

## Signaling, Screening, and Lemons Problems

### Lecture 6: On the Supply and Filtering of Information

(U. Bayreuth, Spring 2006)

#### **I. Introduction**

- A.** The work of Hayek and Stigler reminded economists that some of the assumptions used by economists to model rational decisions to purchase and supply goods and services are conditioned on consumer and firm information.
- Production requires the coordination of many "experts" whose knowledge differs in ways that, when combined in the right way, yields far more output than any member of the "team" can produce on their own.
  - Prices contain information about the costs and rewards associated with different kinds of productive activities, but prices themselves are products of informational demands by consumers.
  - In the course of searching for the best price, consumers cause the variance of posted prices to fall.
- B.** Of course, as noted by Stigler, firms attempt to reduce search costs by advertising their prices and products, which tends to improve market performance insofar as honest accurate information is provided.
- C.** The question raised today, is whether such honest accurate information is likely to be provided when the interests of information providers differs from that of information demanders.
- The answer provided by Michael Spence's (1974) and George Akerlof's (1970) work suggests that this is not always clear.
  - In some cases, the truth predictably wins out.
  - But, in other cases, false signals may be the only available information.
  - In such cases, the incentives to provide false "signals" or "messages" implies that information freely supplied (cheap talk) should be ignored.

**D.** Modern game theory tends to affirm their conclusions, but tend to investigate how much information may be indirectly available to individuals through the structure of the game setting itself.

**P** If it is clear that "signalers" have incentives to send misleading or false messages, then such "rational signal processors" will simply ignore the messages sent.

**E.** This debate over the reliability of messages is relevant both for the philosophy of science and for ethics.

**P** How often scientists lie about their results (or at least over state them) will vary with the choice setting of interest, and also, perhaps, with the norms of the scientific community.

**P** (How often persons filling out survey forms lie about their situation or opinions is also clearly a matter of ethics and "signaling interests" on the part of the person filling out a form. Do they want to please the person handing out the form or advance their own interest in being an honest person?)

#### **II. Informational Competition: Signaling Games**

**A.** Spence's "Market Signaling" (Harvard U Press, 1974) analyzes the kinds of "signals" people may use.

i. For example,

**P** Individuals may invest in expensive college degrees to signal their talent.

**P** Firms may spend money on advertising to signal their confidence in the quality or low price of their goods and services.

**P** Individuals may purchase expensive suits of cloths to signal their "good taste" or their willingness to play by the local rules of a social game.

ii. The types and number of signaling equilibria depend on the game setting and the "signal processing" or "signal extraction" ability of individual in the game.

iii. Spence's most provocative finding is that there may be an infinite number of signaling equilibria.

**B.** The essential signaling game can be represented as a non-cooperative game with a Nash equilibrium.

i. Consider a simple version where two firms compete to serve a group of customers who are initially indifferent between the two firms, because the expected price difference equals the transactions cost of shopping at the two stores.

**P** A model of persuasive advertising can be constructed using Bayesian learning models.

**P** If information (advertising) can be used to change the price or quality expectations of this group it will pay both firms to attempt to do so.

**P** Note that the result may be that too much information will be provided by these firms.

**P** This game is analogous to a "rent-seeking" contest, in which over investment is the usual result.

ii. [Nelson has argued that advertising expenditures can be used by consumers as a proxy for the confidence that they have in the appeal of their product in the case where purchasers learn the quality of products ex post. Does this make sense?]

**C.** Note also that the "persuasion model" is not fully rational in that individuals do not take full account of incentives for firms to lie about their prices or the quality of their products.

i. In more recent signaling games, players are assumed to know the incentives of firms (or other information providers) and so they can gauge how seriously to take the messages sent.

**P** In some cases, "cheap talk" equilibria are informative, in others they are simply "babbling" equilibria in which messages are sent without affecting individual opinion.

ii. Note also that legal institutions have emerged to support "honest advertising" and discourage both fraud and puffery.

**D.** The signaling model may be combined with a "screening model" where a some natural or designed process sorts out people by ability or signals.

### **III. Affects of Uncertainty on Market Structure: Akerlof's "Lemon's Problem"**

**A.** Given the ambiguity of signals provided by advertisers, individuals will often be *uncertain about the quality of goods* that can be purchased in markets, but may have an idea about the quality distribution that they face.

**B.** Akerlof's "The Market for Lemons: Quality Uncertainty and the Market Mechanism" (QJE, 1970) argues that in some cases, uncertainty about quality may cause some markets to disappear.

i. The reasoning goes as follows:

ii. Suppose that prior to purchase buyers can not distinguish the quality level of, say, some brand of used cars. But, sellers know the quality of the car from personal experience.

**P** In this case, the amount that a buyer is prepared to pay for a car (his reservation price) is based on the expected or average quality of the cars that are for sale.

iii. Consequently owners of superior cars sell at "a loss" while owners of below average cars sell at "a profit."

**P** In some cases, the owners of superior cars will simply withhold their cars from the market and drive them longer than they would have had information been better.

iv. This of course further reduces the average quality of automobiles, which lowers the price consumers are willing to pay.

**P** This price adjustment causes more "cream puff" owners to withhold their cars from the market, and so on.

v. In the limit some markets may disappear entirely. In other cases, some market segments may disappear--e.g. markets for "cream puffs" will disappear.

vi. Akerlof's analysis provides an explanation for the big price difference between new and late model used cars.

- P New cars become much less valuable "used cars" the moment they are driven from the lot.
- vii. Of course in real markets firms try to tell consumers about the quality of their merchandise and about their prices.
- P If such information can be "filtered" by consumers or verified by "disinterested" or "honest" groups, then such subsidized information may reduce many of Akerlof's information problems.
- P [How might auto dealers attempt to deal with this problem? Would warranties help? What would limit the extent to which warranties could be used to address this problem? Is there a moral hazard problem here?]

#### IV. Screening: Hiring the Most Productive Person for the Right Job

- A. One of the problems facing a firm owner is finding the right person for each job in the firm. Not all employees are created equal. Some are more talented, have more education, have a stronger work ethic or greater honesty, others have more experience.
- The second and fourth of these are observable in principle: as employees submit vita's characterizing their backgrounds. The first and third of these characteristics are not.
  - In any case, there are often informational problems in deciding whom to hire.
  - The characteristic of interest may be well known to the employee, but the employees can not just tell the owner about their talent. "Cheap talk" is discounted by the owner.
  - To solve this problem, the owner may try to devise a contract which causes potential employees to sort themselves out: for example, into groups with different talent levels.
- B. A contract (game) that causes potential employees to sort themselves into groups is said to have a "separating equilibrium." A contract that does not induce any sorting is said to have a "pooling equilibrium." However, not all separating equilibria are helpful. Some induce the problem of "adverse selection" where the undesirable employees "crowd out" the more desirable

ones. [Akerlof's famous lemons problem is an example of a perverse separating equilibrium.]

- C. An Illustration: Suppose that the skills that a firm is interesting in are correlated with academic talent. E. g., people who find it easy to get good grades in school will be expected to be more productive within the firm. The firm proposes to pay people more if they received higher grades in school or have higher degrees:  $w_o$  for  $G < G^*$  and  $w_v$  for  $G > G^*$ . To "simplify" further, suppose that there are just two types of people: very talented,  $t_v$ , and not so talented  $t_o$ . Grades increase as time spent studying,  $S$ , increases for a given talent level,  $G = g(S, t)$ . (The opportunity cost of a high grade is lower for a talented individual than for a less talented one.)
- Each maximizes a utility function defined over leisure and income (here at school work).
  - $U = u(W, T - S)$  where  $W = w_o$  if  $g(S, t) < G^*$  and  $W = w_v$  if  $G > G^*$ .
  - Note that solutions to this problem are essentially corner solutions. (There is a kinked total benefit curve for academic achievement but a rising cost curve.) This is a common assumption in these models, but is not entirely necessary. (See Kreps ch. 17.)
  - In a pooling equilibrium both groups invest in the same level of education either  $S = 0$  or  $S$  is just sufficient for each to achieve  $G^*$ .
  - In the separating equilibrium the high talent individual study enough to secure grades greater than  $G^*$  and the less talented group doesn't study at all, and receives grade  $G < G^*$ .
  - In this last case, the contract has sorted potential employees into relevant groups for the firm.
  - [Education is in this game said to be a "signal" by which potential employee's try to inform potential employers of their talent and/or gumption.]

#### V. Motivation by Contingent Contracts

- A. After hiring the right people, the motivational problem remains. Monitoring with creditable punishments is one way of discouraging shirking, as we have seen. Alternatively one may devise contracts with effort incentives. The hidden action or moral hazard problem is most

interesting in cases where even low effort levels may occasionally secure high output results. (Even a lazy salesman may make a great sale.)

- B.** In principle, an incentive contract has to satisfy two constraints: it has to be attractive enough to cause the potential employee to take the job (the participation constraint), and it has to encourage the optimal effort from the employee once he accepts the job (the incentive constraint). The best contract will satisfy these two constraints at least cost.
- C.** A simple example: In the non-stochastic shirking problem developed above, if one can observe an employee's output, but not effort, salary could be conditioned on output rather than being fixed at  $W$ . Note that some compensation schedules eliminate shirking. E. G. an output based reward system such that:  $UYL > UL$  for all  $L$ . [Piece rate contracts, and many contracts in sports and sales seem to do this.]
- i. In the stochastic case, one can not infer effort by observing output, but the same logic applies. One can make expected marginal benefits of not shirking greater than that of shirking over the range of interest.
  - ii. Note that the conditions at the margin, are sufficient to satisfy the incentive constraint, inframarginal payments are required to satisfy the participation constraint (the employee has to earn his opportunity cost wage).
- D.** Tideman and Tullock (1976 JPE) showed how contingent contracts (Clarke taxes) can be used to induce honest information from voters about the value that they place on public services.
- i. Clearly, similar conditional incentive systems can encourage more truthful reporting of information in the Spence and Akerlof settings.
  - ii. Here, we may note the existence of laws against fraud and misleading advertising.
  - iii. On the other hand, it seems clear that such contracts can not be used to solve all informational problems of the sort that Spence and Akerlof identify.