CHAPTER 12 Uncertainty and Information

TEACHING SUGGESTIONS

To convey the ideas of signaling and screening using examples other than those in the book, your sources will depend on your focus. If your course is economics oriented, you can use the standard examples from Spence (education as a signal of quality) and Rothschild-Stiglitz (an insurance company using a contract with a low premium but incomplete insurance as a device for separating clients who are good risks from those who are bad risks). These are available at a relatively accessible level in many intermediate microeconomics textbooks. Another good example about how institutions are designed to create incentives for truthful revelation is Alvin Roth's classic hospital resident matching story. If your course is more politics oriented, there are many examples in Jeffrey Banks, *Signaling Games in Political Science* (Chur, Switzerland/Reading, U.K.: Harwood, 1992). For science- or biology-oriented courses, you can develop and use the examples of signaling in evolution, based on the discussion in *The Red Queen* that is cited in the text.

Here are some examples of situations in which moral hazard or adverse selection may arise. Moral hazard: (1) when a firm's owner can't observe the effort (or work quality) of a manager or worker, (2) when an insurance company can't observe contributory negligence of a policyholder, and (3) when an insurance company can't accurately value a loss and must rely on the policyholder's valuation. Adverse selection: (1) when an employer doesn't know the skill level of a potential employee, (2) when an insurance company doesn't know the risk level of an applicant for insurance, and (3) when players don't know actions available to other players as in a war game.

The health care system has all kinds of information asymmetries and is a good topic for discussion to get across the ideas of moral hazard and incentive contracts and of adverse selection, signaling, and screening. Here is a summary of such a discussion we conducted in class. The topic proved far too big for one week's discussion, and we managed to touch on only a few of the relevant points. That is hardly surprising; numerous experts have struggled for years without resolving all the issues.

DISCUSSION TOPIC INFORMATION AND INCENTIVES IN THE HEALTH CARE SYSTEM

Informational Limitations and Asymmetries

Users (potential and actual patients): (1) Know more about their own health risks (creates adverse selection) and control aspects of their behavior that affect the risk (creates moral hazard). (2) Don't know their own diagnosis, and don't know the appropriate treatment (are poorly informed consumers. But they do have some information supplied by the media and the drug companies (which have their own incentives to misinform). (3) Don't know the providers' quality or effort for sure (face adverse selection and moral hazard) but have various sources of partial information, for example, word of mouth, the media, databases on malpractice suits, and so on.

Providers: (1) The doctor knows much more about the patient's diagnosis and appropriate treatment. But there is some inherent uncertainty. (2) Doctors and hospitals know much more about their own quality (create adverse selection).

Insurers: (1) Don't know enough about new customers' health risks and behavior (face adverse selection and moral hazard). (2) Know the historical success record of providers and therefore have better idea of quality.

Government: (1) Can centralize information and reduce adverse selection and moral hazard. (2) Large organizations face limits on their span of control and cannot monitor quality or actions of all employees, users, and so on. This especially increases moral hazard.

Systemwide Objectives

1. Universal coverage
2. Quality of care
3. Cost control
4. Availability of choice
5. Public-private mix

Different systems of insurance, charges to users, payment to providers, and so on, affect the participants' incentives and therefore the achievement of the system objectives differently. There are trade-offs: a better performance in one dimension may come at the cost of a worse performance in some other dimension. We looked at just a few examples of this.

Users' Incentives

Conventional insurance, with 80% or more coverage, gives the users an incentive to overdemand services. This includes insistence on coverage of very expensive and experimental treatments. Insurance companies try to restrict coverage but with limited success when faced with lawsuits.

The problem would be much more severe for prepaid or HMO-type systems, because the patient's marginal contribution to the cost of each use is essentially zero. HMOs control this by limiting coverage to what is available within the group of providers. But that restricts consumer choice. In national (government-run) systems, queues are used to restrict access to certain procedures deemed less urgent or essential. This is an even more extreme restriction on choice.

If consumers had to pay a much greater share of the cost of each use, this incentive problem would be reduced. But then access would be limited by income or wealth even more than it is now and coverage would be even less universal.

Providers' Incentives

Under the fee-for-service system, doctors and hospitals have the incentive to overprovide services. When the patients have insurance coverage, they offer no opposition. For items such as diagnostic tests, this is worsened by the threat of malpractice suits. To counter this tendency and to control budgetary costs, the government (in its Medicare and Medicaid systems) keeps the reimbursement rates low and uses primary providers as gatekeepers for specialists. But this has reduced the availability of care to people in these systems. Private insurers have instituted prior approval mechanisms; this has reduced consumer choice and perhaps (at least the doctors claim so) has reduced the quality of care.

Under a prepaid or HMO-type system, the providers can have the opposite incentive—to shirk or to provide minimal care. This can be controlled using reputation mechanisms in repeated relationships. For example, insurance companies might cut off doctors with persistent poor performance. (The profession's own procedures for detecting and removing poor quality seem to work only imperfectly and with very long lags.) More generally, success-based compensation schemes could be used to self-select the most able doctors into specialties.

HMOs have more incentive to offer better preventive care. So should public (national health) systems, but these are often subject to cost-cutting squeezes.

Doctors, hospitals, and equipment and drug makers have mixed incentives to innovate. Technical innovations can bring fame and profit. Cost-cutting ideas may be less attractive, and also limited because many procedures need a certain labor time and their costs go up as productivity and wages in the rest of the economy go up (this is often called "Baumol's disease").

Insurers' Incentives

Adverse selection can lead to cream skimming. Each insurance company practices screening by offering a contract that is attractive only to the most healthy individuals. Then a residual insurer, like Blue Cross or the government, is left with the worst risks and the highest costs. In fact employment-based insurance can act as a screening device of this kind, to the extent that a person needs a certain minimum of good health to get and hold a full-time job.

Cream skimming and the resulting loss of coverage or increase in cost to residual groups can be avoided by requiring pooling: each plan has to have certain basic provisions and to accept all comers. A nationalized system does this automatically, enrolling everyone into the same pool at birth.

ANSWERS TO EXERCISES FOR CHAPTER 12

1. Of course, many schemes are possible. Here is one that maintains the same basic structure as the book example (in which the farmer gets $2,000 in a bad year but pays $2,000 in a good year): If the farmer has to pay his

neighbor \$428.71 to acquire this "insurance policy," then the farmer's expected utility is held constant:

$$0.5\sqrt{5{,}000 - 428.71 + 2{,}000} + 0.5\sqrt{15{,}000 - 428.71 - 2{,}000}$$
$$= 0.5\sqrt{6{,}571.29} + 0.5\sqrt{12{,}571.29}$$
$$= 96.59$$

The neighbor's expected utility is

$$0.5\sqrt{10{,}000 + 428.71 - 2{,}000} + 0.5\sqrt{10{,}000 + 428.71 + 2{,}000}$$
$$= 0.5\sqrt{8{,}428.71} + 0.5\sqrt{12{,}428.71}$$
$$= 101.65$$

which is above the 100 he gets on his own.

2. As in the text example, the firm has to pay the manager a bonus equal to \$250,000 if the process is successful. If high effort is induced, the expected bonus payment is 0.8 × \$250,000 = \$200,000.

   The bonus system thus gives the firm an expected net profit of 0.8 × \$400,000 – \$200,000 = \$120,000. Alternatively, the firm could pay the manager \$100,000 and settle for low effort (and a 0.6 probability of success). Doing so gives it an expected net profit of 0.6 × \$400,000 – \$100,000 = \$140,000.

3. (a) To achieve separation, the incentive compatibility conditions are:

   Qualified workers: $100 - 0.5n^2 > 10$, so $n^2 < 180$, or $n \leq 13$

   Unqualified workers: $10 > 100 - n^2$, or $n^2 > 90$, or $n \geq 10$

   With separation, the qualified get an income of 100 but pay a cost of $0.5(10^2) = 50$ for education, so they get a payoff of 100 – 50 = 50. The unqualified get a payoff of 10.

   (b) If the signal is not available, then every worker is treated like a random draw from the population. The expected output on a good job is

   $$0.6(100) + 0.4(0) = 60$$

   On a bad job, the expected output is 10. Therefore, good jobs will offer 60 and everyone will take them. Bad jobs will go unfilled. Both sides fare better in this case when the signal is unavailable.

4. (a) To casual users, Mictel offers to sell a low-end machine for a price of 4. The firm makes a profit of 3 by doing so; it would make only 2 by selling this user a high-end machine. To intensive users, Mictel offers to sell a high-end machine for a price of 8. The firm makes a profit of 5 by doing so; it would make only 4 by selling this user a low-end machine. The firm's total profit is thus $3c + (1 - c)5 = 5 - 2c$.

   (b) If producing only low-end machines, Mictel can either set $x = 4$ and sell to everybody (earning a profit of 3), or it can set $x = 5$ and sell only to intensive users (earning a profit of $(1 - c)4$). The higher price produces a larger profit when $(1 - c)4 > 3$. Thus, when $c < 1/4$, the firm sets $x = 5$; for $c > 1/4$, $x = 4$.

   (c) If producing only high-end machines, Mictel either sets $y = 5$ and sells to everybody (earning a profit of 2), or sets $y = 8$ and sells only to intensive users (earning a profit of $(1 - c)5$). The higher price produces a larger profit when $(1 - c)5 > 2$. Thus, when $c < 3/5$, the firm sets $y = 8$; for $c > 3/5$, $y = 5$.

   (d) The incentive compatibility constraints are:

   For casual users: $4 - x > 5 - y$, which simplifies to $y - x > 1$

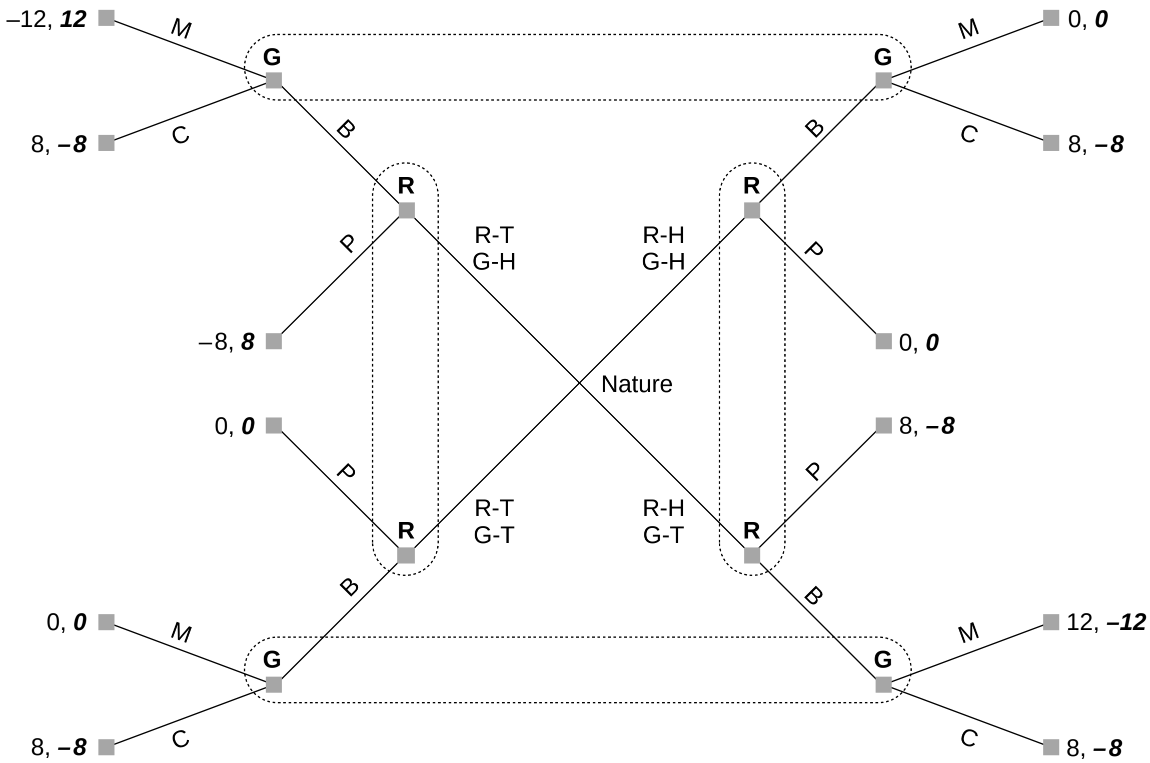
   For intensive users: $8 - y > 5 - x$, which simplifies to $y - x < 3$

   If Mictel wants to separate its customers (and sell to both types), it sets $x = 4$ and can't set y above 7. If $y > 7$, the intensive users would switch to buying the low-end machine. Mictel's profit in this case is $3c + 4(1 - c) = 4 - c$.

   (e) In the absence of perfect knowledge, we have described five pricing schemes that Mictel could use. The profit each earns is 3, $(1 - c)4$, 2, $(1 - c)5$, and $4 - c$.

   Clearly, only the last two would be used. Equating those profit formulas shows that, for c < 1/4, Mictel does best by selling only high-end computers at a price of 8. (If it sold low-end computers to casual users, it would have to drop its high-end price to 7, which reduces its profit when $c < 1/4$.) When $c > 1/4$, Mictel does best by selling both types of computers with the low-end priced at 4 and the high-end priced at 7. Note that Mictel's profit using this system is less than the $5 - 2c$ it would earn if it could costlessly identify everybody's type.

5. (a)



Payoffs are always shown in the order (**R, G**).

(b) The table at the top of the next page shows how the expected payoffs are computed. For an example of how the entries are computed, consider that if Rosencrantz uses strategy BP, and Guildenstern uses MC, and the coin tosses are: (i) HH, then R bets, G matches, and R gets 0; (ii) HT, then R bets, G concedes, and R gets 8; (iii) TH, then R passes and gets –8; (iv) TT, then R passes and gets 0. Each of these four outcomes is equally likely, so the expected payoff is (1/4)(0 + 8 – 8 + 0) = 0.

(c) Rosencrantz's strategies PP and PB are dominated. Guildenstern's strategies CC and CM are dominated. The resulting payoff table is:

		GUILDENSTERN		
		MM	*MC*	*g-mix*
ROSENCRANTZ	BB	0	1	1 – *q*
	BP	1	0	*q*
	p-mix	1 – *p*	*p*	

In the mixed-strategy equilibrium, Rosencrantz plays each of BB and BP with probability 0.5, and Guildenstern plays each of MM and MC with probability 0.5. In other words, Rosencrantz always Bets when he tosses Heads, and Bets with probability 0.5 when he tosses Tails. Given that Rosencrantz has Bet, Guildenstern always Matches when he tosses Heads, and Matches with probability 0.5 when he tosses Tails.

(d) Rosencrantz's decision may reveal information (whether he tossed Heads or Tails), and he has an advantage when he tosses Heads. If Rosencrantz always Bets when he tosses Heads and always Passes on Tails, Guildenstern can defend optimally, and the subgame-perfect equilibrium outcome then has an expected payoff of 0 (to R). Fully revealing his coin toss thus limits Rosencrantz's winnings. Rosencrantz must sometimes (but not always) Bet when he tosses Tails in order to avoid exploitation. Using this strategy allows him to (partly) conceal his private information; this is signal jamming, or bluffing.

6. See the Discussion Topic, pages 207–210.

7. Yes, the act of throwing away two years can demonstrate a commitment to a business career. Stanford admits only smart people, but a corporation could also presumably determine who was smart. What a corporation may be unable to determine is how committed a person is to a business career (since all job applicants will claim to have such a commitment).

R's play after		G's play after		Rosencrantz's payoff with toss				Rosencrantz's expected payoff
H	T	H	T	HH	HT	TH	TT	
P	P	C	C	0	8	–8	0	0
P	P	M	M	0	8	–8	0	0
P	P	M	C	0	8	–8	0	0
P	P	C	M	0	8	–8	0	0
B	B	C	C	8	8	8	8	8
B	B	M	M	0	12	–12	0	0
B	B	M	C	0	8	–12	8	1
B	B	C	M	8	12	8	0	7
B	P	C	C	8	8	–8	0	2
B	P	M	M	0	12	–8	0	1
B	P	M	C	0	8	–8	0	0
B	P	C	M	8	12	–8	0	3
P	B	C	C	0	8	8	8	6
P	B	M	M	0	8	–12	0	–1
P	B	M	C	0	8	–12	8	1
P	B	C	M	0	8	8	0	4

A corporation will be willing to pay more to hire a highly committed person. This is because a more-committed applicant is (a) likely to work harder when hired and (b) not likely to shift careers after the business has trained him or her (at a substantial cost to the firm). In order to be labeled highly committed, a person needs to take an action that only those who are committed will take. Somebody who plans to stay in the business field will be willing to devote two years to an M.B.A. because (a) spending two years learning about business will be relatively less painful to somebody very interested in business and (b) the future returns (which last only as long as the person stays in business) will eventually be large enough to outweigh the immediate cost.

Now consider somebody who has (private) doubts about a career in business. He may well (a) consider learning about business more costly and (b) expect that his future returns from an M.B.A. degree (which will extend only over a short time period if he decides to change professions) may not offset the immediate cost of earning the degree. Thus, those who are committed to a business career are more willing to accept the immediate cost of getting an M.B.A. And, since the less-committed types do not find it in their own interest to pay the cost needed to acquire the M.B.A. label, corporations are willing to pay M.B.A.s higher salaries.

8. The most obvious actions include the gentleman's trying to signal "great cook" or "romantic" or "sophisticated" by serving a great dinner and cappuccino with dessert, the gentleman's trying to signal-jam by faking noises of a cappuccino machine, and the lady friends attempting to screen by asking to see the machine. The gentleman's false signal will be discovered (and the screen will be successful) if the lady friend enters the kitchen and finds instant cappuccino. The lady friend may, of course, attribute other positive attributes to the gentleman's attempts to sound like a cappuccino machine.
9. The student knows the true probability p. If he answers x, his expected payoff is $F(x) = p \log(x) + (1 - p) \log(1 - x)$. To maximize this, we need $F'(x) = p/x - (1 - p)/(1 - x) = 0$ which implies $x = p$. Truthful revelation is optimal for everyone no matter what the true value of p.

ADDITIONAL EXERCISES WITH ANSWERS

1. In a poker game, *bluffing* means betting as though one has a good combination of cards in one's hand when one really doesn't. Bluffing has an obvious disadvantage; if your opponent isn't scared out of the game, your increased bet may lead to an increased loss. Bluffing also has two possible advantages. Describe them both. Relate bluffing to the topics of this chapter.

   ANSWER If bluffing causes the other players to drop out of the game, it allows you to win with a weak hand. Also, when you have a good hand and the other players know that you sometimes bluff, you may be able to increase your bet without leading the other players to drop. When you hold a good hand, therefore, your past bluffing may allow you to win more than you would have otherwise. The goal of bluffing is to mislead your opponent about the strength of your hand (your hidden information), or at least to make it difficult for the opponent to infer your strength.

2. In 1971, the jazz-rock group Blood Sweat and Tears hit number 32 on the *Billboard* pop chart with a song that had the following chorus:

   Go down gamblin'
   Say it when you're running low.
   Go down gamblin'
   You may never have to go,
   No, no, no, no.

   Use a strategic perspective to interpret the song's advice.

   ANSWER A person who trails in a contest should adopt a strategy that makes the outcome more uncertain; doing so increases the chance that he'll be able to catch up.

3. Consider a world in which there are two rival species—*A* and *B*. Some proportion of species *A* is weak; the rest is strong. There is some feature that all strong *A*'s naturally possess; at some cost to himself, a weak *A* can also display this feature.

   Each member of *A* chooses whether to challenge a member of *B* for valuable territory. Strong *A*s always challenge. If the *B* player fights back, a strong *A* wins the fight, and a weak *A* (whether displaying or not) loses. A *B* player cannot tell the difference between a strong *A* and a displaying weak *A* merely from observation.

   A weak *A* in this scenario has to make a decision [back down or (display and) challenge], and a *B* player that is challenged also has to make a decision (fight or retreat). Two critical factors influence the behavior of weak *A*s and of *B*s—the cost to a weak *a* of displaying, and the proportion of *A*s who are weak. Depending on these factors, a weak *A* will always, sometimes, or never (display and) challenge, and a *B* will always, sometimes, or never fight.

   Each square in the following table represents a combination of the two critical factors.

	High cost of displaying	Low cost of displaying
Small proportion of weak *A* s	I	II
Large proportion of weak *A* s	III	IV

   Complete the following. The pooling equilibrium in which weak *A*s always (display and) challenge and *B*s always retreat is found in square _____.

   (a) I
   (b) II
   (c) III
   (d)IV

   ANSWER (b)