**GSM of PKU, IO**
**Problem Set 9**

Spring 2013 L. Shi

**1. Question on the use of signaling in selecting workers.**

The set-up is the same as that in the class (and the note at the bottom). Use the below numbers:
The productivity of the Q type is 2.5 and that of the S type is 1. The proportion of Q type is 0.2. The cost of acquiring the signal for Q type is c/2 and that for the S type is c.
(i) In what range of c would a separating equilibrium obtain?
(ii) What is the critical element of the set-up which allows the employer to separate worker Q and S?

2. In a market of used cars, there are two types of sellers, those of good used cars and those of bad used cars. Sellers know what kind of seller they are but the buyers do not. What the buyers do know is that the proportion of good used cars is 50% and that of bad used cars is 50%. A buyer is willing to pay $5,000 for a good used car and $1,000 for a bad used car. A good used car will not break down within one year of the purchase, and a bad used car will break down with an 80% probability within a year after the purchase.

a. If you are a buyer who is endowed with the above information only, what is the price that you are willing to pay for a used car? At the price that you offer, is the seller of a good used car willing to sell? Who is willing to sell?

b. A seller can offer a guarantee -- if the sold car breaks down within a year, the seller will pay for the repair cost. Assume that the guarantee specifies that the seller will pay $6,000 worth of repair if the car breaks down within one year after the transaction. Question: can an equilibrium be reached where i) only the seller of a good used car offers the guarantee, and ii) the buy is willing to pay $5,000 when she sees warranty offered and $1,000 when she does not.

3. In the tourist-trap model
Step 1, suppose the equilibrium is a full-information, competitive price $p_c$, show that it pays for the deviant firm to raise its price by an amount just less than the cost of additional search.
Step 2, suppose the equilibrium is $p_m$, where $p_m$ is monopoly price, should a deviating firm lower its price by an amount just more than the cost of additional search?
Step 3, what is the equilibrium price?

4. Tourist-native model
Case 1. Many informed consumers.
Show that the equilibrium is the full-information, competitive equilibrium price.
Case 2. Few informed consumers.
Note that in Figure 13.1, it is assumed that $p_c + c > p_u$.
Show that in the case of few informed consumers, it pays to deviate from the proposed full-information, competitive price equilibrium.
Show that there can't be an equilibrium where all firms charge $p_u$.
Show that there cannot be an equilibrium with more than two prices.
Show that in the two-price equilibrium, the low-price stores' share of the market is greater than the proportion of informed consumers.

**Lecture note on The Problem of Asymmetric Information in Recruiting**

One of the most important problems facing firms is attracting the ``right" types of employees. This would not be a problem in a world of perfect information, because then we would know the characteristics and productivity of every potential employee. But suppose that prospective employees have better information about themselves than you do (which makes sense in many contexts). For example, suppose that your firm has decided to hire skilled workers and to offer the market wage of $W_s$. Suppose also that skilled and unskilled workers know their own types (S or U), but you do not. If skilled workers cannot be distinguished *ex ante* (at the time of hire) from unskilled ones, then your offer to pay $W_s > W_u$ is just sufficient to attract skilled workers, but it is very attractive to unskilled ones. Your applicant pool and workforce turn out to be mainly unskilled, as type U's happily try to pass themselves off as type S's.

One possibility is that you interview all workers. But anyone who has done much interviewing (or has been interviewed much) will know that this is a very noisy signal on an individual's true characteristics.

The problem just outlined arises in many different contexts and it is not limited to the labor market. Think about the market for used cars, for example. If sellers know the qualities of their cars and buyers don't, only the "lemons" will be offered for sale. An economist (George Akerlof) got a Nobel Prize for thinking about that.

A model of Lemons.
Set-up:

1. A buyer wants to buy a used car. The buyer's utility function is u=utility_from_the_car – price.
2. There are two kinds of used car in the market, G and B. The good used car brings utility of $7,000 and the bad used car brings utility of $3,000. In this market, 50 percent of the sellers have good used cars and 50 percent have bad used cars.
3. The market is competitive; the buyer needs to pay a competitive price.
4. The seller knows what kind of car he has, the buyer does not. But the buyer does know the 50% of the used cars are good.

Questions: What offer would the buyer make? What kinds of cars are sold in the market?

Broadly speaking, the problem arises because of *asymmetric information*:

What features of used car market help alleviate the adverse selection depicted above?

**<u>Asymmetric information</u> means that one party to a transaction has more information about relevant characteristics than does the other party.**

In our problem, the relevant characteristic is skill, which workers (sellers) know but the firm does not. The firm's goal in this situation is to find strategies that identify skilled and unskilled workers, and thus improve the average skill level in its labor force.

You have to resort to two possible mechanisms to get workers to reveal their true characteristics:

i. Signaling
ii. Self-selecting.

*Signaling* refers to requiring a potential worker to carry out some activity that makes it clear that he is genuinely the type of worker that you would like.

*Self-selection* implies that the firm offers a contract where the terms of the contract are only attractive to certain types of workers.

**Signaling**

Another possible solution is to use a **signal**. A signal is an acquired characteristic, say schooling that employers believe to be correlated with the things they are looking for, say productivity. Then an employer will offer higher wages ($W_s$) to workers who have acquired the signal. As we have seen, in order for employers' beliefs to be rational (correct), it must be true that skilled workers can obtain the signal at lower cost than can unskilled workers. If so, then the signal can result in an effective sorting of workers, which enables the firm to hire the ``right'' kinds of workers.

**Job Market Signaling: An Alternative Model of Schooling**

Why are you studying for an undergraduate degree? One view – consistent with the human capital model – is that you are obtaining new skills that will raise your productivity with future employers. But another, perhaps more cynical view is that nothing you learn at the school will do anything for your productivity – *education does not raise productivity*. People who can earn a degree would have been more productive anyway, and employers use the degree as a "signal" of who is productive. Since productive people get paid more, you have an incentive to acquire the degree signal – it doesn't raise your productivity, but it tells employers that you will be more productive than other people. The UW's role is to certify who the most productive people are by making them perform useless tasks that others can't do.

To see what is necessary to get this view of education (or other types of signals) to "work," let's do an example. Suppose there are 2 types of people, Quicks (Q) and Slows (S). As shown in **Table 1**, all Q's have a marginal product of 2, and all slows have a marginal product of 1. If types were known to employers, then Q's would get a wage of W=2, and S's would get a wage of W = 1. But we assume that employers cannot tell the Q's from the S's ex-ante. There is *asymmetric information*: the Q's and S's know their own types, but potential employers do not.

Table 1: Characteristics of Workers for Signaling Example

| Worker Type | *Population Share* | *Marginal Product* | Cost of the Signal |
|---|---|---|---|
| S | *.8* | *1* | *c* |
| Q | *.2* | *2* | *c/2* |

The proportion of S's in the population is .8. Absent any method of distinguishing Q's from S's, firms would pay workers their *expected* marginal product, *E*MP = .2*2 + .8*1 =1.2< 2. Of course Q's don't like this. If they could just tell employers (truthfully) who they are, then they could get a wage of 2. To do this, they need a signal.

Suppose such a signal exists, and suppose that employers *believe* that anyone with the signal (an undergraduate degree) is a type Q worker, with MP = 2. Now, if everyone has the same cost of getting the signal, and if people with the signal get paid 2, then everyone will get it, including the S's. Then employers' original belief (only Q's have the signal) is wrong, and the signal doesn't work. *For the signal to work, it must be the case that only the Q's choose to obtain it*. For this to be the case, the cost of obtaining the signal must be lower for

them. In the table, we assume that the cost of obtaining the signal for the S's is *c*, but the cost for the Q's is *c*/2. So Q's are better at obtaining the signal. (These costs should be considered as psychic costs; such as the possibility of flunking, or how hard you have to work to get through). Let c=1.5. Questions: Can a separating equilibrium obtain? That is, in that equilibrium, Q acquires the signal and S does not.

The sequence of events is

Beliefs –> Wage Offers –> Actions –> Outcome –> Beliefs

Here "Beliefs" refers to what employers believe about the productivity of persons with the signal, for example: "Only type Q people have an undergraduate degree." These beliefs then determine "Wage Offers" that employers are willing to make. Based on how much employers pay to persons with the signal, Q's and S's undertake an "Action"; i.e. whether to get the signal or not. Then the "Outcome" is data on who has the signal. If in fact it is the Q's who have it, and the S's do not, then the original beliefs have been confirmed. Then we have a signaling "equilibrium" in the sense that employers have no reason to change their beliefs.

Let's see what happens:

Beliefs of Employers

If the job applicant (she) possesses the signal then employer believes she is type Q

If the job applicant does not possesses the signal then employer believes she is type S

Actions by Job Applicants

Type S:

If obtain the signal then total utility= $2 - c = 2 - 1.5 = .55$.

If does not obtain the signal then total utility =1

So choose not to obtain the signal.

Type Q:

If obtain the signal then total utility = $2 - c/2 = 2 - 0.75 = 1.25$.

If does not obtain the signal then total utility $= 1$.

So choose to obtain the signal.

So the type Q workers acquire the signal and the type S workers do not – just as employers expected. Only the type Q workers obtain the signal. Beliefs are confirmed, and we get equilibrium because there is no reason for employers to change their beliefs. There are several things to note about this example:

1. The signal only works because it is cheaper for the type Q's to obtain it. The point of the signal is to distinguish among types, and it only works as a sorting device if the Q's get it but the S's don't. In the case of schooling, it is easier (less costly) for a smart person to get it, so employers may use schooling as a signal of ability.

2. *Socially inefficient investment in the signal is privately optimal.* No one's productivity was affected by the signal. In fact, the total value of social output was unchanged, because all productivities were unchanged. This means that signal is a social waste, even though it is privately rational to obtain it, because society's resources were devoted to producing it. This is actually the view of some critics of education – it allows the

elite to distinguish themselves, raising their incomes and reducing the incomes of others, but it has no social value. (Proof. The Q type's income increases from 1.2 to 2, yet the S type's income changes from 1.2 to 1. The change in total surplus is *0.2(2-1.2-0.75) +0.8(1-1.2) =0.2*2+0.8*1-0.2*075<1.2*.)

The signaling model just outlined is a good explanation for why people do certain things, like wear Rolex watches ("I can afford this. You should infer that I'm wealthy."), but it is surely not the main reason that people obtain schooling and advanced degrees. Indeed, empirical tests show that persons with more schooling earn more even when there is no opportunity to signal – more educated farmers are more productive, as are self-employed persons with more schooling. In other words, the main reason that people invest in education is that it raises wages by raising *productivity.* Education produces human capital. Even so, there is probably some truth to the signaling model of education. A DEGREE has some aspect of a "credential," quite apart from what you learn.

**Question**: Does the law constrain the types of signals that you can use?

While a signal may work, it is not without problems. One is that the observed proxy may be only weakly correlated with the particular type of skill you want. Then it will not do a good job of sorting. Another is that signals are generally inefficient because (by definition) they don't really raise an individual's productivity, but they are costly to obtain. If some other, cheaper, method of sorting can be found, then it should be used.

Schooling is only one example of how signaling can operate. There are many others that operate in organizations. Among them are:

i. Firms often make new employees work extremely hard to ``buy in'' to the company. The signal that operates here is that firms are worried that workers are either (a) not going to stay around for long or (b) are not dedicated enough. They can make workers signal this information by working long hours (``He must like the company if he is willing to give up all that time he could spend with his family'').
ii. Often in joint venture investment projects, individuals are made to put up some of the investment themselves to signal that the project is actually worth something.

Harvard Business School makes new professors take an executive program to signal that they are interested in business.