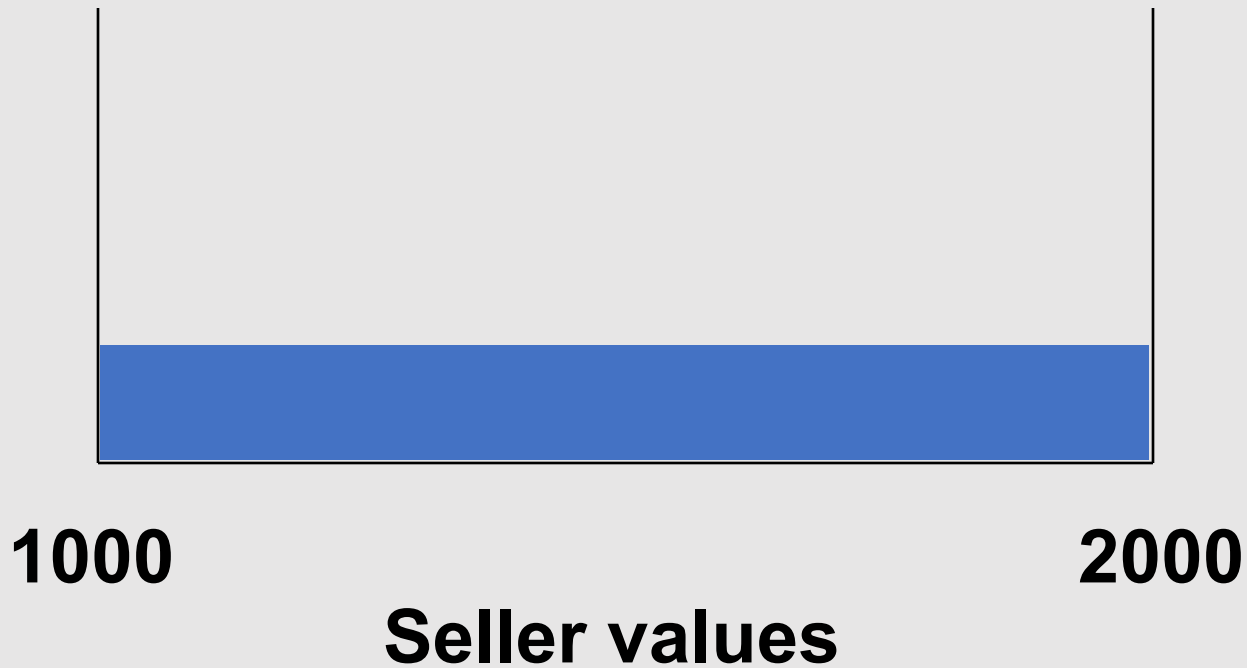
The Lemons market - Equilibrium

- **Pooling equilibrium:** A market equilibrium in which both types of cars are traded, and buyers cannot distinguish the type of car.
- **Separating 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.

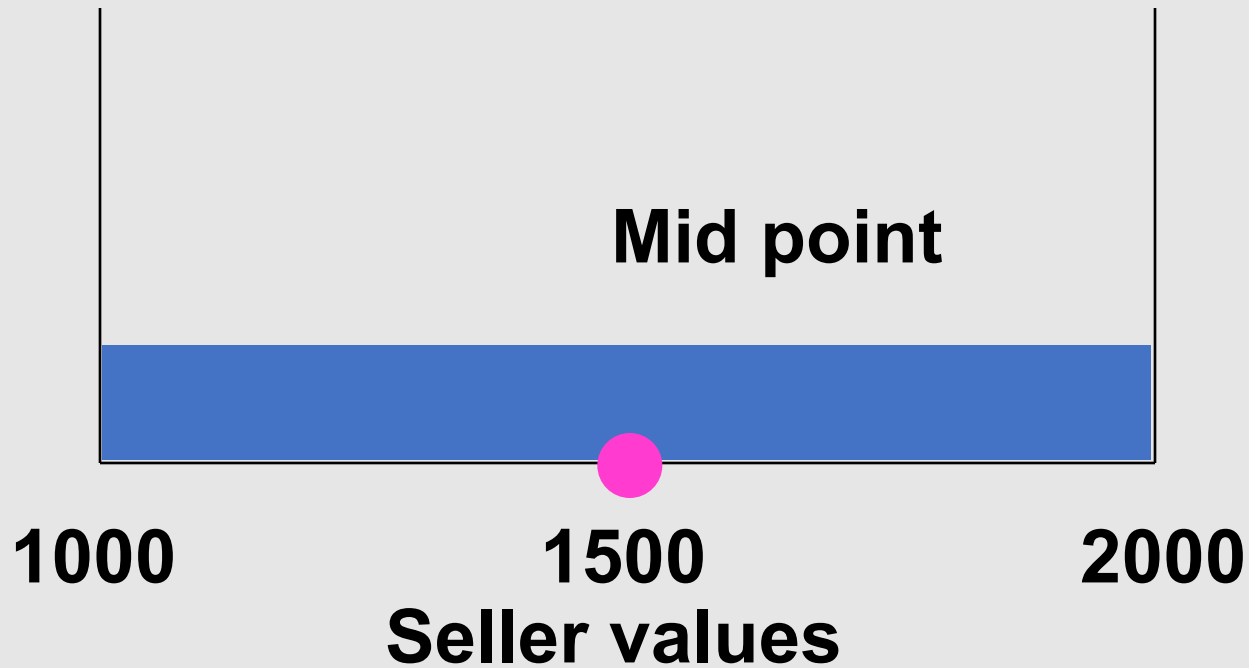
The Lemons market – continuous quality

- 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?

The Lemons market – continuous quality

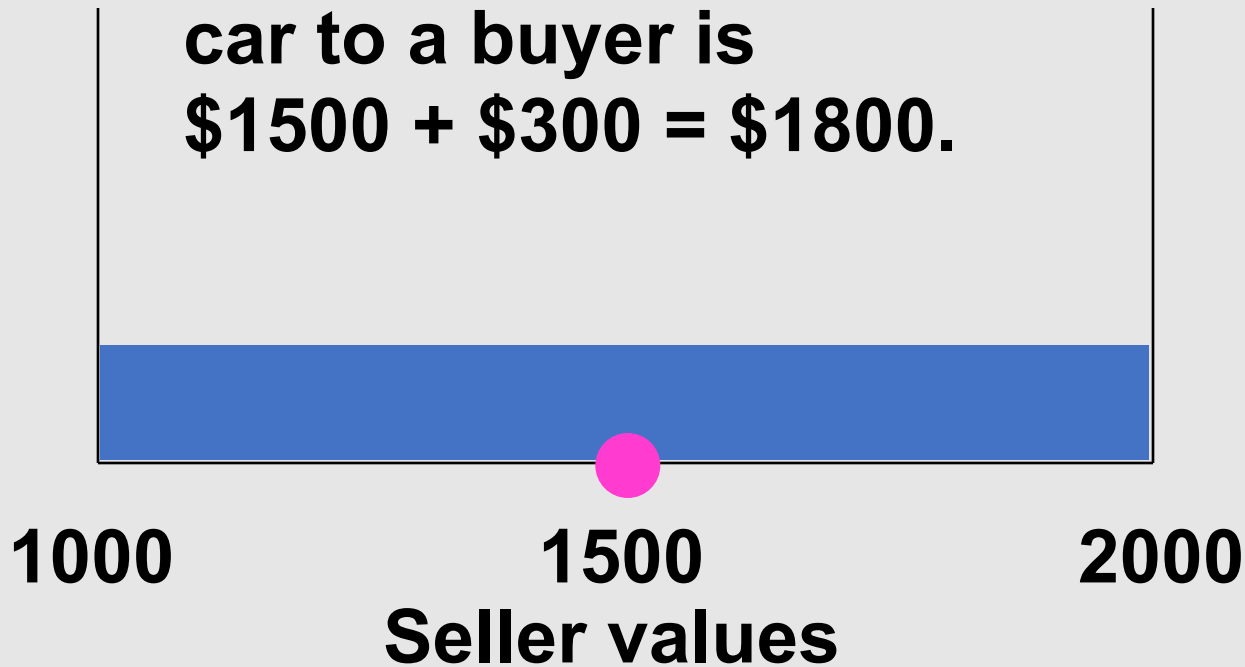


The Lemons market – continuous quality



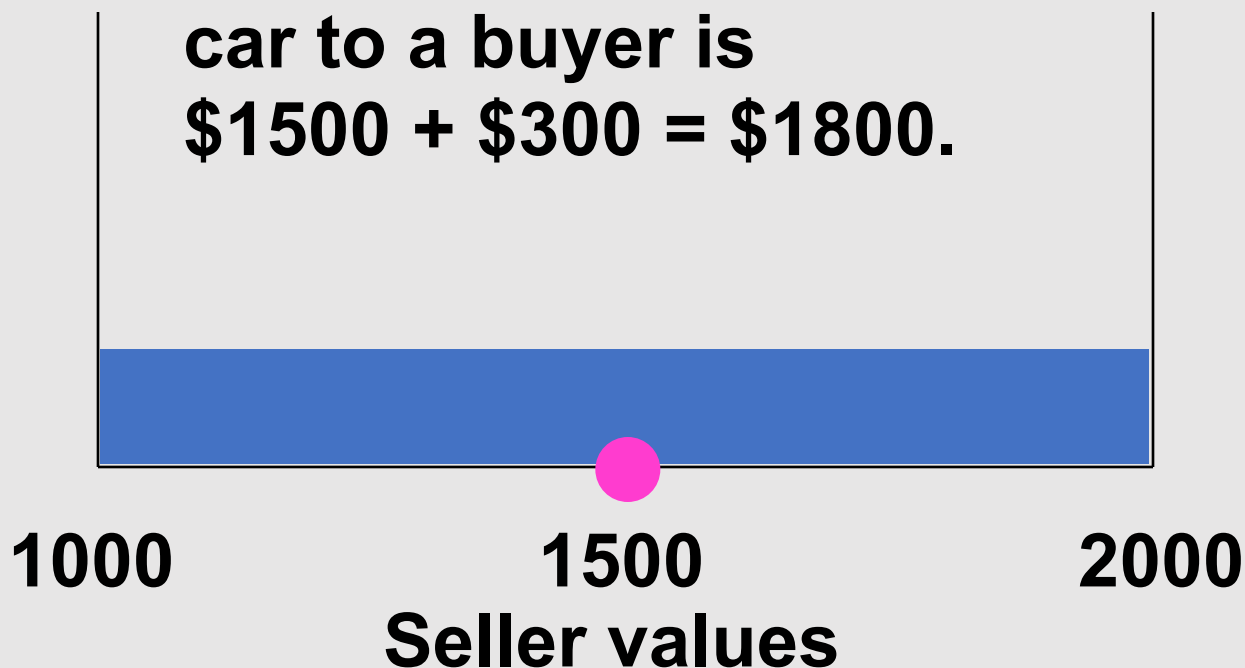
The Lemons market – continuous quality

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



The Lemons market – continuous quality

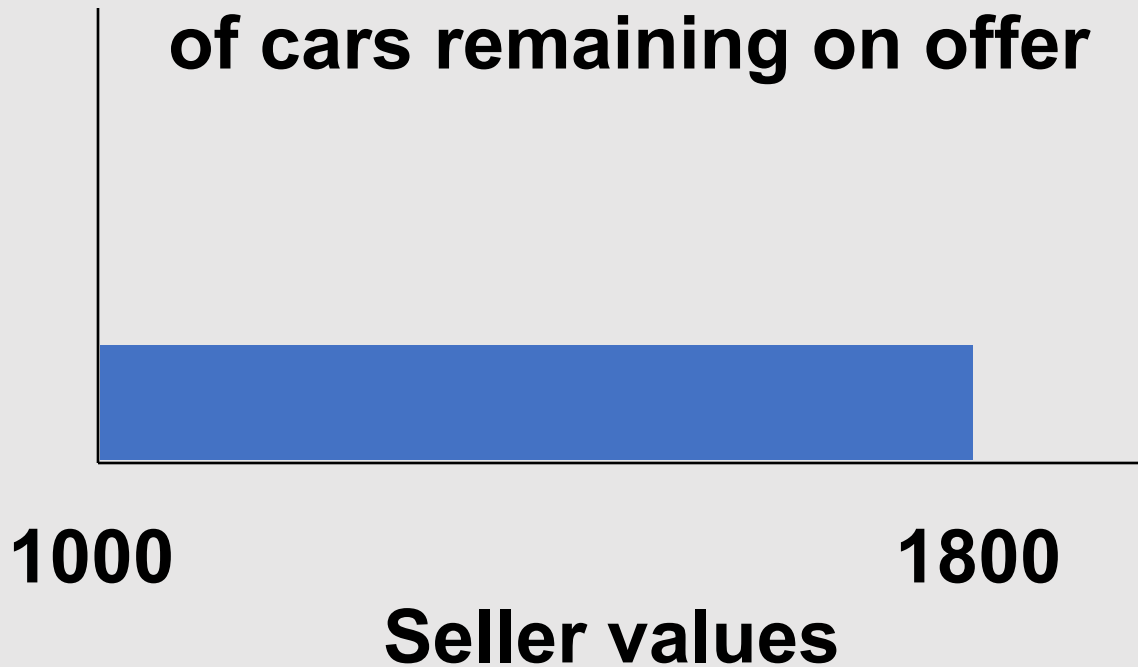
**The expected value of any car to a buyer is
 $\$1500 + \$300 = \$1800$.**



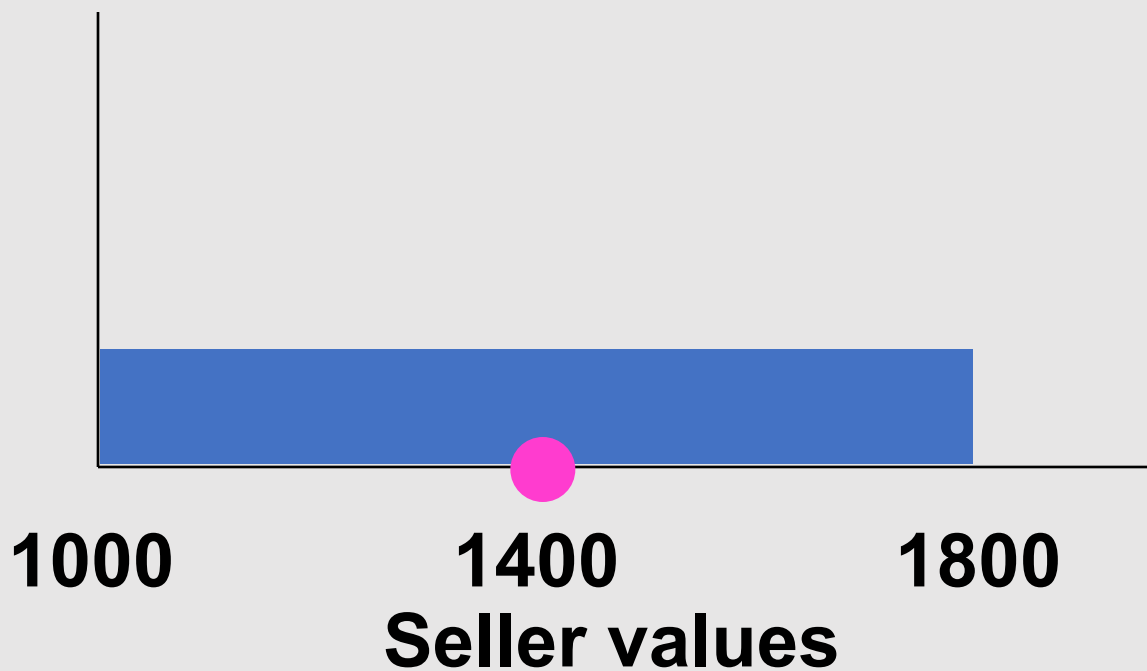
So sellers who value their cars at more than \$1800 exit the market.

The Lemons market – continuous quality

**The distribution of values
of cars remaining on offer**

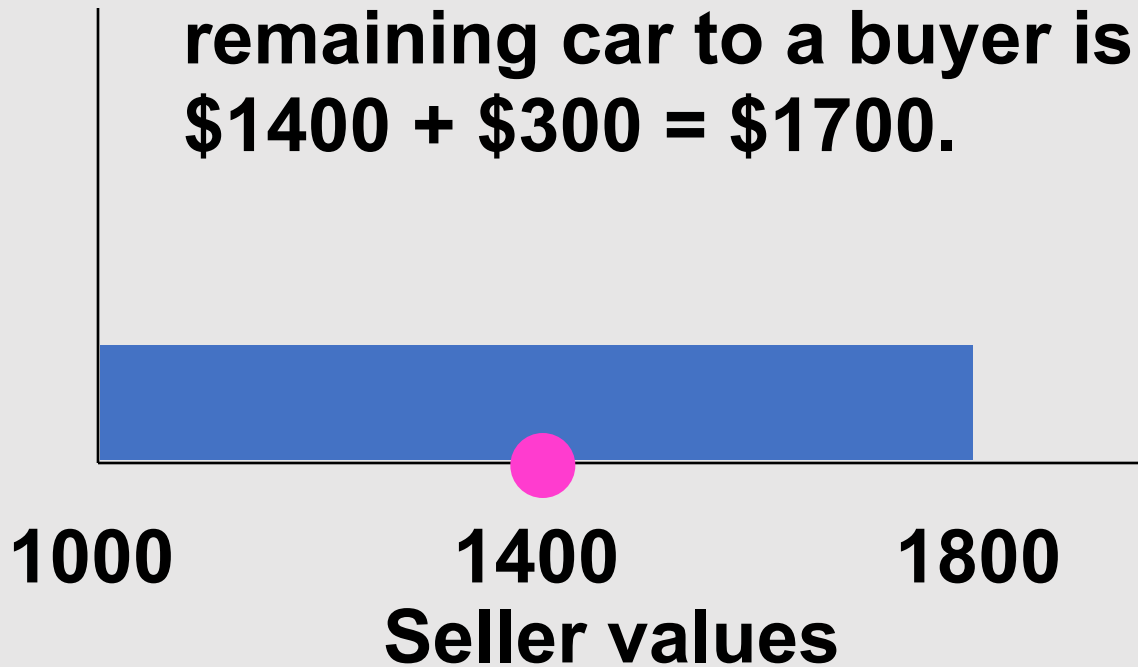


The Lemons market – continuous quality



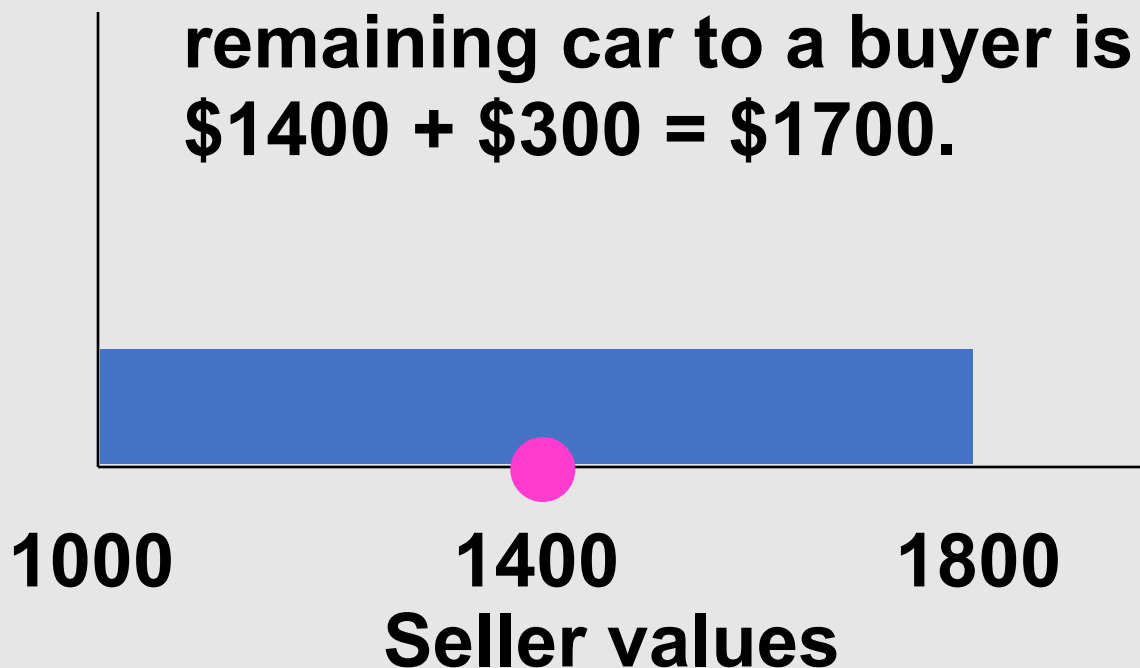
The Lemons market – continuous quality

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



The Lemons market – continuous quality

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.

The Lemons market – continuous quality

- 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

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

The Lemons market – continuous quality

→ So a buyer will pay at most:

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

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

$$\begin{aligned} \frac{1}{2} \times 1000 + \frac{1}{2} v_H + 300 &= v_H \\ \Rightarrow v_H &= 1600 \end{aligned}$$

→ This drives out all cars valued by sellers at more than \$1600.

The Lemons market – continuous quality

- This is an example of **ADVERSE SELECTION**
 - There is an *adverse* selection of one type of cars (low-quality ones)
- Adverse selection refers to situations where one side of the market can't observe the “type” or quality of the goods on other side of the market.
- Adverse selection is the **hidden type problem**
- The term adverse selection was first used in the insurance industry to describe the fact that only more risky clients would contract an insurance
 - Solution: compulsory insurance

2. Adverse Selection with Quality Choice

→ Now assume that each seller can choose the quality, or value, of her product.

EXAMPLE

→ 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,
$$EV = 8 + 6q \geq 11 \Rightarrow q \geq \frac{1}{2}$$

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 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

To sum up

→ The market has no equilibrium

- with just one umbrella type traded (separating eq.)
- with both umbrella types traded (pooling eq.)

→ So the market has no equilibrium at all!

→ Adverse selection has destroyed the entire market!

- Low-quality items crowded out the high-quality items because of the high cost of acquiring information

3. 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.
- 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

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

→ $w_p = (1 - h)a_L + ha_H < a_H$,

→ The pooling wage is lower than the wage paid to high-ability workers if the firm can know the type

→ 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.

→ High-ability workers will acquire e_H education units if

1. $w_H - w_L = a_H - a_L > c_H e_H$, and

2. $w_H - w_L = a_H - a_L < c_L e_H$.

1. Acquiring e_H units of education benefits high-ability workers since increase in salary is higher than cost

2. Acquiring e_H education units hurts low-ability workers since for them it is more costly to acquire the same education.

Signaling

→ $a_H - a_L > c_H e_H$ and $a_H - a_L < c_L e_H$ require that

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

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

Signaling

Is this an equilibrium?

→ For firms: YES. They are paying each worker his or her marginal product, so the firms have no incentive to deviate

But...

→ 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.

→ So, YES. This is an equilibrium → a **separating equilibrium**

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.
 - Since we assumed that education does not increase productivity, which is a strong assumption
- So improved information need not improve gains-to-trade.

This is not always true!

- For the used cars market, acquiring a signal (a warranty) can increase efficiency by allowing a separating equilibrium

4. Moral Hazard

With adverse selection, moral hazard is another problem in the insurance industry.

- If you have full car insurance, are you more likely to leave your car unlocked?
- **Moral hazard** is the lack of incentives to take care of something or of yourself.
- Trade-off:
 - Too little insurance means that people bear a lot of risk,
 - Too much insurance means that people will take inadequate care.
- Moral hazard is a consequence of asymmetric information.
 - The issue is that *care* is not observable.

Moral Hazard

- If an insurer knows the exact risk from ensuring 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 drivers with histories of safe driving.
- Moral hazard is the **hidden action problem**

5. Incentives Contracting

How can I get someone to do something for me?

→ With the appropriate **incentive system**

→ This question will involve asymmetric information...

Incentives Contracting

EXAMPLE

- 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.
- 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 reward is $y = f(e)$

→ An incentive contract is a function $s(y)$ specifying the worker's payment when the principal 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 to choose e to

$$\max_e \Pi_P = f(e) - s(f(e))$$

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

→ To maximize his profit the principal agent designs the contract to provide the worker with his reservation utility level

→ That is...

Incentives Contracting

→ The principal's problem becomes

$$\max_e \Pi_P = f(e) - s(f(e))$$

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

Participation constraint is now an equality!

Incentives Contracting

To solve it, substitute $s(f(e))$ in the maximization

$$\max_e \Pi_P = f(e) - c(e) - \tilde{u}$$

The principal's profit is maximized when

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

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.

→ So, the contract $s(y)$ must satisfy the **incentive-compatibility** constraint:

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

Meaning: the worker's payoff of putting effort e^* must be higher than the payoff from putting any other level of effort

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

$$f'(e) = c'(e) \quad \text{that is} \quad e = e^*$$

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

$$s(f(e^*)) - c(e^*) - R = \tilde{u}$$

This is:

$$R = s(f(e^*)) - c(e^*) - \tilde{u}$$

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, equal to marginal product

$$w = MP(e^*)$$

K is a lump-sum payment, chosen to satisfy the participation constraint

K makes the worker just indifferent between participating and not participating.

Other Incentives Contracts

(ii) Wages contracts: worker's problem

$$\Pi_A = s(f(e)) - c(e)$$

Here $s(e)$ does not depend on $f(e)$. The problem becomes:

$$\Pi_A = we + K - c(e)$$

The worker chooses e such that $w = MC(e)$

Since the wage is $MP(e^*)$, the optimal choice of the worker will be e^* such that $MP(e^*) = MC(e^*)$

which is just what the firm wants.

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.

→ L is chosen to make the worker indifferent between participating and not participating.

$$L^* - c(e^*) = \tilde{u} \quad \text{so} \quad L^* = \tilde{u} + c(e^*)$$

→ If the worker chooses $e \neq e^*$ he gets a equal to $-c(e)$, so the worker will choose $e = e^*$ and get a utility equal to \tilde{u}

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.
- At this point all these schemes are equivalent, no reason to choose between them
 - They all give the worker a utility equal to \tilde{u}
 - All give workers the incentive to set an effort equal e^*