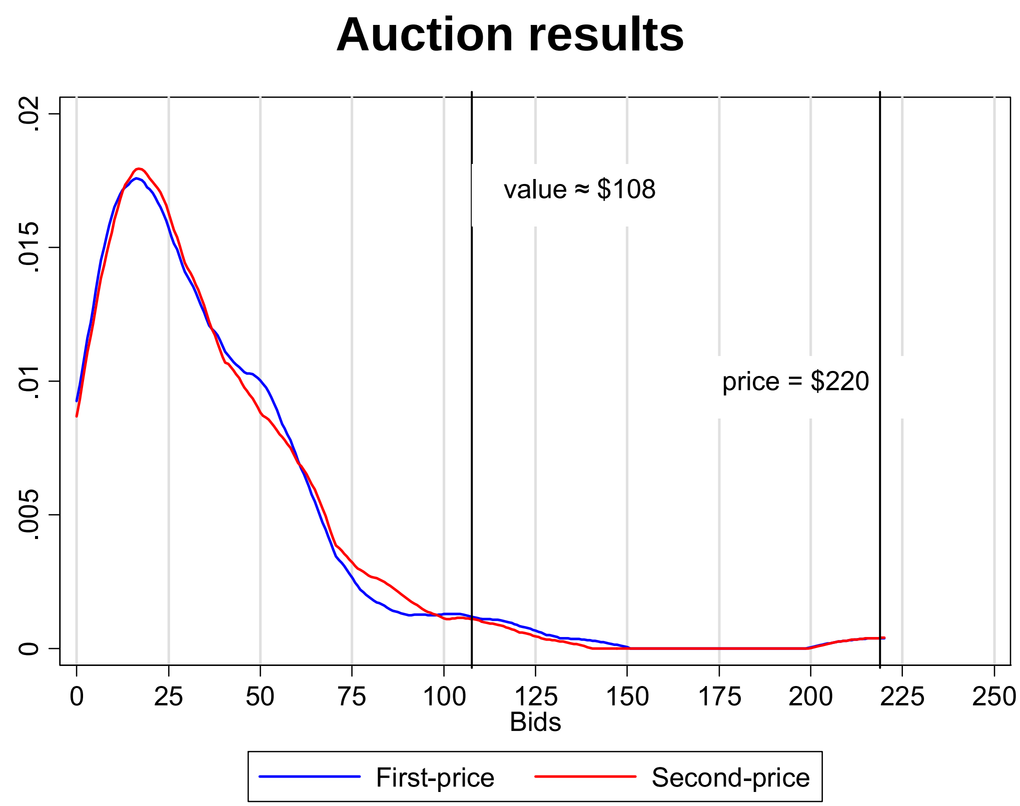
UC Berkeley
Haas School of Business
Economic Analysis for Business Decisions
(EWMBA 201A)

Asymmetric Information (PR 17)

Lectures 11-12

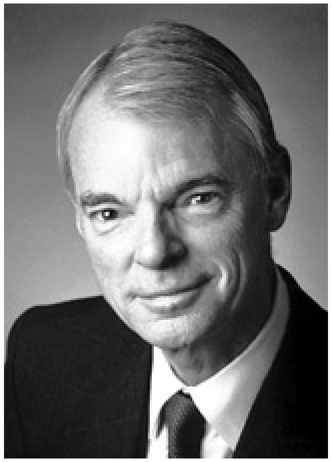
Sep. 26, 2009

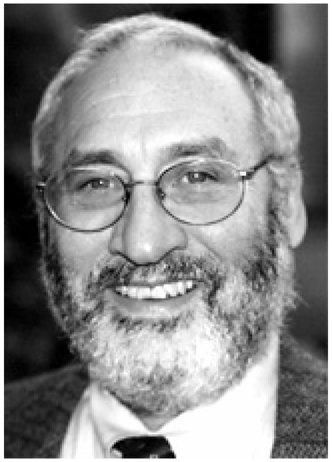


Auction results
value ≈ $108
price = $220
0
.005
.01
.015
.02
0
25
50
75
100
125
150
175
200
225
250
Bids
First-price
Second-price

Nobel Prize 2001

“for their analyses of markets with asymmetric information”





Markets with asymmetric information

- The traditional theory of markets assumes that market participants have complete information about the underlying economic variables:
  - Buyers and sellers are both perfectly informed about the quality of the goods being sold in the market.
  - If it is not costly to verify quality, then the prices of the goods will simply adjust to reflect the quality difference.

$\Longrightarrow$ This is clearly a drastic simplification!!!

- There are certainly many markets in the real world in which it may be very costly (or even impossible) to gain accurate information:
  - labor markets, financial markets, markets for consumer products, and more.

- If information about quality is costly to obtain, then it is no longer possible that buyers and sellers have the same information.

- The costs of information provide an important source of market friction and can lead to a market breakdown.

The Market for Lemons

Example I

- Consider a market with 100 people who want to sell their used car and 100 people who want to buy a used car.
- Everyone knows that 50 of the cars are "plums" and 50 are "lemons."
- Suppose further that

	seller	buyer
lemon	\$1000	\$1200
plum	\$2000	\$2400

- If it is easy to verify the quality of the cars there will be no problem in this market.

- Lemons will sell at some price $\$1000 - 1200$ and plums will sell at $\$2000 - 2400$.

- But happens to the market if buyers cannot observe the quality of the car?

- If buyers are risk neutral, then a typical buyer will be willing to pay his expected value of the car

$$\frac{1}{2}1200 + \frac{1}{2}2400 = \$1800.$$

- But for this price only owners of lemons would offer their car for sale, and buyers would therefore (correctly) expect to get a lemon.

- Market failure – no transactions will take place, although there are possible gains from trade!

Example II

- Suppose we can index the quality of a used car by some number q, which is distributed uniformly over $[0, 1]$.

- There is a large number of demanders for used cars who are willing to pay $\frac{3}{2}q$ for a car of quality q.

- There is a large number of sellers who are willing to sell a car of quality q for a price of q.

– If quality is perfectly observable, each used car of quality q would be soled for some price between q and $\frac{3}{2}q$.

– What will be the equilibrium price(s) in this market when quality of any given car cannot be observed?

– The unique equilibrium price is zero, and at this price the demand is zero and supply is zero.

$\Longrightarrow$ The asymmetry of information has destroyed the market for used cars. But the story does not end here!!!

Signaling

- In the used-car market, owners of the good used cars have an incentive to try to convey the fact that they have a good car to the potential purchasers.

- Put differently, they would like choose actions that signal that they are offering a plum rather than a lemon.

- In some case, the presence of a "signal" allows the market to function more effectively than it would otherwise.

Example – educational signaling

- Suppose that a fraction $0 < b < 1$ of workers are *competent* and a fraction $1 - b$ are *incompetent*.

- The competent workers have marginal product of a_2 and the incompetent have marginal product of $a_1 < a_2$.

- For simplicity we assume a competitive labor market and a linear production function

$$L_1 a_1 + L_2 a_2$$

where L_1 and L_2 is the number of incompetent and competent workers, respectively.

– If worker quality is observable, then firm would just offer wages

$$w_1 = a_1 \text{ and } w_2 = a_2$$

to competent workers, respectively.

– That is, each worker will paid his marginal product and we would have an <u>efficient</u> equilibrium.

– But what if the firm cannot observe the marginal products so it cannot distinguish the two types of workers?

– If worker quality is unobservable, then the "best" the firm can do is to offer the average wage

$$w = (1 - b)a_1 + ba_2.$$

– If both types of workers agree to work at this wage, then there is no problem with adverse selection (more below).

– The incompetent (resp. competent) workers are getting paid more (resp. less) than their marginal product.

– The competent workers would like a way to signal that they are more productive than the others.

– Suppose now that there is some signal that the workers can acquire that will distinguish the two types

– One nice example is education – it is cheaper for the competent workers to acquire education than the incompetent workers.

- To be explicit, suppose that the cost (dollar costs, opportunity costs, costs of the effort, etc.) to acquiring e years of education is

$$c_1 e \text{ and } c_2 e$$

for incompetent and competent workers, respectively, where $c_1 > c_2$.

- Suppose that workers conjecture that firms will pay a wage $s(e)$ where s is some increasing function of e.

- Although education has no effect on productivity (MBA?), firms may still find it profitable to base wage on education – attract a higher-quality work force.

Market equilibrium

In the educational signaling example, there appear to be several possibilities for equilibrium:

[1] The (representative) firm offers a single contract that attracts both types of workers.

[2] The (representative) firm offers a single contract that attracts only one type of workers.

[3] The (representative) firm offers two contracts, one for each type of workers.

- A separating equilibrium involves each type of worker making a choice that separate himself from the other type.

- In a pooling equilibrium, in contrast, each type of workers makes the same choice, and all getting paid the wage based on their average ability.

  Note that a separating equilibrium is wasteful in a social sense – no social gains from education since it does not change productivity.

Example (cont.)

– Let e_1 and e_2 be the education level actually chosen by the workers. Then, a separating (signaling) equilibrium has to satisfy:

[1] zero-profit conditions

$$\begin{aligned} s(e_1) &= a_1 \\ s(e_2) &= a_2 \end{aligned}$$

[2] self-selection conditions

$$\begin{aligned} s(e_1) - c_1 e_1 &\geq s(e_2) - c_1 e_2 \\ s(e_2) - c_2 e_2 &\geq s(e_1) - c_2 e_1 \end{aligned}$$

– In general, there may by many functions $s(e)$ that satisfy conditions [1] and [2]. One wage profile consistent with separating equilibrium is

$$s(e) = \begin{cases} a_2 & \text{if} \quad e > e^* \\ a_1 & \text{if} \quad e \leq e^* \end{cases}$$

and

$$\frac{a_2 - a_1}{c_2} > e^* > \frac{a_2 - a_1}{c_1}$$

$\Longrightarrow$ Signaling can make things better or worse – each case has to examined on its own merits!

The Sheepskin (diploma) effect

The increase in wages associated with obtaining a higher credential:

- Graduating high school increases earnings by 5 to 6 times as much as does completing a year in high school that does not result in graduation.
- The same discontinuous jump occurs for people who graduate from collage.
- High school graduates produce essentially the same amount of output as non-graduates.

Example – quality choice

- Next we consider a variation of the lemons model where quality may be determined by the producers.

- Suppose that each consumer wants to buy a single unit and that there are two different qualities available:

	value	cost
high	\$1400	\$1150
low	\$800	\$1150

If the industry is perfectly competitive (zero profits), then what we would expect to be the equilibrium quality produced?

- If the fraction of high-quality producers is q, then a risk-neutral consumer would be willing to pay

$$p = 1400q + 800(1 - q).$$

- For both qualities to be produced we must have $p \geq 1150$. The lowest value of q that satisfies this inequality is $q = \frac{7}{12}$.

- The equilibrium value of q is between $\frac{7}{12}$ and 1. But these equilibria are not equivalent from the social point of view.

Adverse selection

- Reducing the cost to manufacture a low-quality product in the above example will completely destroy the market for both qualities.

- This is an example of so-called adverse selection – low-quality items crowd out high-quality items.

- A similar problem arises in insurance markets – the externality between high-risk and low-risk people.

$\Longrightarrow$ It is possible that everyone can be made better off by requiring the purchase of insurance that reflects the average risk in the population!!!

Moral hazard

- Another problem that arises in the insurance industry is known as the moral hazard problem.

- The tradeoff: too little insurance means that people bear a lot of risk, too much insurance means that people take inadequate care...

- If the amount of care in unobservable, the insurance company will want the consumer to face some part of the risk ("deductible").

$\Longrightarrow$ Adverse selection refers to situations where there is a hidden information problem, whereas moral hazard refers to situations where there is a hidden action problem.

Incentive systems

- The central question in the design of incentive systems is “How do I get someone to do what I want?”

- We will pose this question in a specific context – a manager-worker compensation system.

- The problem is to determine exactly how sensitive the payment should be to the produced output.

Example – incentive design

– Let x be the amount of effort that the worker expends, and let

$$y = f(x)$$

be the amount of output produced by the worker.

– Let $s(y)$ be the amount paid to the worker if he produces y dollars worth of output.

– Presumably, the manager would like to choose the function $f(x)$ to maximize

$$y - f(x).$$

– Let $c(x)$ be the cost of effort, where both total and marginal costs increase as effort increases – $c' > 0$ and $c'' > 0$.

– The utility of the worker who chooses effort level x is then simply

$$s(y) - c(x) = s(f(x)) - c(x),$$

– The worker is assumed to have other alternatives available that give him some utility $\bar{u}$. This gives the participation constraint

$$s(f(x)) - c(x) \geq \bar{u}. \tag{1}$$

– The manager would like to induce the worker an effort level x the greatest possible surplus:

$$\max_x f(x) - s(f(x))$$
$$\text{subject to } s(f(x)) - c(x) = \bar{u}.$$

Substituting,

$$\max_x f(x) - c(x) - \bar{u}.$$

– This problem is easy to solve – choose x^* so that marginal product equals marginal cost $f'(x) = c'(x)$.

– To induce the worker to out in x^* amount of effort, the manager must design the incentive scheme $s(y)$ such that

$$s(f(x^*)) - c(x^*) \geq s(f(x)) - c(x) \text{ for all } x. \tag{2}$$

This is called the incentive compatibility constraint.

– Thus, we have two conditions that the incentive scheme must satisfy: the participation constraint (1). and the incentive compatibility constraint (2).

There are several ways to do this!

[1] **Rent**: The manager can simply "rent" the firm to the worker for some price R. For this scheme

$$s(f(x) = f(x) - R$$

so the worker maximizes

$$s(f(x) - c(x) = f(x) - R - c(x).$$

The worker will choose the effort level where $f'(x^*) = c'(x^*)$, which is exactly what the manager wants, and the rental rate R is determined by the participation constraint (1) which says

$$R = f(x^*) - c(x^*) - \bar{u}.$$

[2] **Wage labor**: The manager pays the worker a constant wage w per unit of effort along with a lump sum K. This means that the incentive payment takes the form

$$s(x) = wx + K.$$

The wage rate should be equal to the marginal product at the optimal choice $f'(x^*)$.

The lump sum K is chosen to satisfy the participation constraint (1)

$$K = f'(x)w - c(x) - \bar{u}.$$

Perhaps surprisingly, an incentive scheme where the manager and the worker each gets some fixed percentage of the output is suboptimal.

Suppose that the worker's share takes the form

$$s(x) = \alpha f(x) + F$$

where F is some constant and $0 < \alpha < 1$. The worker's maximization problem is

$$\max_x \alpha f(x) + F - c(x)$$

which means that he would choose a level of effort $\hat{x} < x^*$ where $\alpha f'(x) = c'(x)$.

Summary

- Imperfect and asymmetric information can lead to drastic diffrences in the nature of market equilibrium.

- Adverse selection refers to situations where the type of the agents is not observable.

- In markets involving adverse selection too little trade may take place.

- Moral hazard refers to situations where one side of the market cannot observe the actions of the other side.

- When adverse selection or oral hazard are present some agents will want to invest in signals that will differentiate them.

- Investment in signals may be privately beneficial but socially wasteful.