

INTERMEDIATE

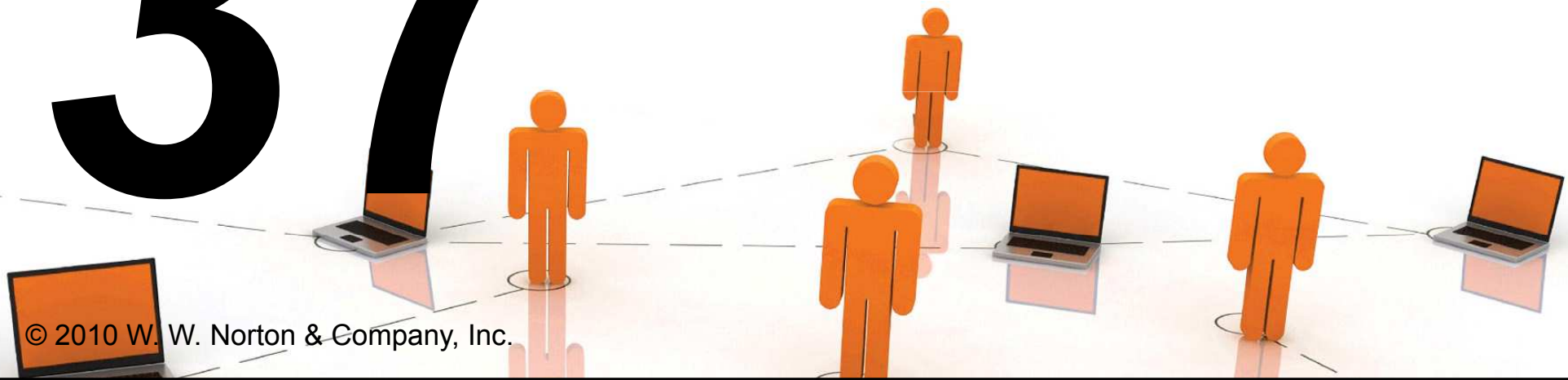
8TH EDITION

MICROECONOMICS

HAL R. VARIAN

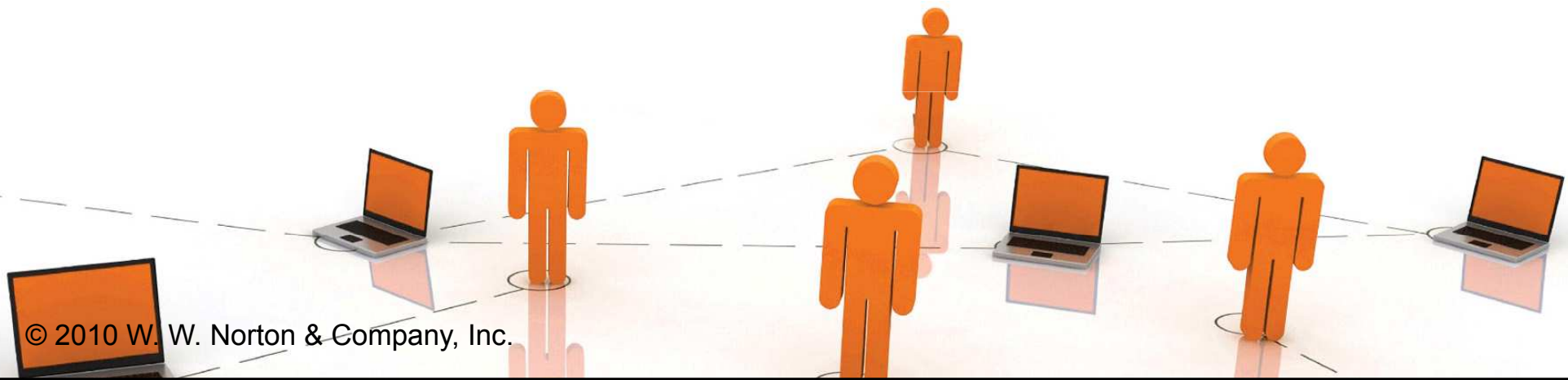
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Asymmetric Information



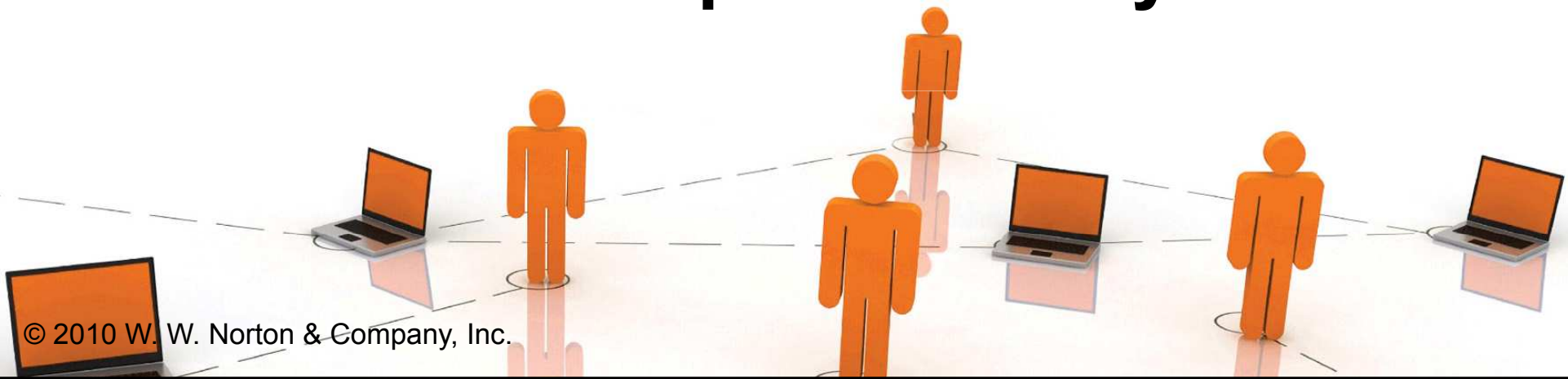
Information in Competitive Markets

- ◆ **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?**



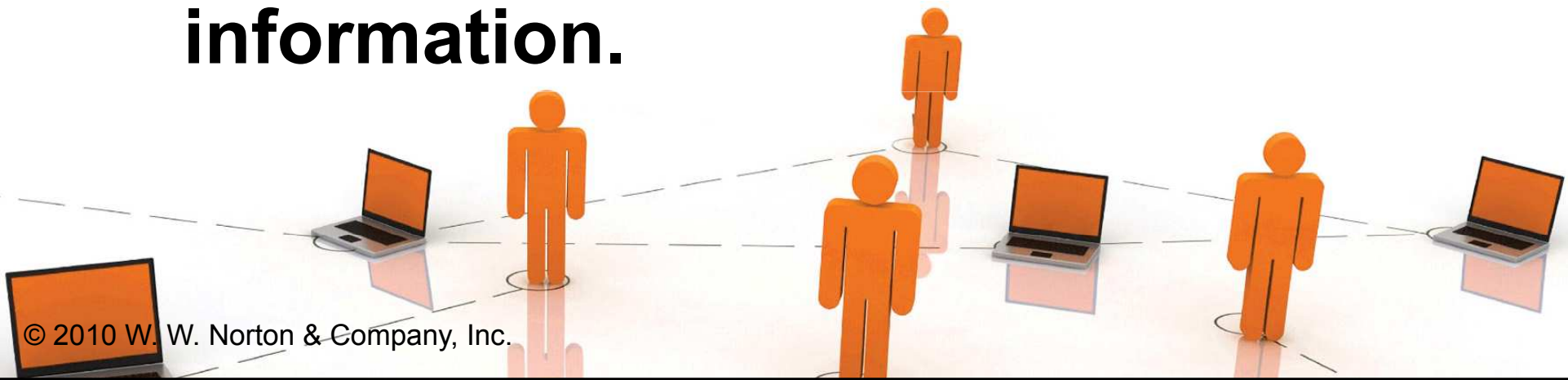
Asymmetric Information in Markets

- ◆ **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**



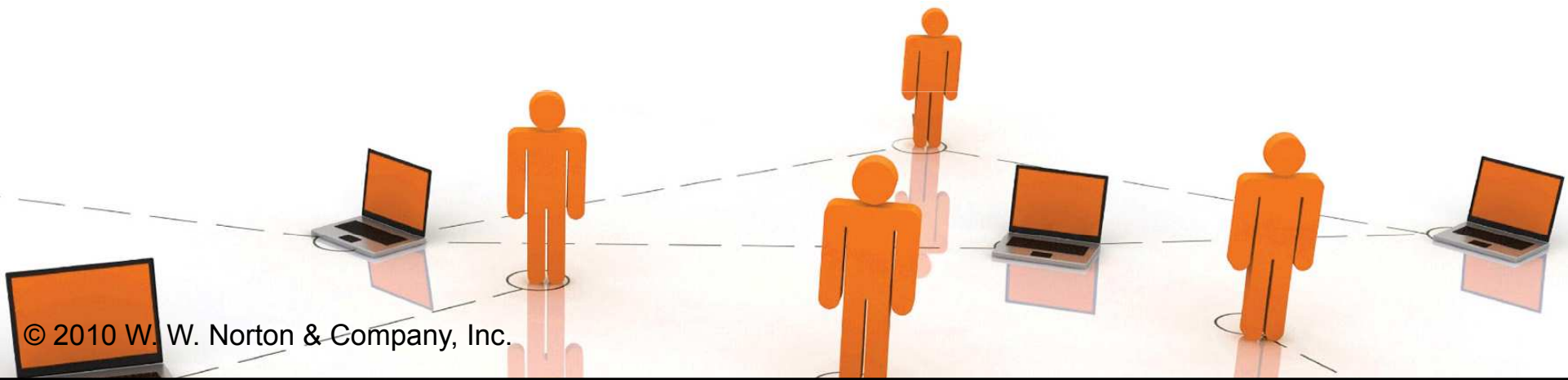
Adverse Selection

- ◆ **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.**



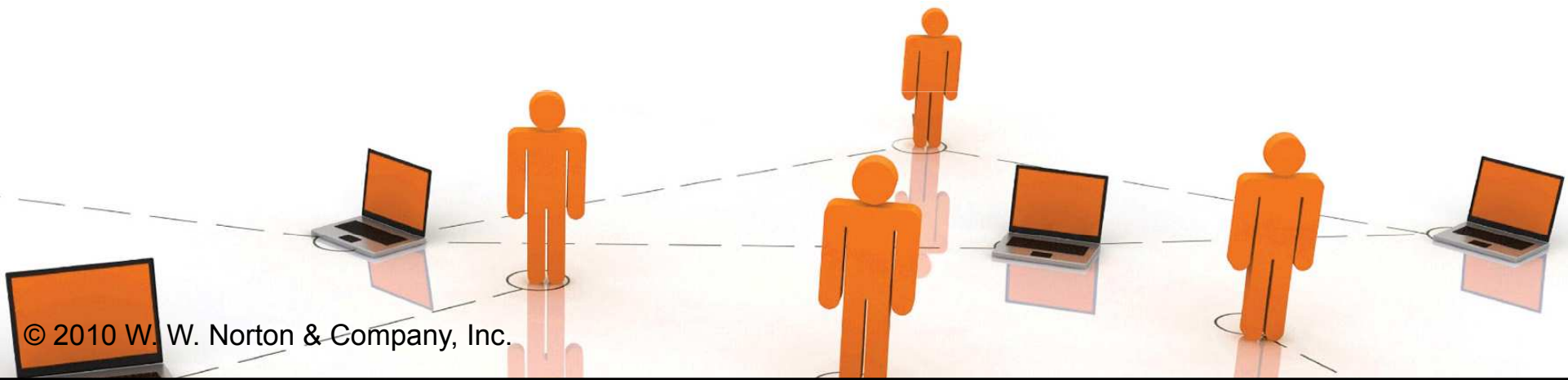
Adverse Selection

- ◆ 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.



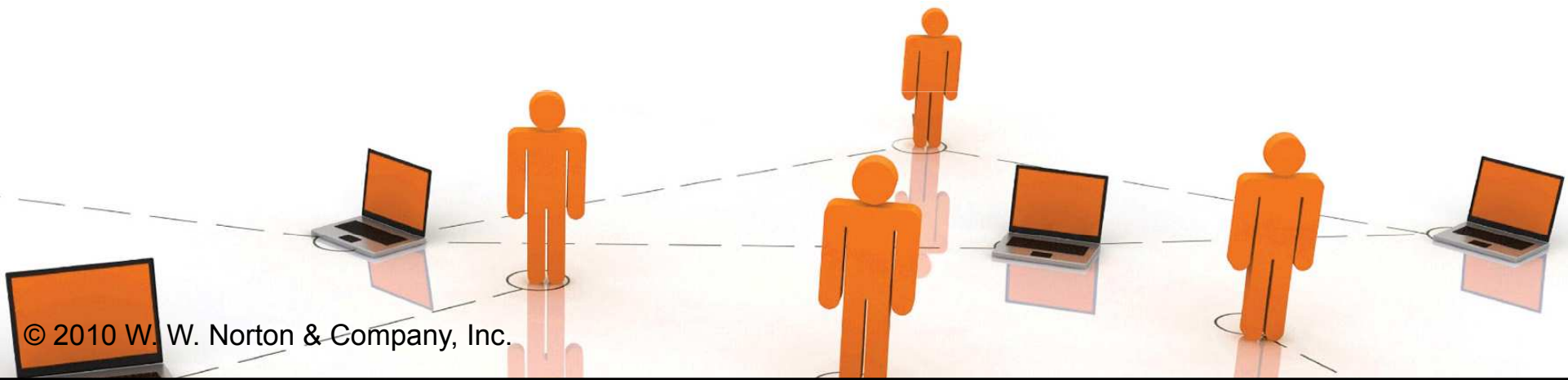
Adverse Selection

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



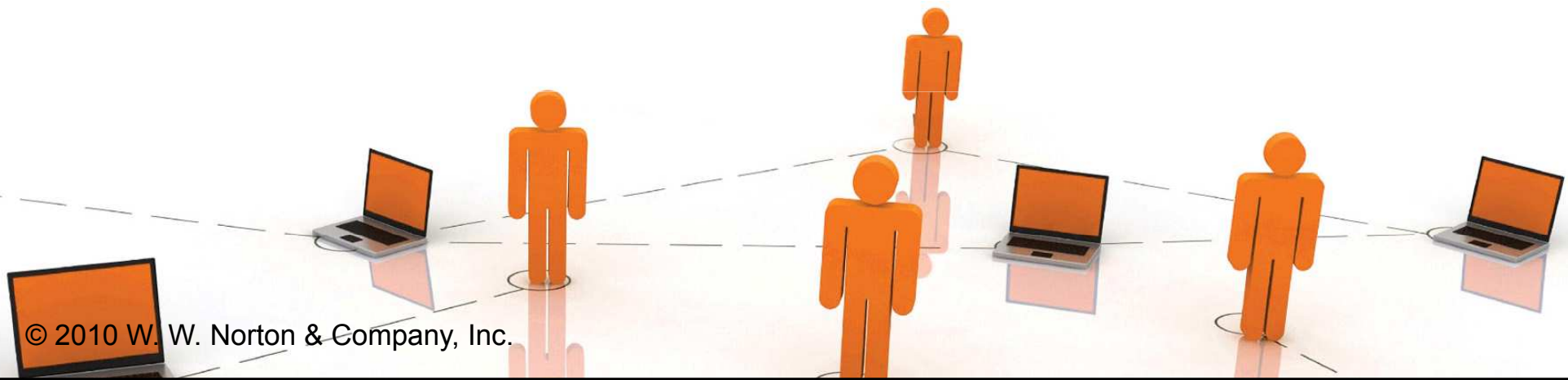
Adverse Selection

- ◆ 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

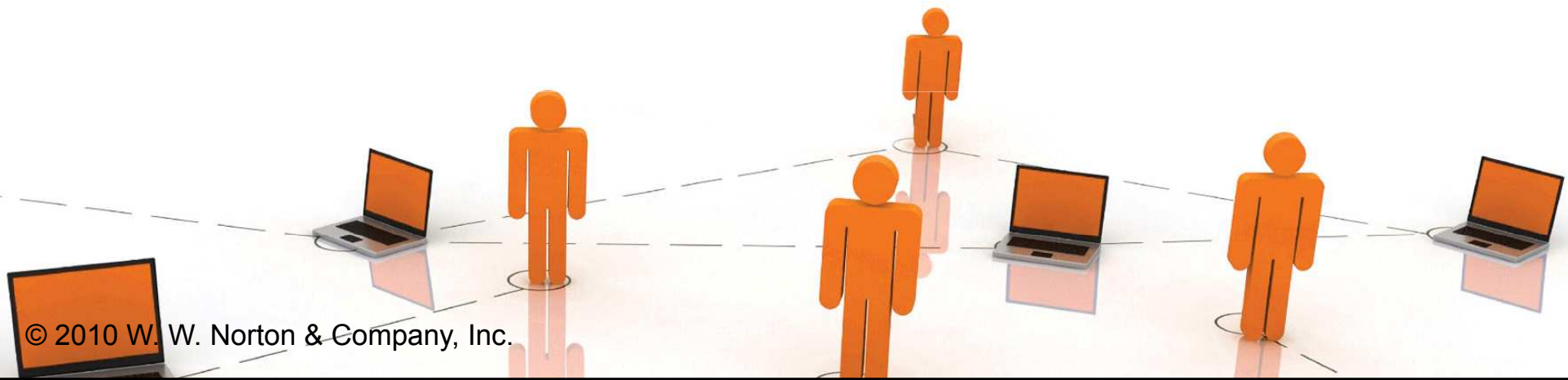
- ◆ Hence “too many” lemons “crowd out” the peaches from the market.
- ◆ Gains-to-trade are reduced since no peaches are traded.
- ◆ The presence of the lemons inflicts an external cost on buyers and peach owners.



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?

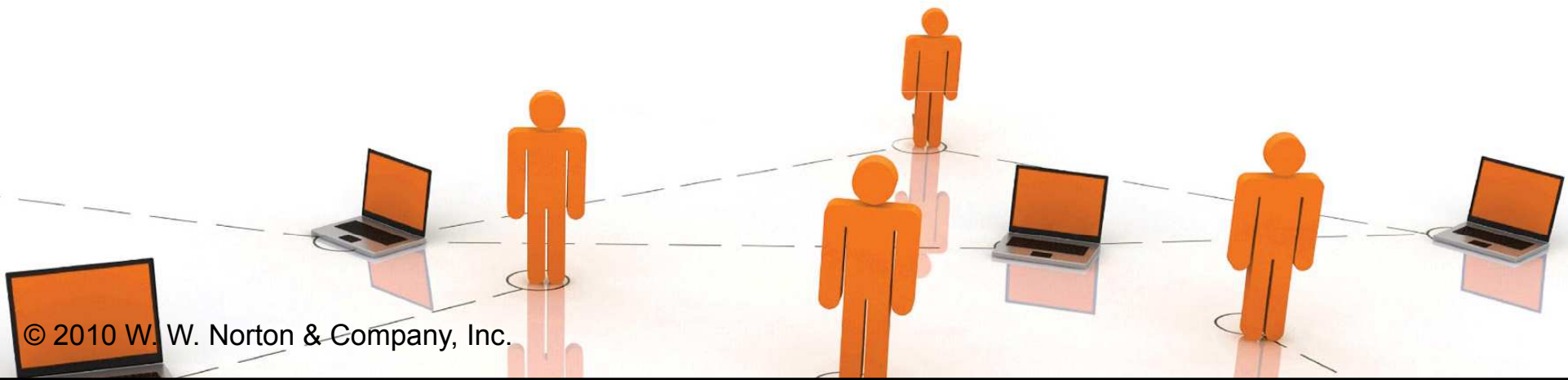
◆ Suppose that

– car quality is Uniformly distributed between \$1000 and \$2000

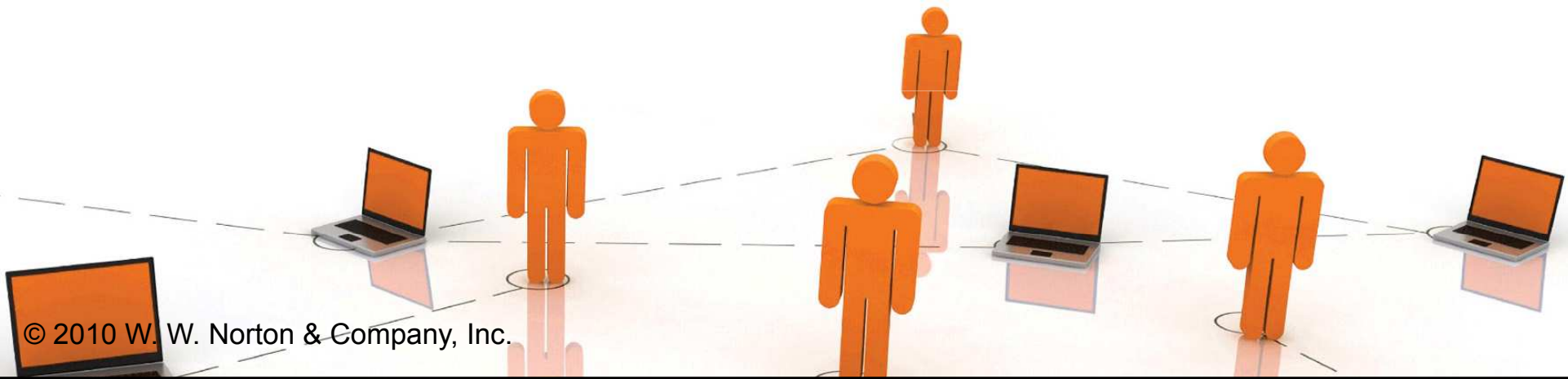
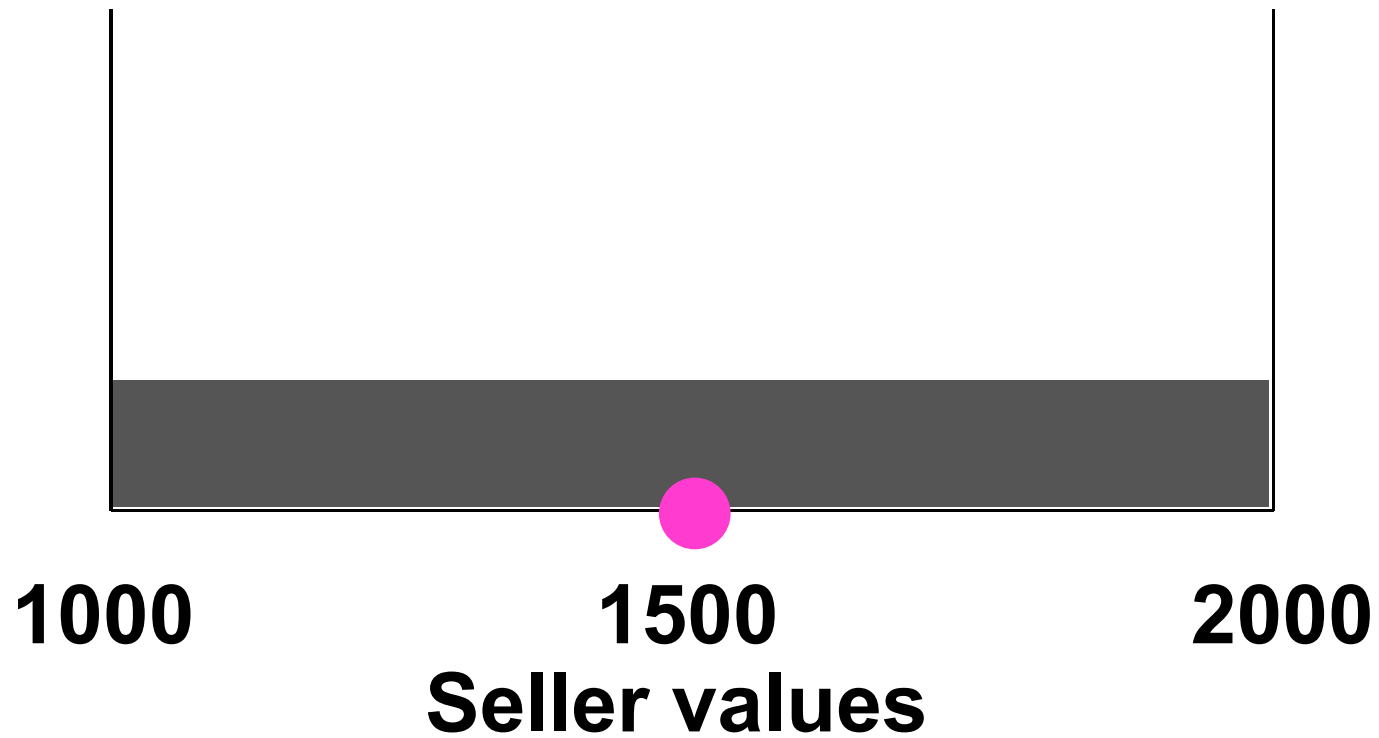
– any car that a seller values at $\$x$ is valued by a buyer at $\$(x+300)$.

◆ Which cars will be traded?

Adverse Selection



Adverse Selection



Adverse Selection

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

1000

1500

2000

Seller values



Adverse Selection

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



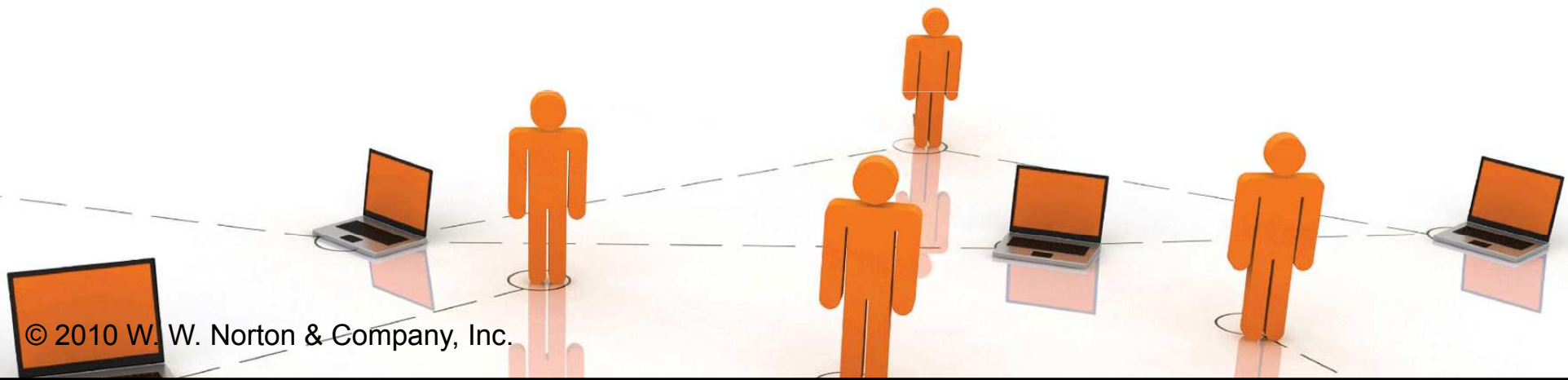
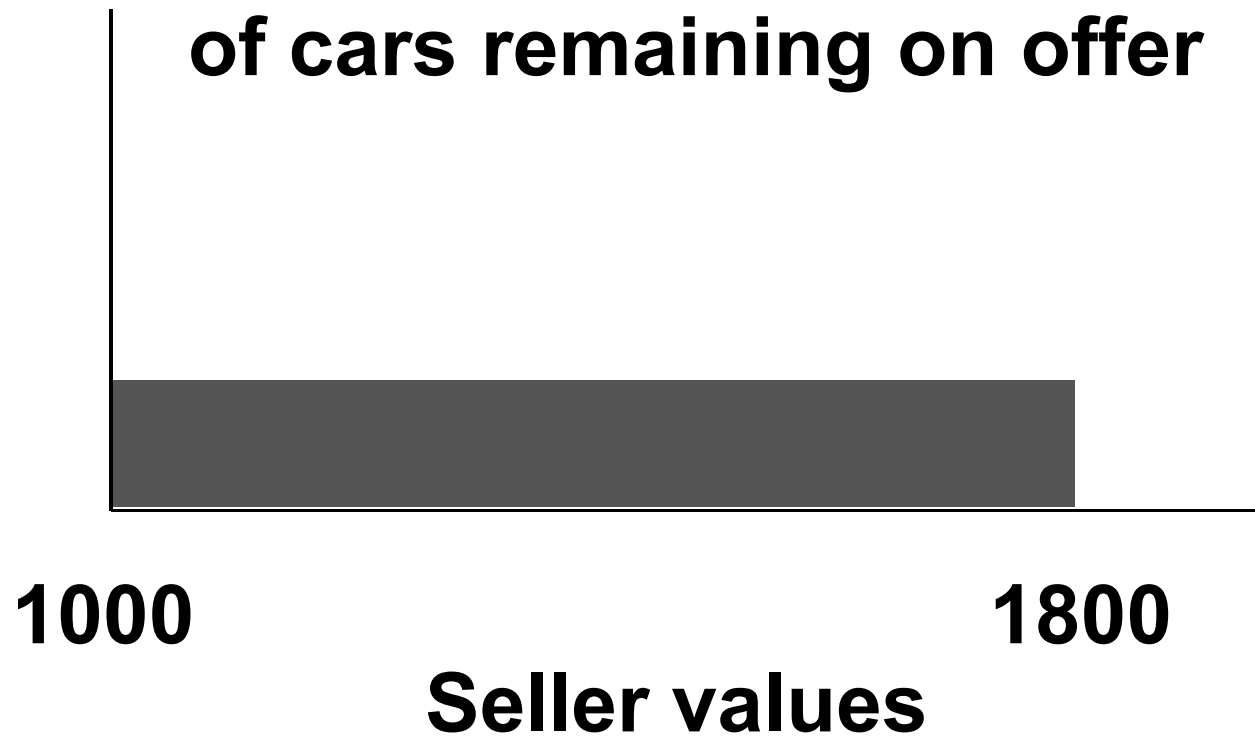
1000 1500 2000
Seller values

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

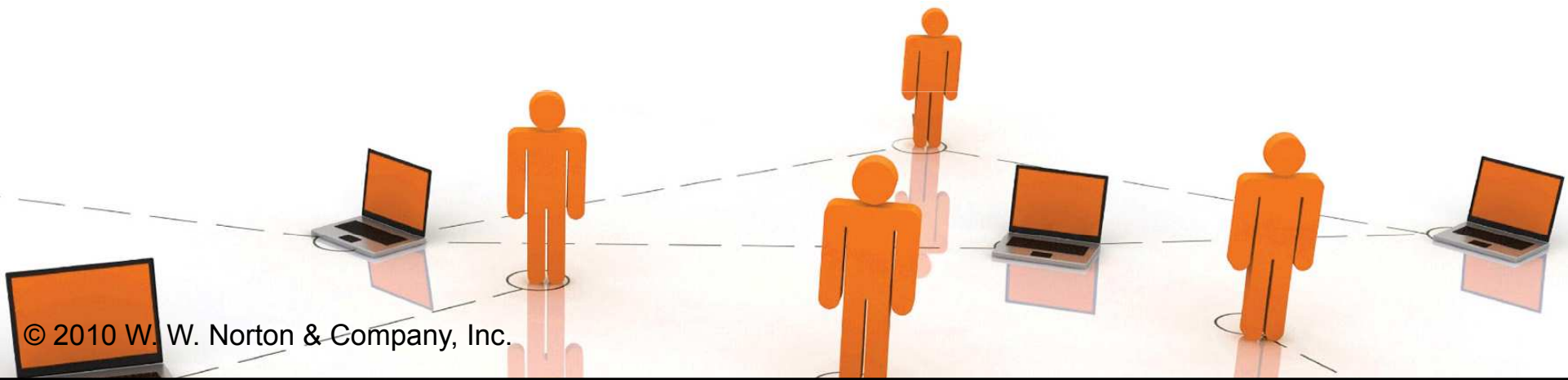
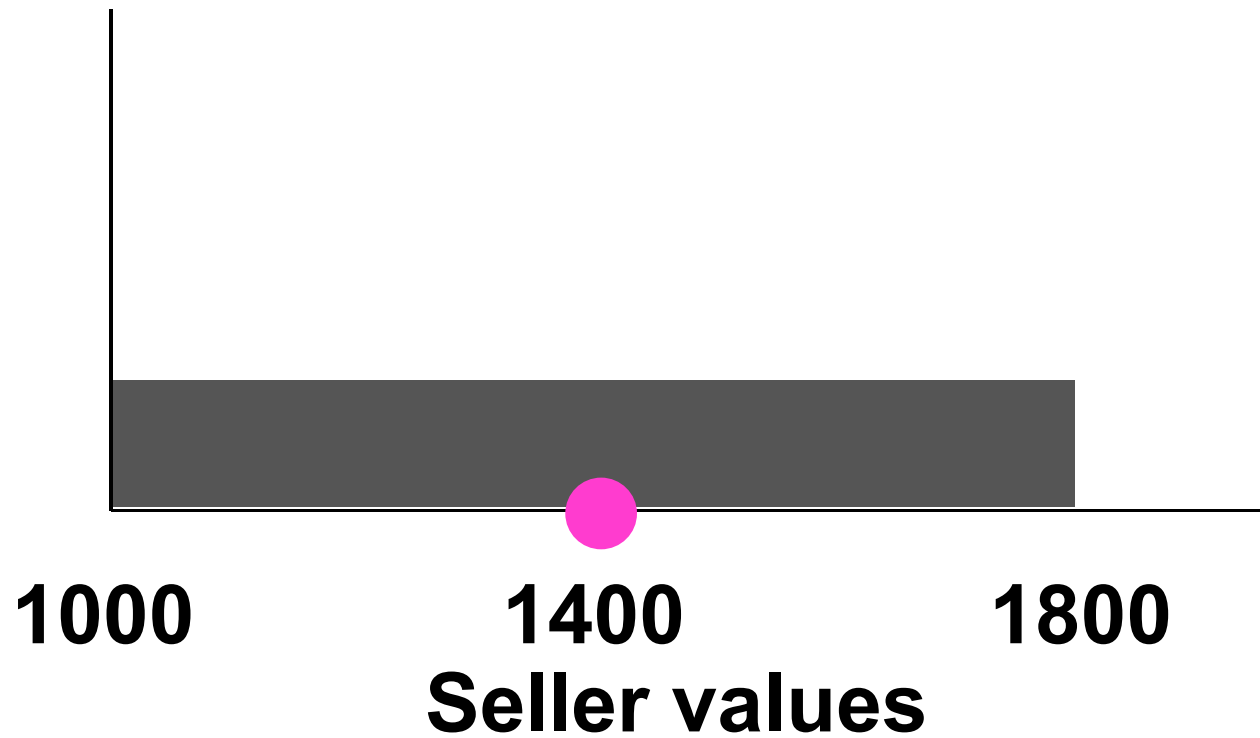


Adverse Selection

The distribution of values of cars remaining on offer



Adverse Selection



Adverse Selection

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



1000 1400 1800

Seller values



Adverse Selection

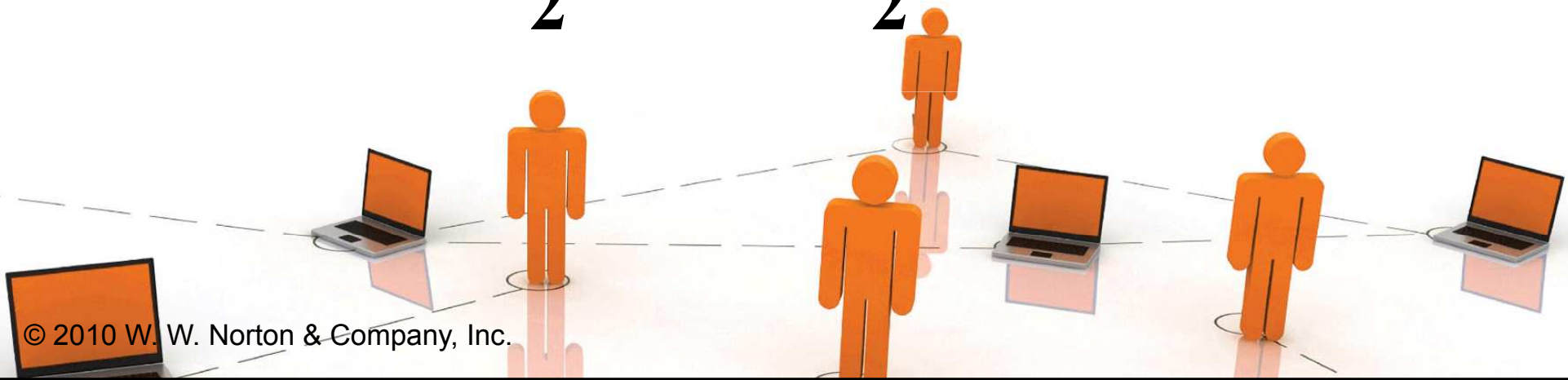
The expected value of any remaining car to a buyer is $\$1400 + \$300 = \$1700$.



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

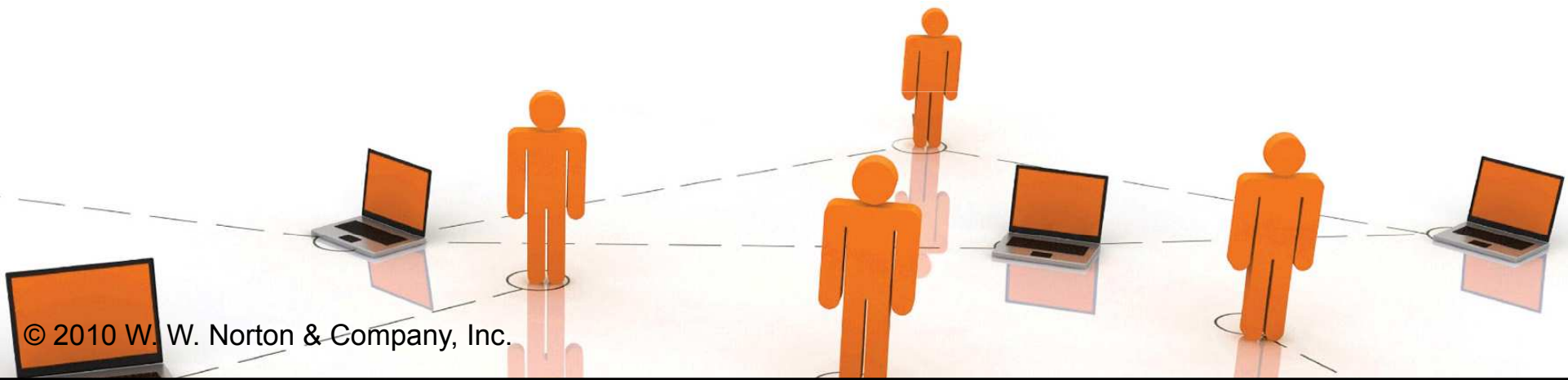
Adverse Selection

- ◆ 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.

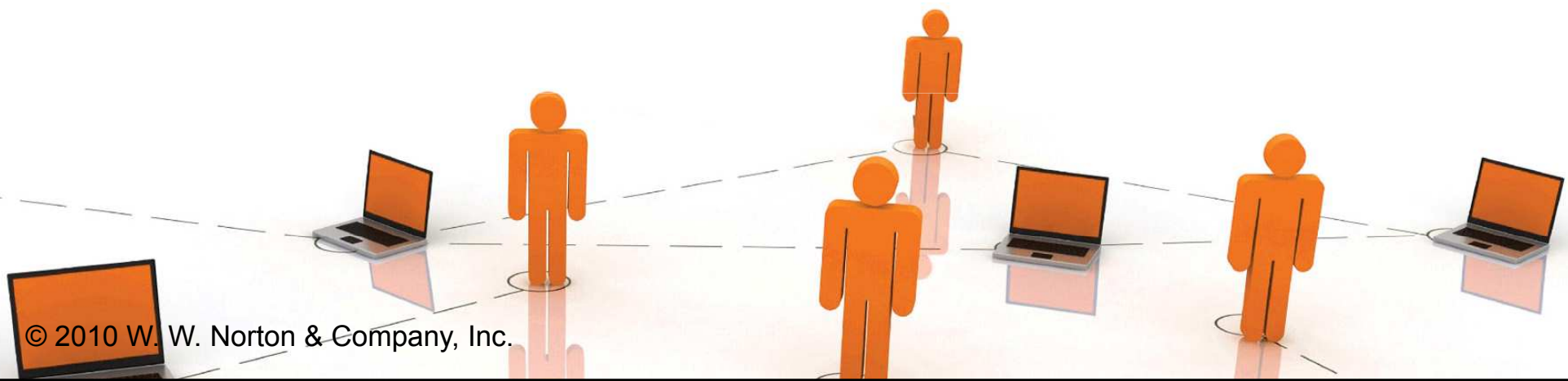
$$\frac{1}{2} \times 1000 + \frac{1}{2} \times v_H + 300 = v_H.$$

Adverse Selection

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

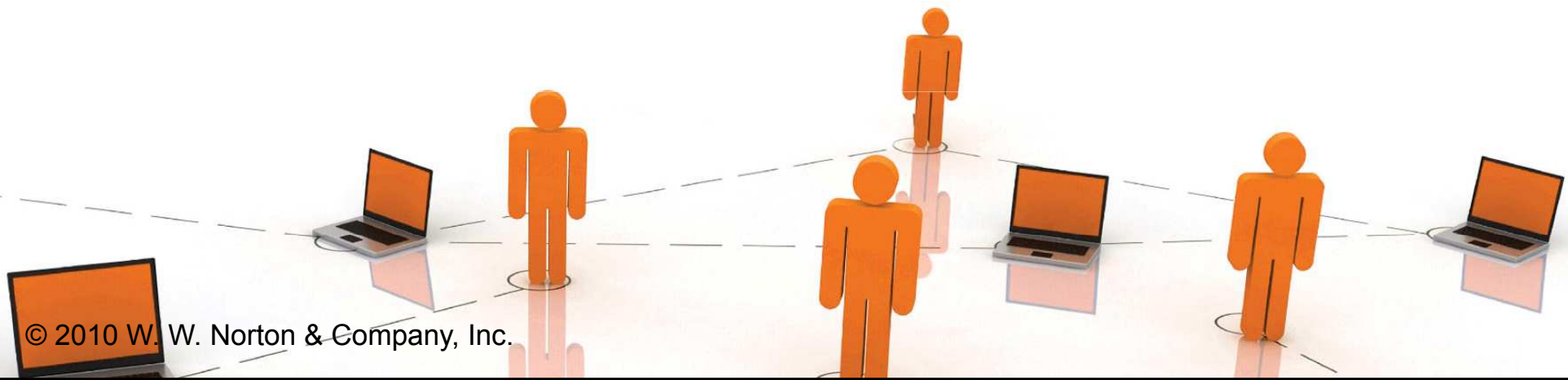
$$\Rightarrow v_H = \$1600.$$

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.



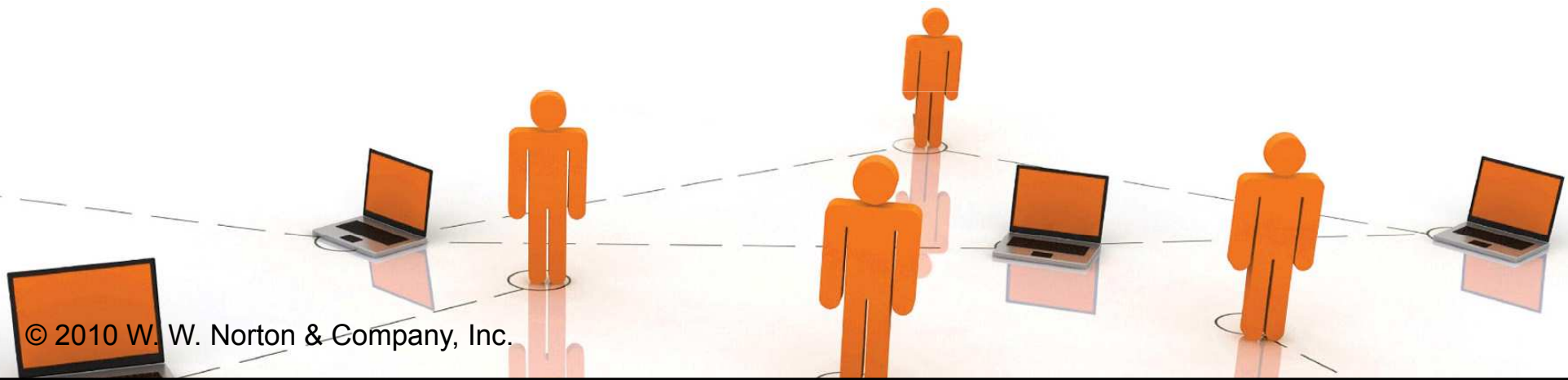
Adverse Selection with Quality Choice

- ◆ **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?**



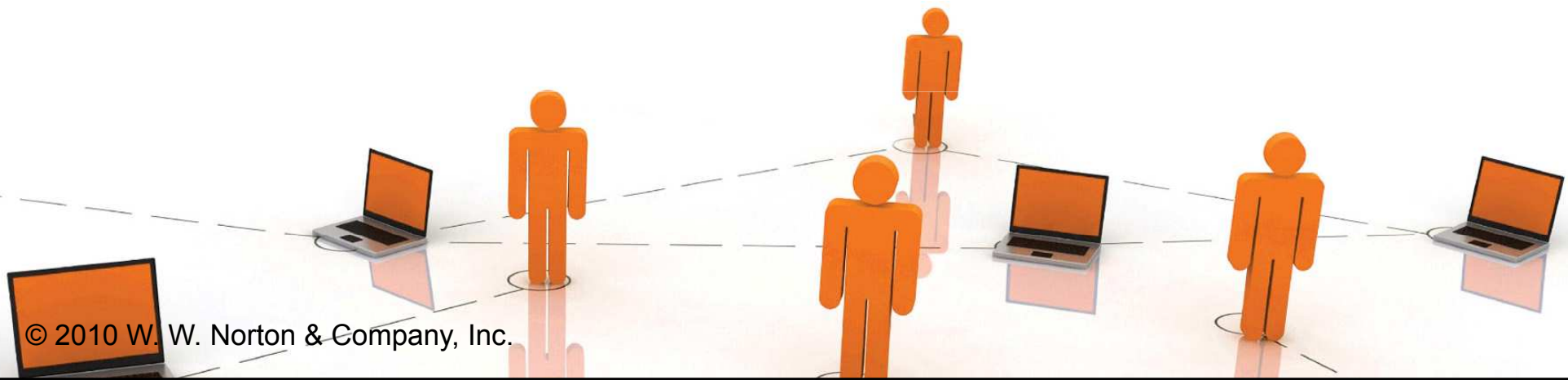
Adverse Selection with Quality Choice

- ◆ **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

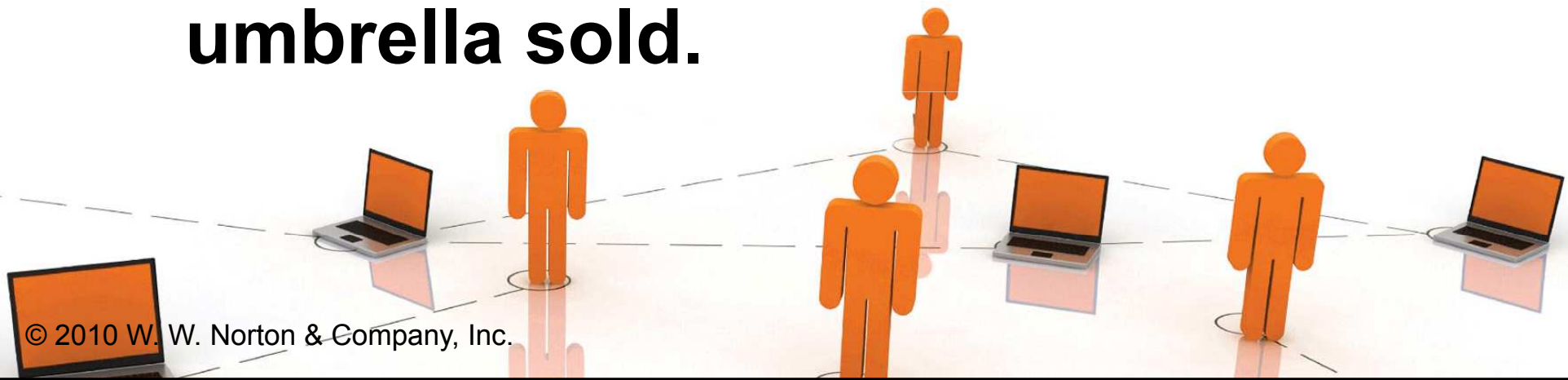
$$EV = 14q + 8(1 - q) = 8 + 6q.$$

- ◆ 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.**



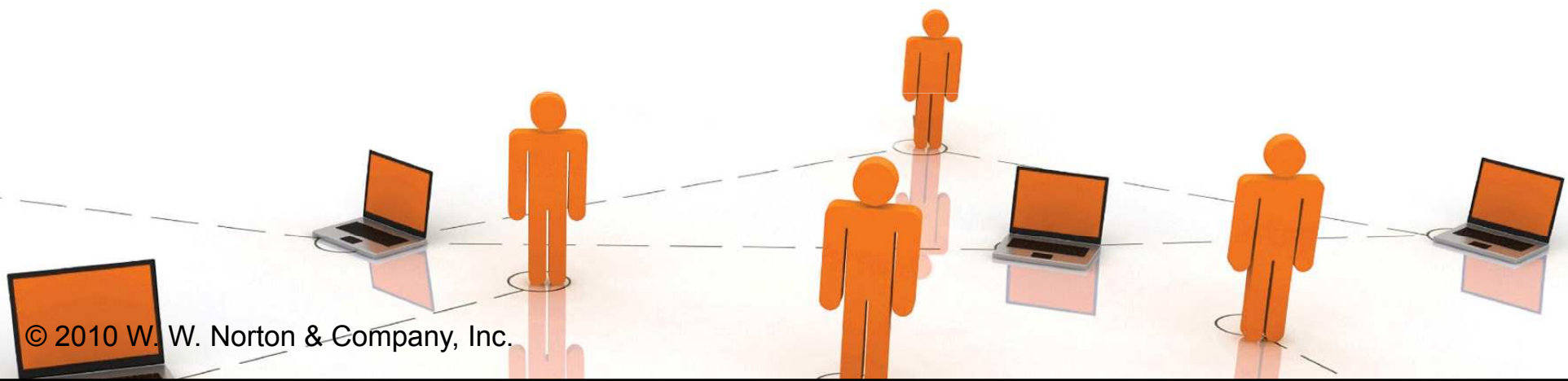
Adverse Selection with Quality Choice

- ◆ **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.**



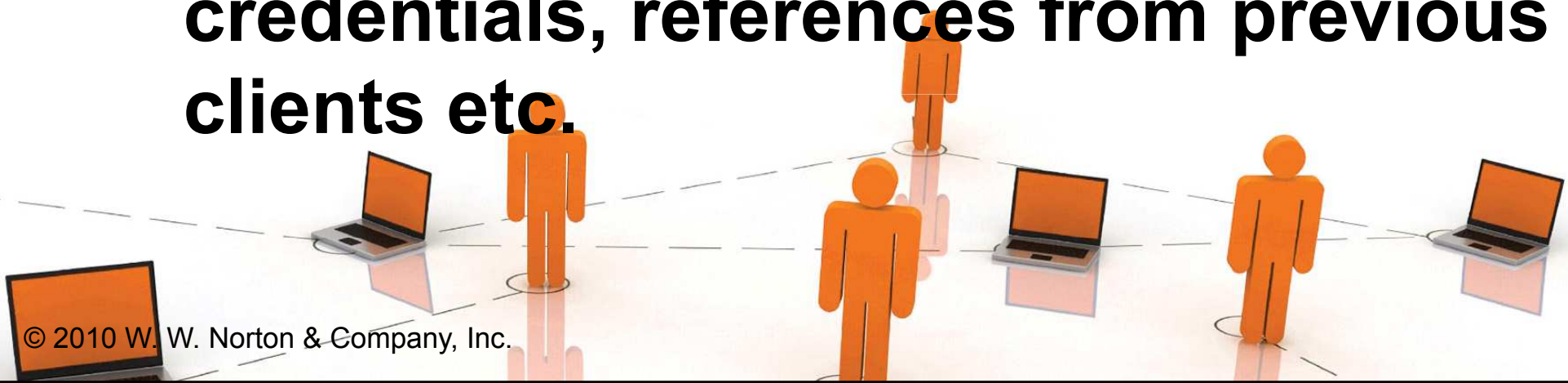
Adverse Selection with Quality Choice

- ◆ **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!**



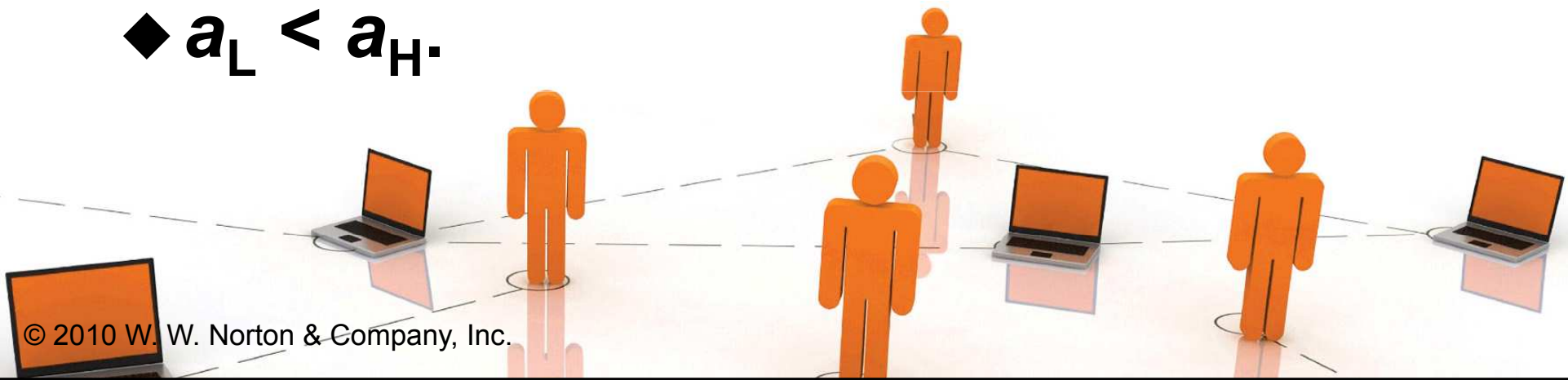
Signaling

- ◆ **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.**



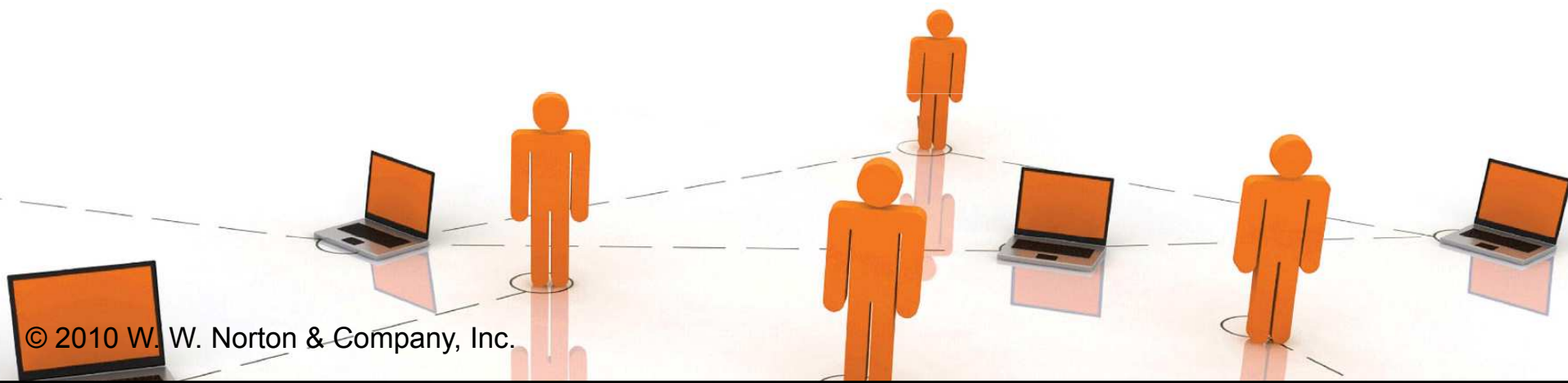
Signaling

- ◆ 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

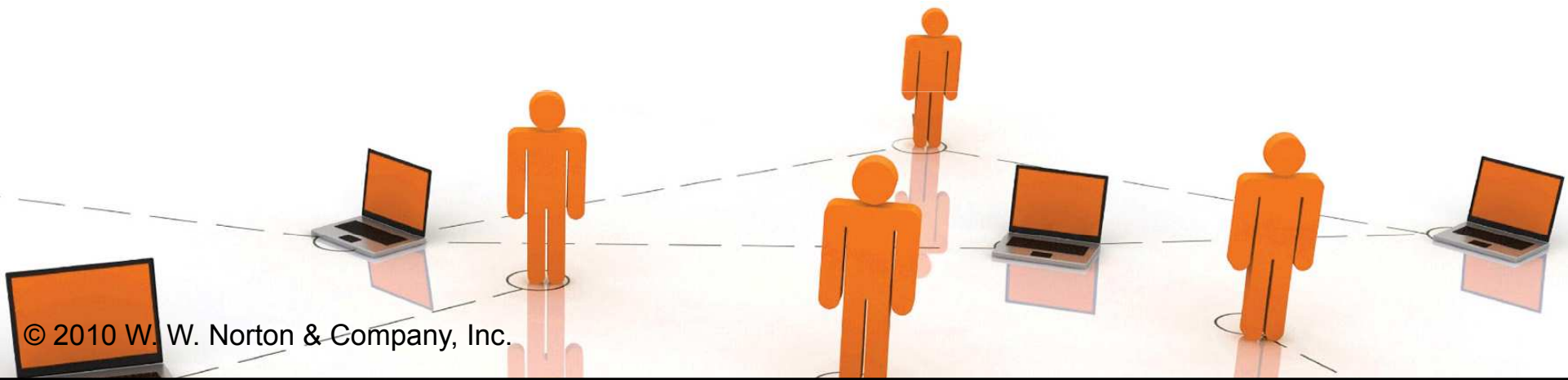
- ◆ Each worker is paid his expected marginal product.
- ◆ If firms knew each worker's type they would
 - pay each high-ability worker $w_H = a_H$
 - pay each low-ability worker $w_L = a_L$.



Signaling

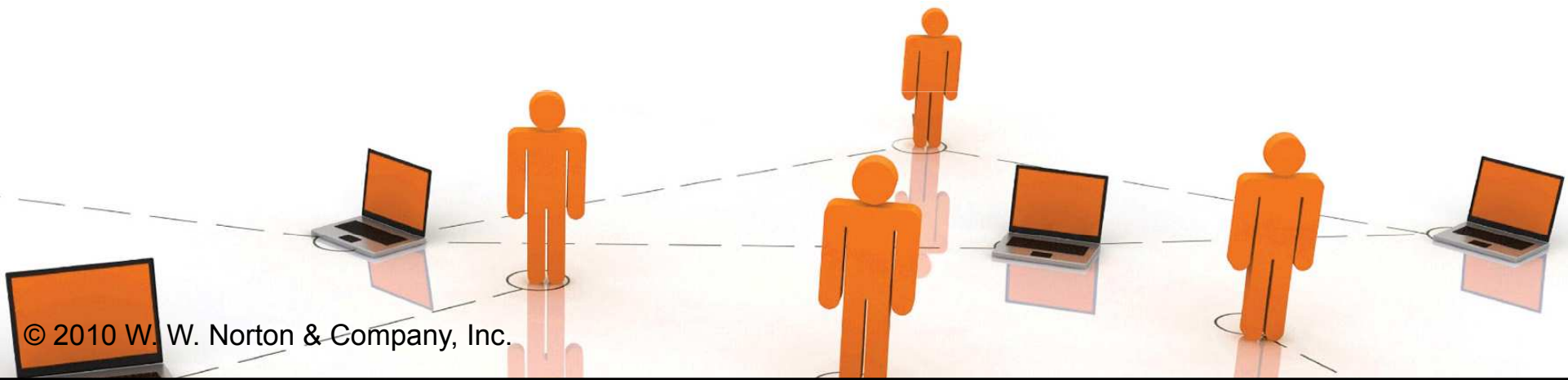
- ◆ If firms cannot tell workers' types then every worker is paid the (pooling) wage rate; i.e. the expected marginal product

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



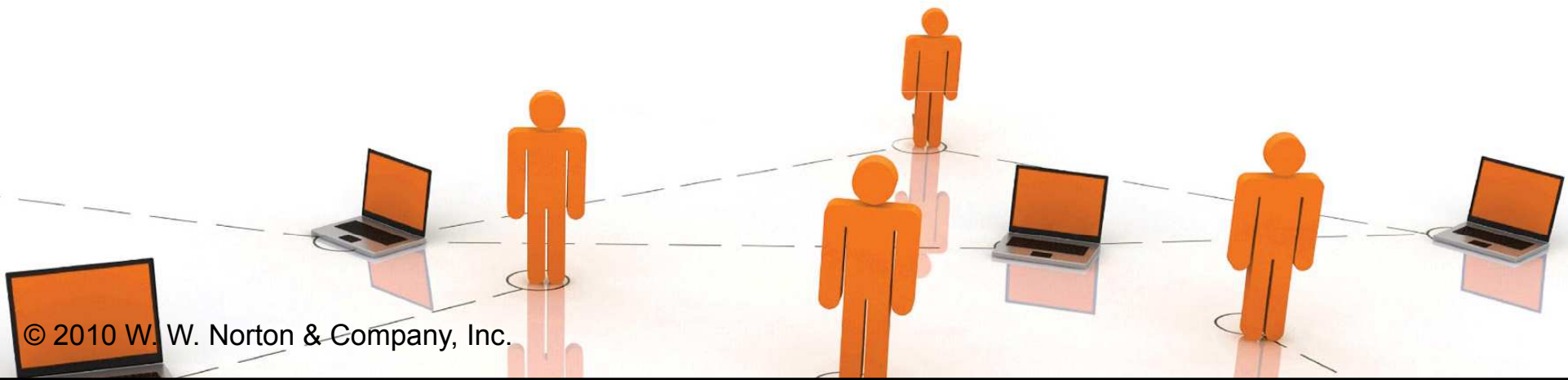
Signaling

- ◆ $w_P = (1 - h)a_L + ha_H < a_H$, 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.



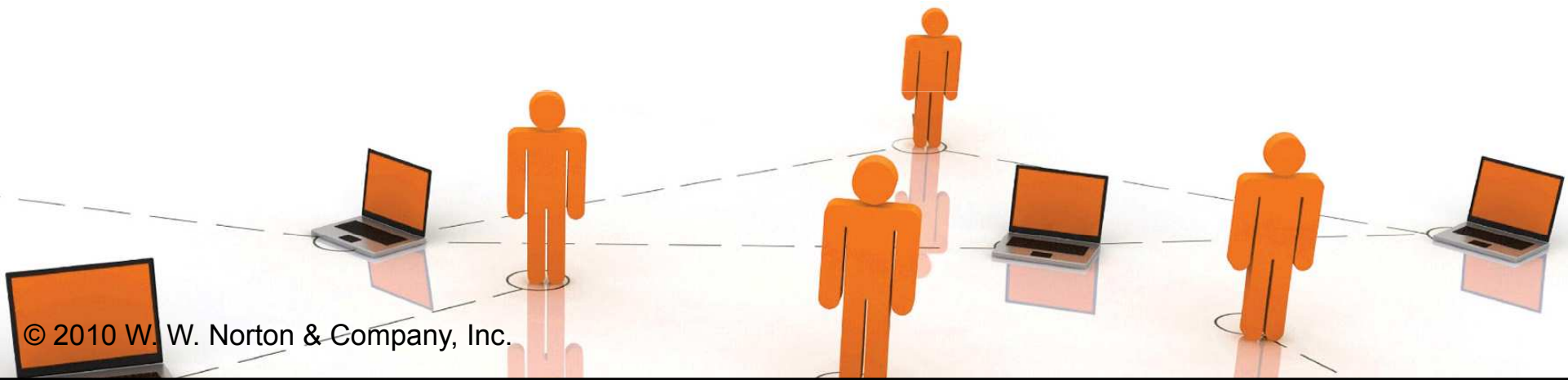
Signaling

- ◆ 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.**

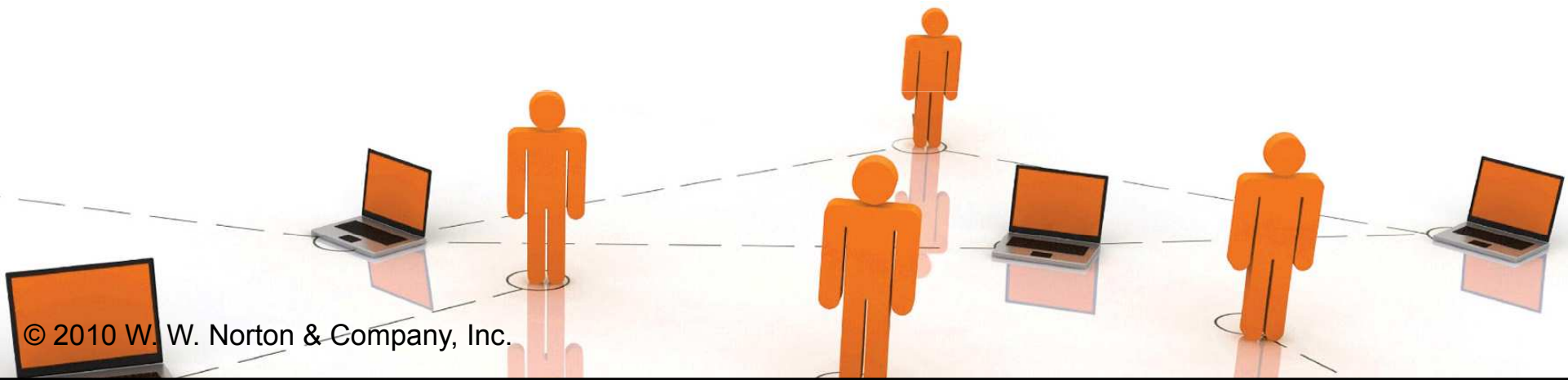


Signaling

◆ High-ability workers will acquire e_H education units if

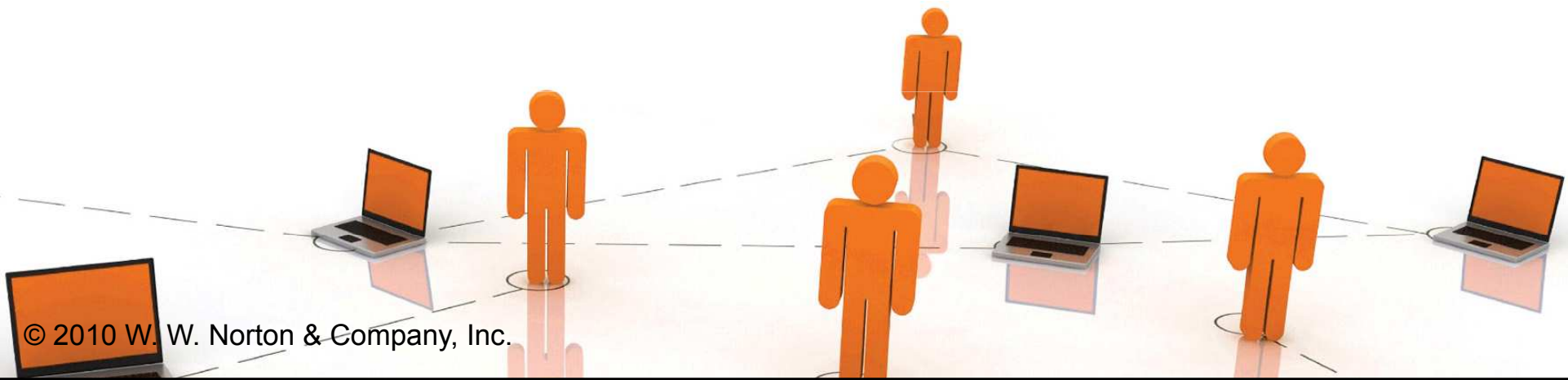
(i) $w_H - w_L = a_H - a_L > c_H e_H$, and

(ii) $w_H - w_L = a_H - a_L < c_L e_H$.



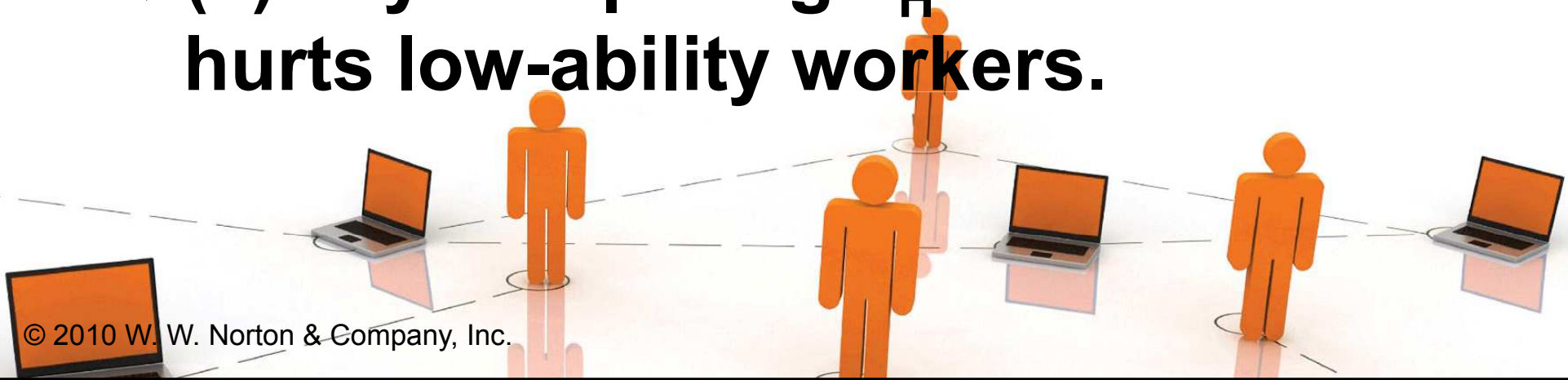
Signaling

- ◆ **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

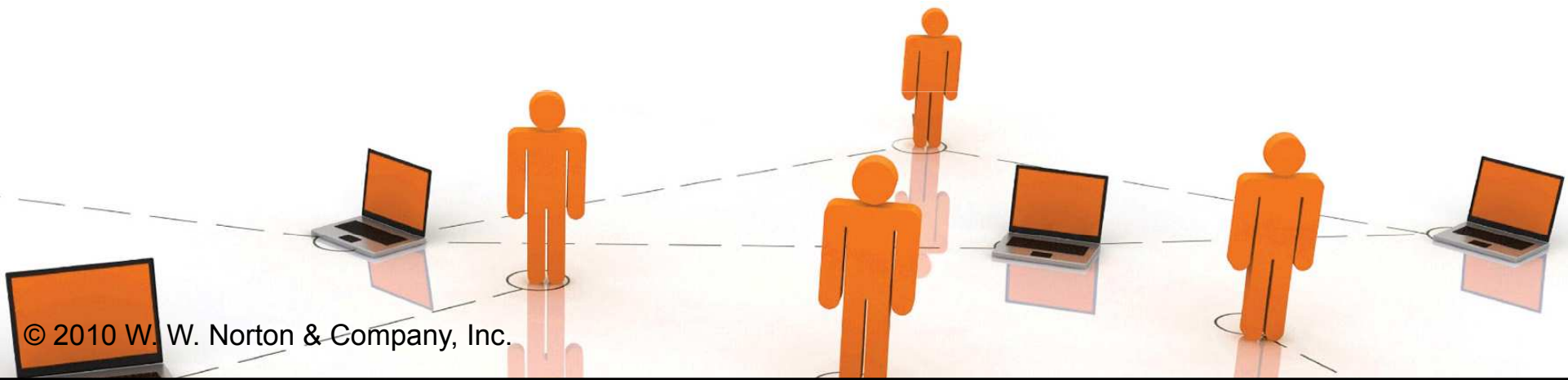
$$\frac{a_H - a_L}{c_L} < e_H < \frac{a_H - a_L}{c_H}.$$

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?**



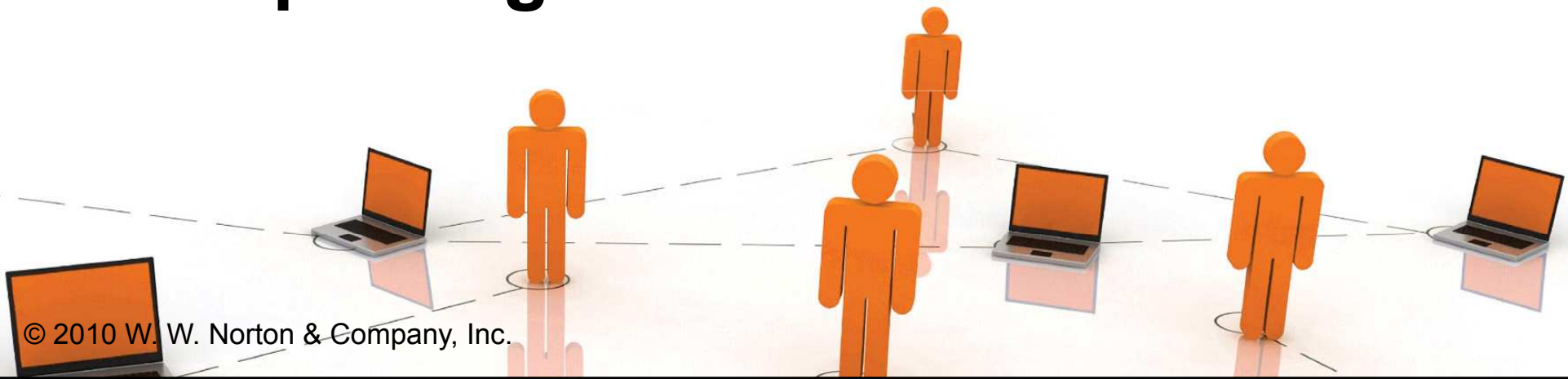
Signaling

- ◆ **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.**



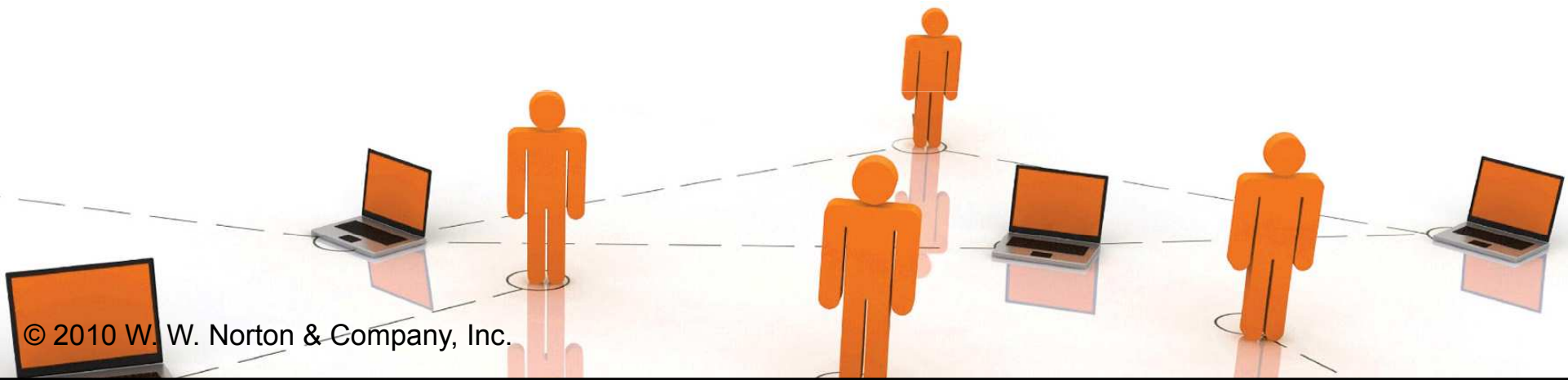
Signaling

- ◆ **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.**



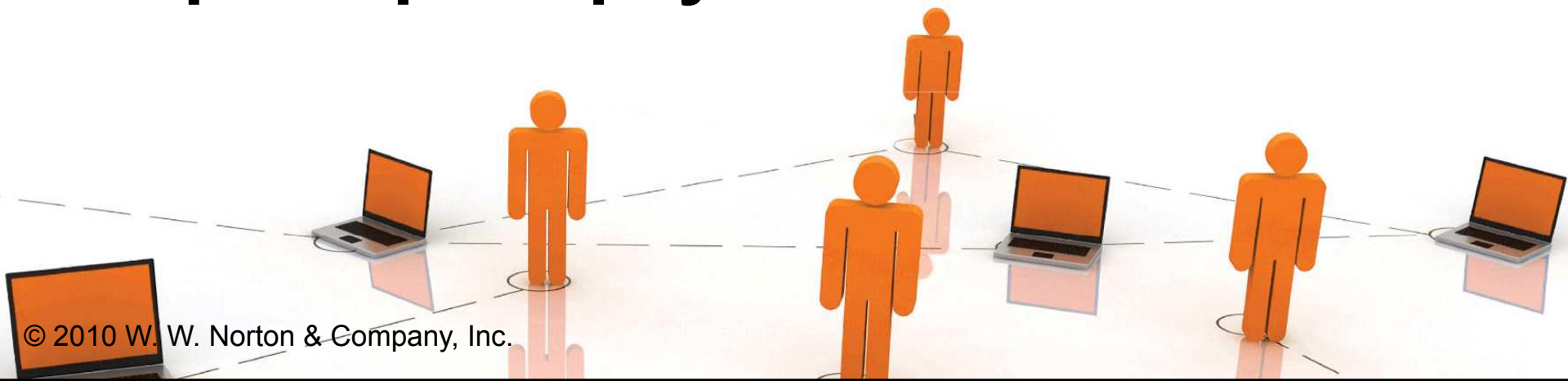
Moral Hazard

◆ **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.**

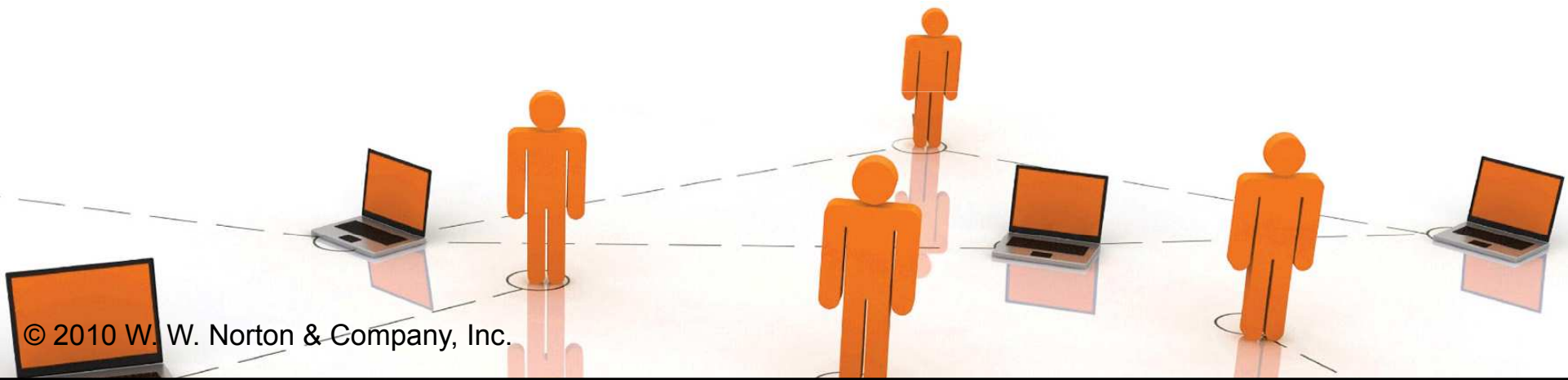
Incentives Contracting

- ◆ **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

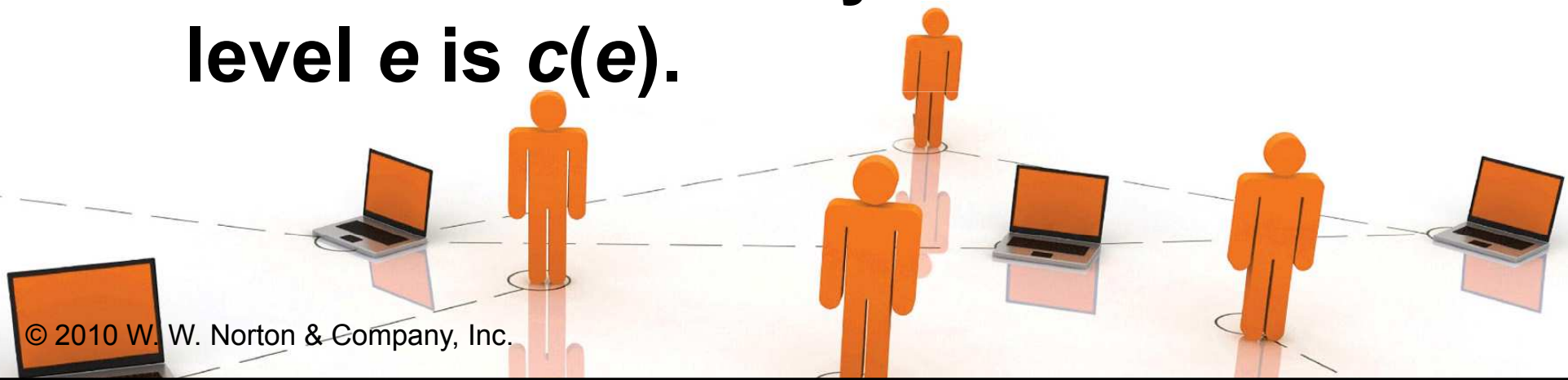
- ◆ e is the agent's effort.
- ◆ Principal's reward is $y = f(e)$.
- ◆ An incentive contract is a function $s(y)$ specifying the worker's payment when the principal's reward is y . The principal's profit is thus

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



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, ...

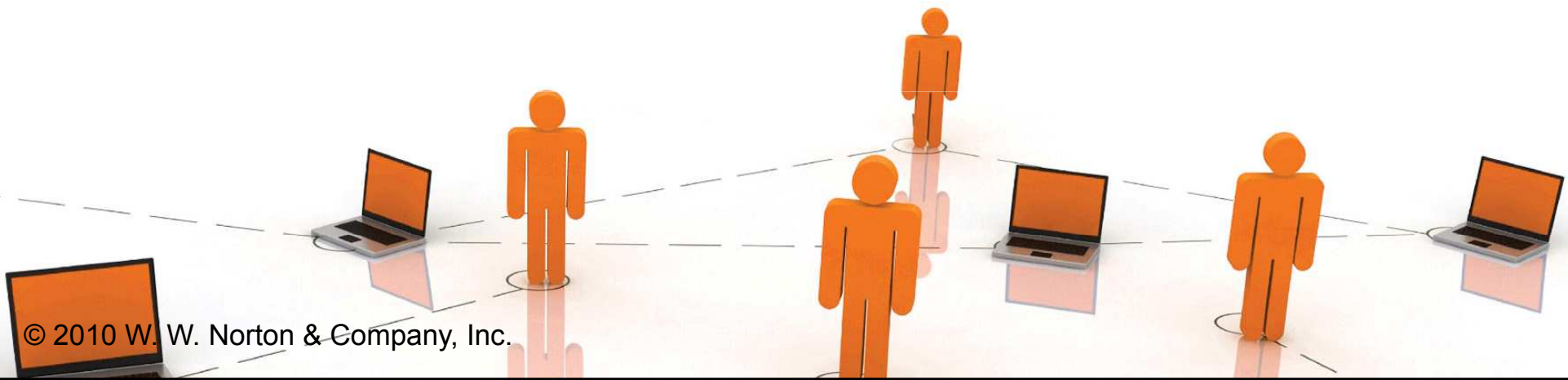


Incentives Contracting

the principal's problem is to

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Incentives Contracting

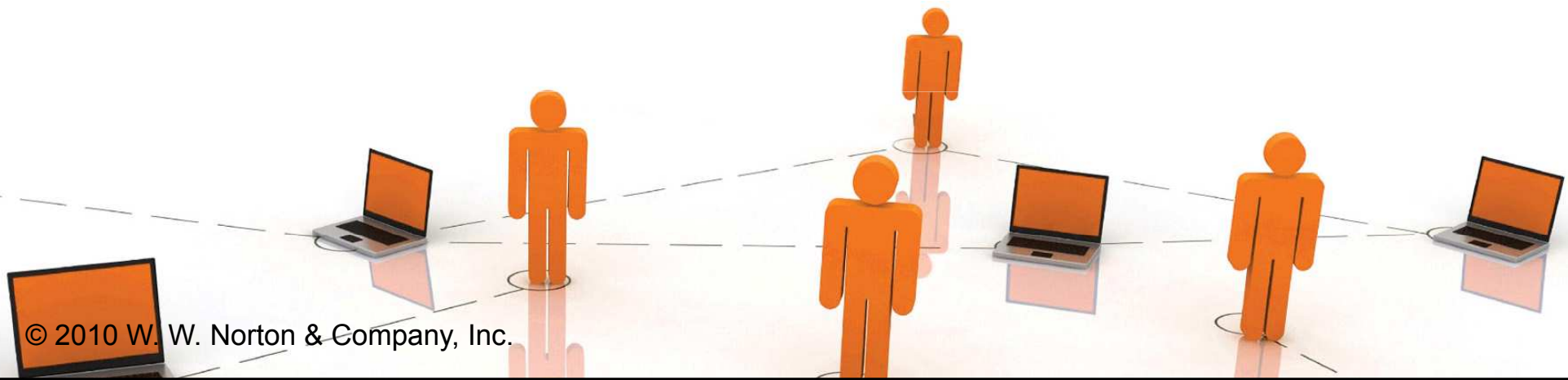
the principal's problem is to

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

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

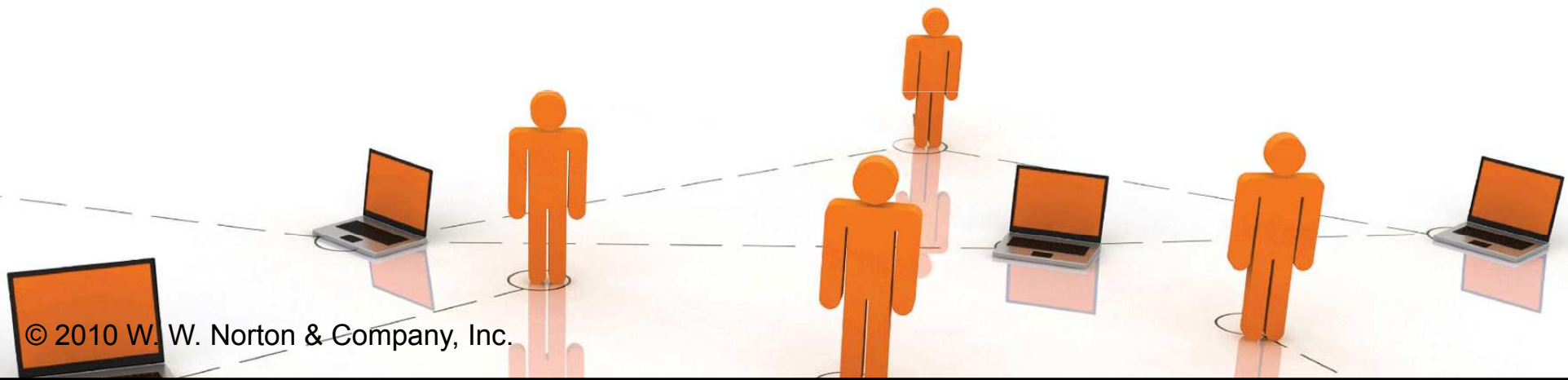
$$f'(e) = c'(e).$$



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

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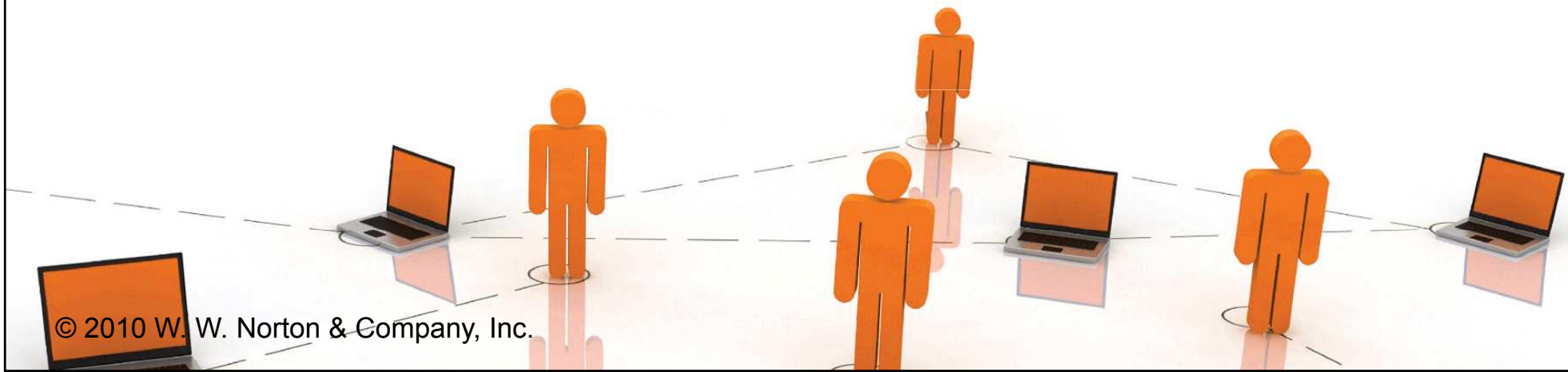
The contract that maximizes the principal's profit insists upon the worker effort level e^* that equalizes the worker's marginal effort cost to the principal's marginal payoff from worker effort.

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



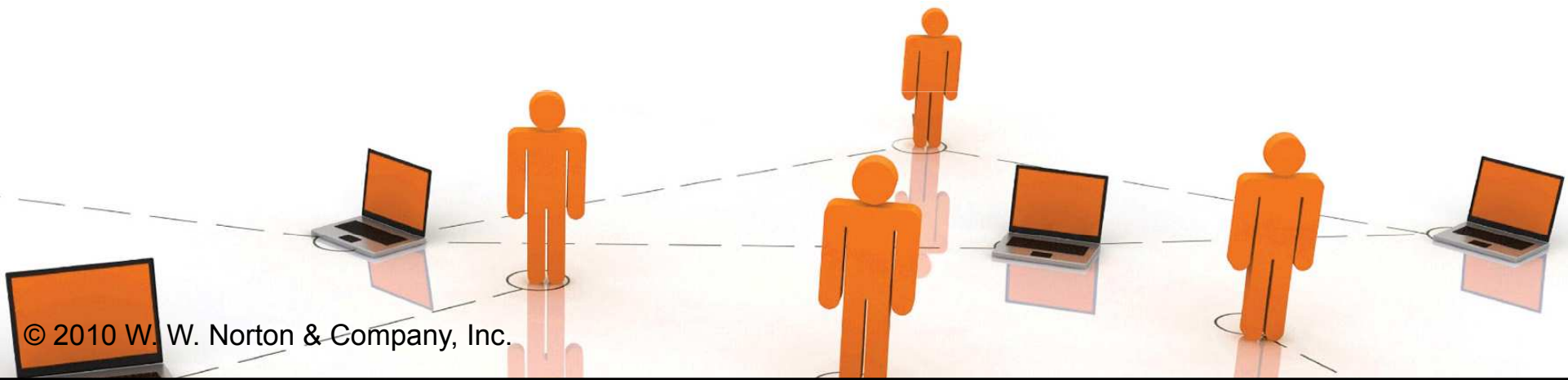
Incentives Contracting

◆ $e = e^*$ 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;
 $s(f(e^*)) - c(e^*) \geq s(f(e)) - c(e)$, 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?**

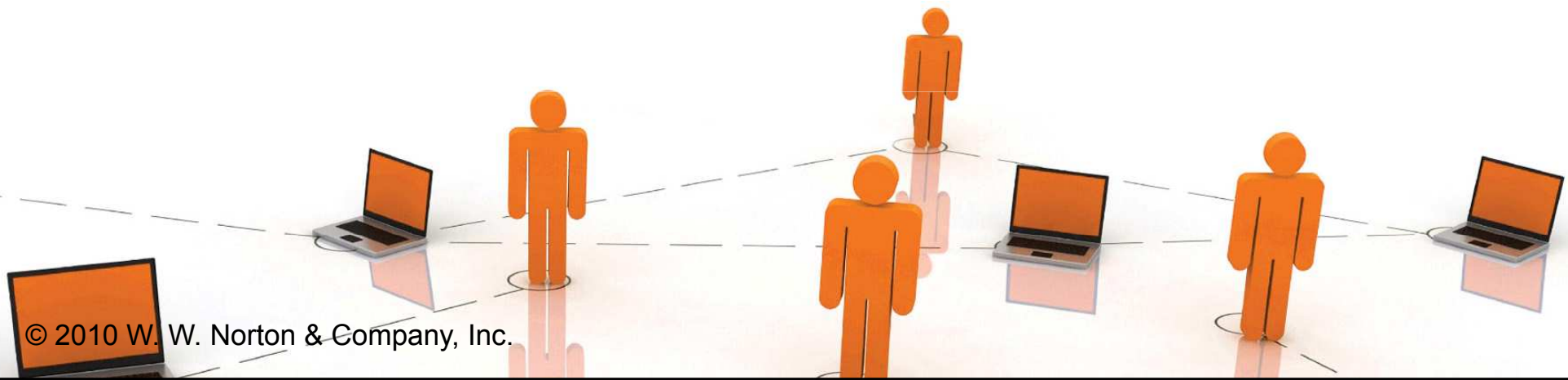


Rental Contracting

- ◆ 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.**

