Chapter 6: Asymmetric Information

Ch 37 in H. Varian 8th Ed.

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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

<u>Asymmetric information</u>

→ 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

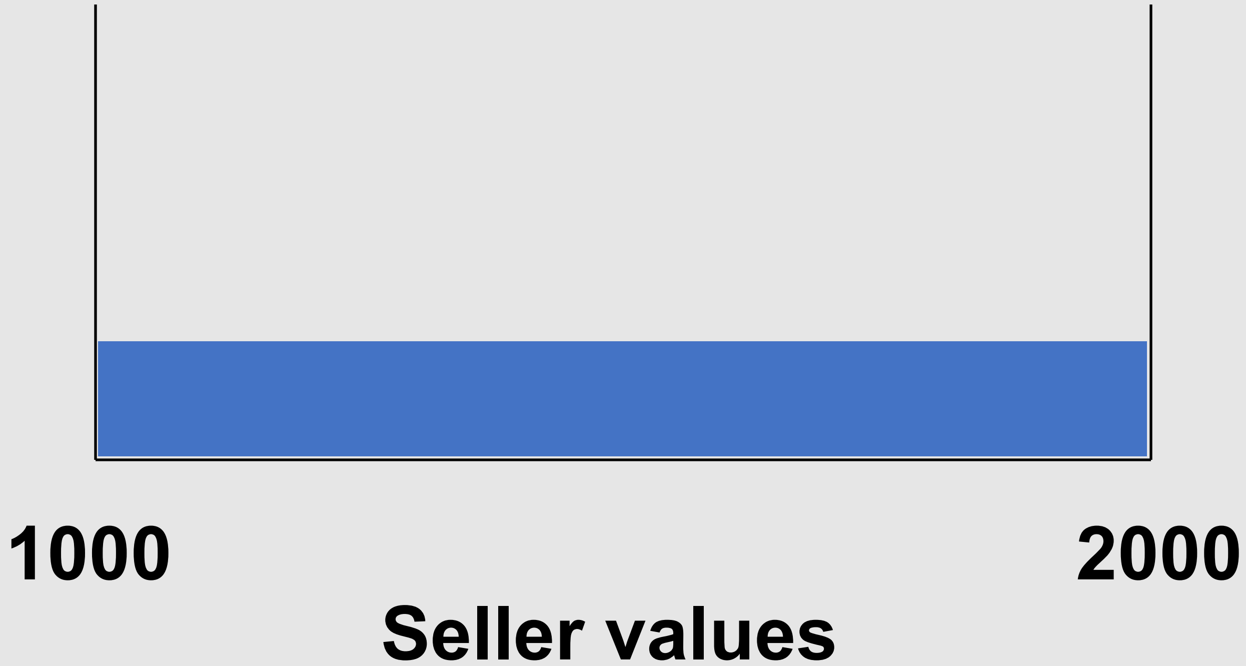
→ **Pooling equilibrium:** A market equilibrium in which both types of cars are traded, and buyers cannot distinguish the type of car.

→ **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.

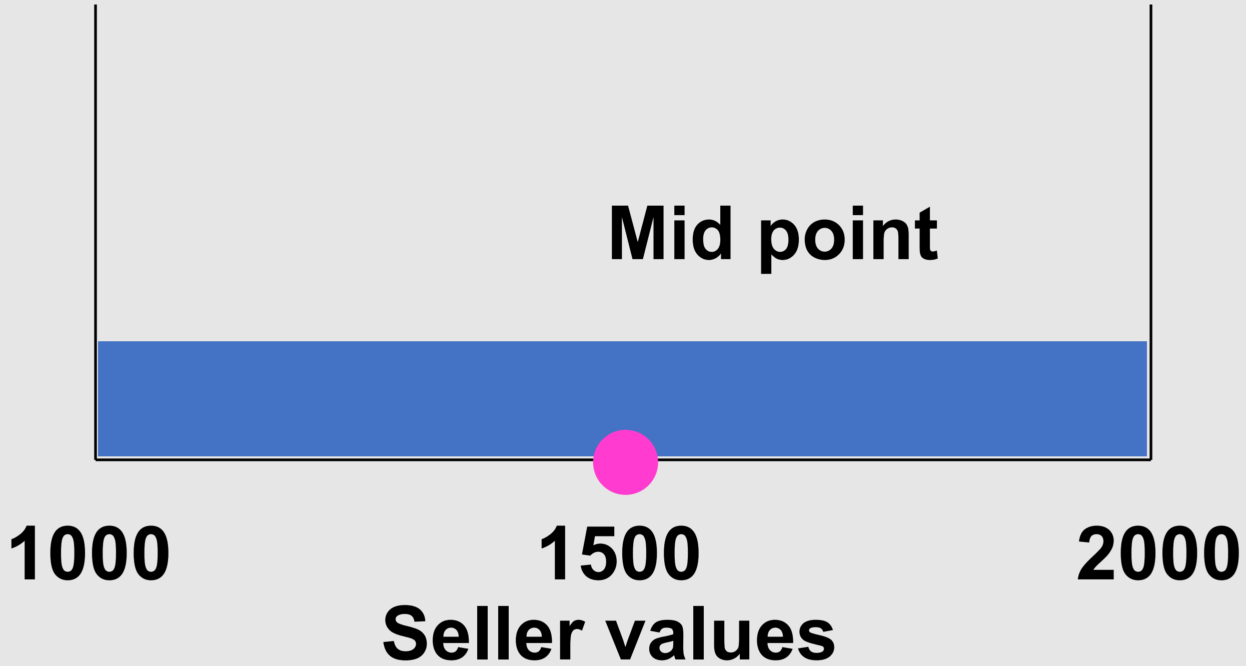
The Lemons market – continuous quality

- 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

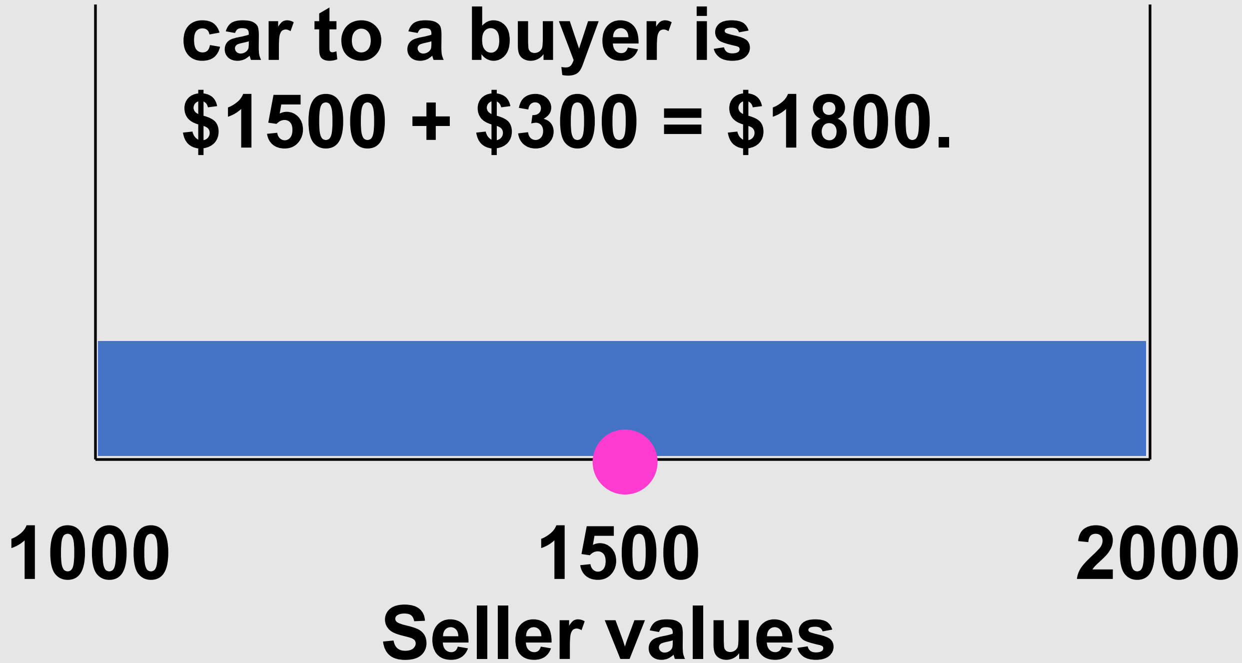


The Lemons market – continuous quality



The Lemons market – continuous quality

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



The Lemons market – continuous quality

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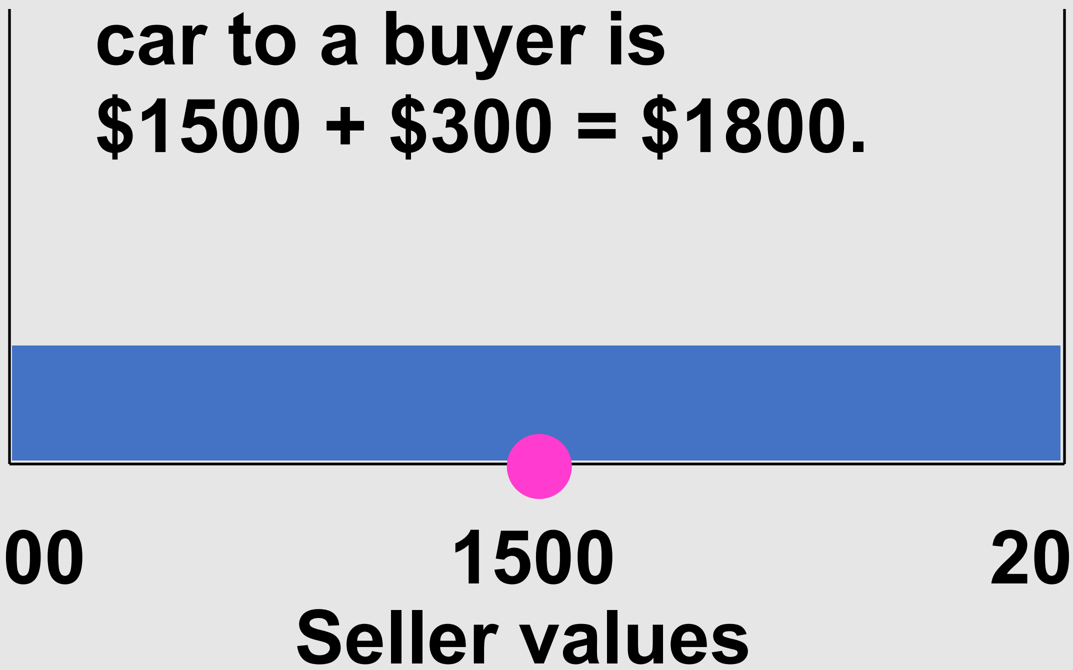
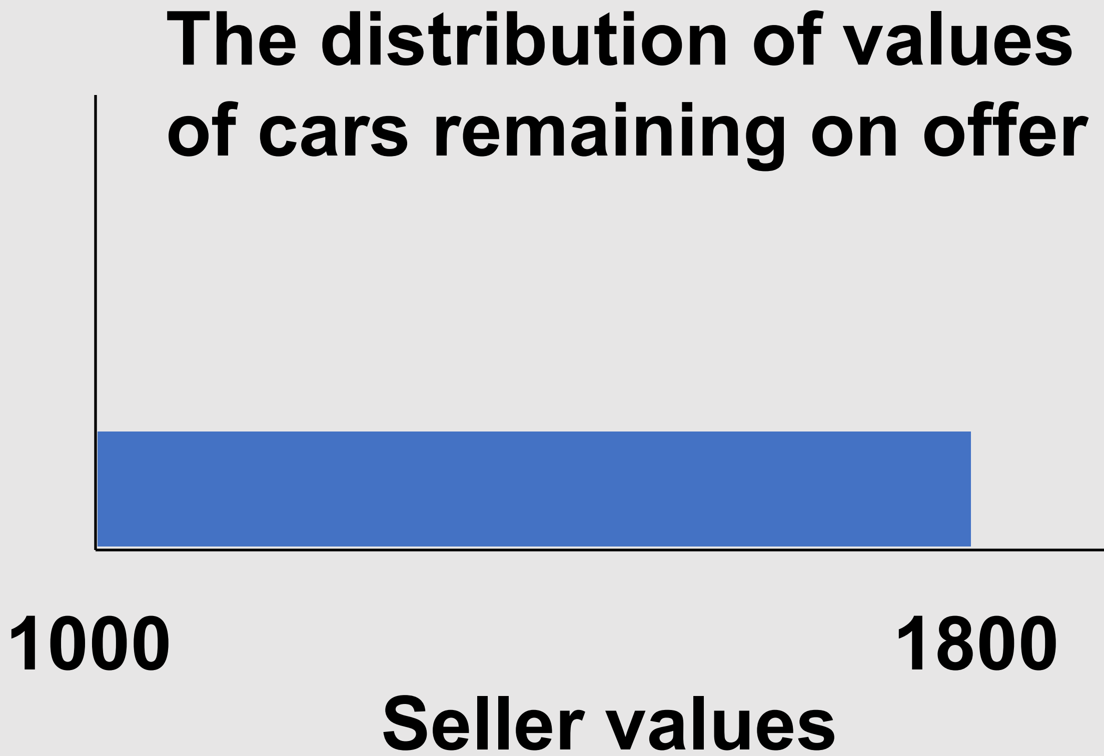


So sellers who value their cars at more than $1800 exit the market.

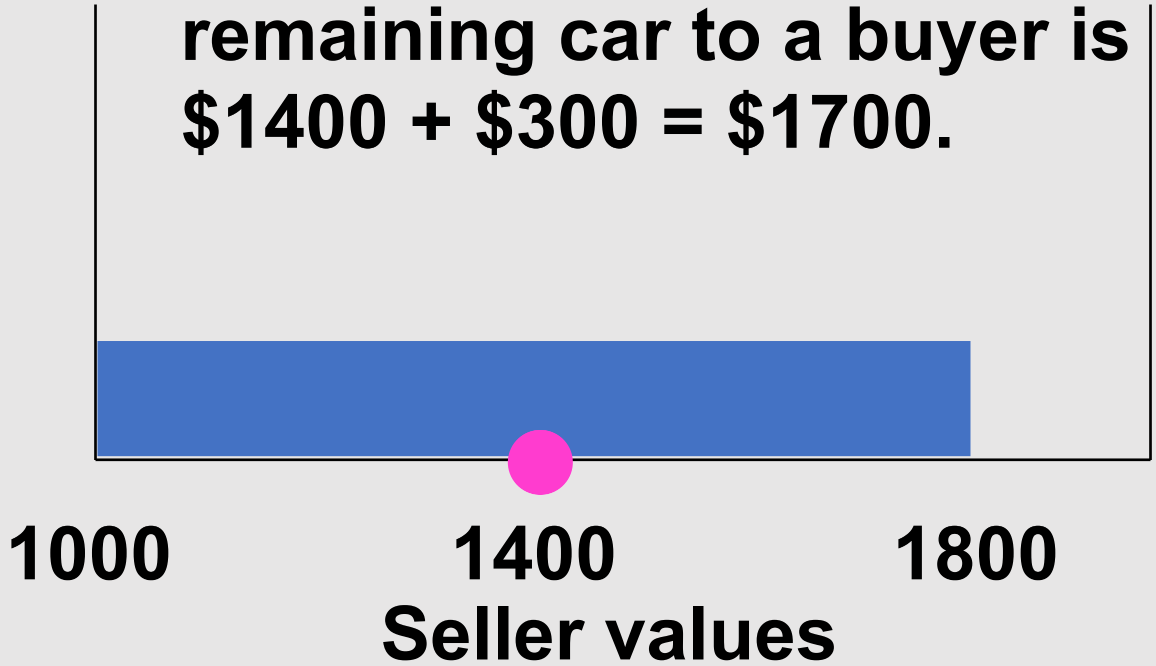
The Lemons market – continuous quality



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

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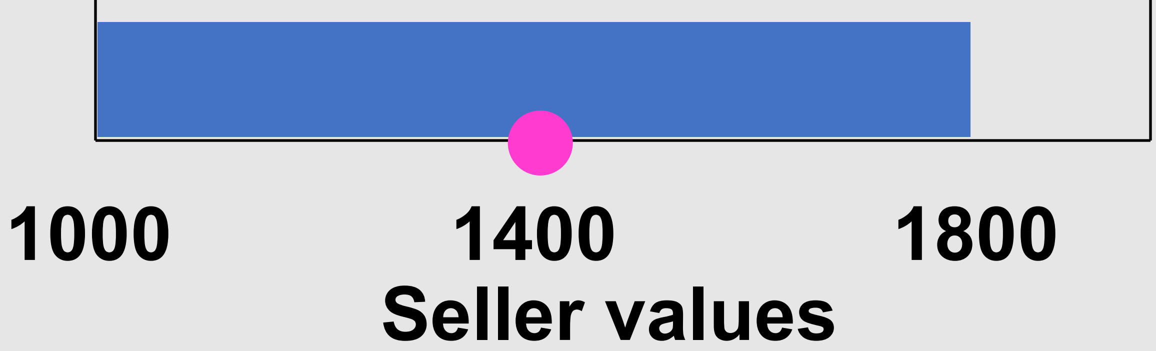

So now sellers who value their cars between $1700 and $1800 exit the market.

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.

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

$$\Longrightarrow v_H = 1600$$

→ 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,
  $EV = 8 + 6q \geq 11 \;\Rightarrow q \geq ½$

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.

   – Hence high-ability workers can separate themselves from low-ability

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** (instead of a hidden type, as before).

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

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

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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 $\mathrm{c}(e)$

Incentives Contracting

→ So the principal's problem is to choose e to

$$\max_{e} \Pi_P = f(e) - s(f(e))$$

Subject to $s\big(f(e)\big) - c(e) \geq \tilde{u}$ (**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 $\quad s\big(f(e)\big) - c(e) = \tilde{u}$ (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

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

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:

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

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.

$$s\big(\mathrm{f}(e)\big) = f(e) - R$$

→ Why does this contract maximize the principal's profit?

Rental Contracting

→ Given the contract $s\big(f(e)\big) = f(e) - R$

the worker's payoff is

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

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

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

This is:

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

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

$$\mathrm{w} = \mathrm{MP}(\mathrm{e}^*)$$

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

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

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

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

The worker chooses e such that $\mathrm{w} = \mathrm{MC}(e)$

Since the wage is $\mathrm{M}P(e^*)$, the optimal choice of the worker will be e^* such that $\mathrm{MP}(\mathrm{e}^*) = \mathrm{MC}(e^*)$

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.

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

→ If the worker chooses $\mathrm{e} \neq \mathrm{e}^*$ he gets a utility 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^*