Chapter 17
Markets With Asymmetric Information

■ Teaching Notes

This chapter explores different situations in which one party knows more than the other; i.e., there is asymmetric information. Section 17.1 discusses the famous "lemons" problem where the seller has more information than the buyer, and the cases of insurance and credit markets where the buyer has more information. The issue of adverse selection is highlighted. Section 17.2 discusses market signaling as a mechanism to deal with the problem of asymmetric information. Section 17.3 discusses moral hazard where one party has more information about his or her behavior than does the other party. Section 17.4 discusses the principal-agent problem, and Section 17.5 extends the analysis to the case of an integrated firm. Both sections address the issue of differing goals between owners and managers. Section 17.6 examines efficiency wage theory.

You might introduce asymmetric information by reminding students that virtually every topic covered in the course has assumed perfect information. For example, except for Chapter 5 and sections of Chapter 15, we have assumed perfect knowledge of the future (no uncertainty). In models of uncertainty, consumers and producers play "games against nature." In models of asymmetric information, they are playing games against each other.

Many students are likely to have bought or sold a used car and will therefore find the lemons model interesting. You could start your presentation by asking the sellers of used cars how they determined their asking price and whether they thought they received a fair price when they sold their vehicle. Emphasize the intuition of the model before presenting Figure 17.1. If they have understood the model, they should realize why they might have gotten less for their car than they thought it was worth. You can ask how a seller can convince a buyer that his used car is of high quality. See if students can come up with strategies such as encouraging the buyer to have the car inspected by a mechanic. You could also ask why some car ads indicate that the used car is a "one-owner" car. If they have trouble with that question, ask whether it would matter to them as potential buyers if they found out a car had been sold a number of times before.

The market for insurance is also one with which most students are familiar. Although car insurance is required in many states, liability limits may vary from policy to policy. Discuss how risk-averse individuals will want to purchase policies with higher limits but so will people who think they are more likely to have accidents. Ask how insurance companies determine the riskiness of insuring a particular driver. If you have used the example of buying a house in Chapter 15, you may extend it here by considering how bankers determine whether borrowers will default on their home loans.

When discussing market signaling, point out the dual function of education (as training and as a signal of higher productivity). The "Simple Model of Job Market Signaling," is presented in Section 17.2. When you cover Figure 17.2, explain how educational degrees lead to discontinuities, and stress the relationship between degrees, guarantees, and warranties of educational quality.

Moral hazard is an easy concept to illustrate with examples, but it is important to draw a clear distinction between adverse selection and moral hazard. For example, consider someone who buys homeowner's insurance. The adverse selection problem is that a greater proportion of people who believe their homes

are likely to suffer damage will want to buy insurance than people who think it is unlikely their homes will suffer damage. Thus insurance companies will find that the homes they insure are more likely than average to be damaged. The moral hazard problem is that once people have homeowner's insurance, they are less vigilant in protecting their homes from damage. This is true regardless of whether the home was originally more or less likely to suffer damage. The ownership of insurance itself changes the probability of damage because it changes people's behavior.

The principal-agent problem is presented in the context of the relationship between employer and employee and between managers and owners. It can be generalized to the relationship between a regulator and a regulated firm and to the relationship between voters and elected officials.

In discussing the problems of monitoring agents, you can introduce the concept of transactions costs if you have not done so previously. The most interesting topic of this section (I think) is how to design contracts to provide the proper incentives for agents to perform in the interest of the principal. The starred Section 17.5 extends this topic to managerial incentives in an integrated firm; that is, a firm consisting of several divisions, each with its own managers. The model can be applied to government contracts, e.g., defense contracts, for a discussion of cost-plus contracting.

The shirking model of efficiency wages is conceptually difficult. After discussing efficiency in Chapter 16, students might wonder what is so efficient about paying workers a wage that is greater than the value of their marginal product. Stress the role of asymmetric information here: firms have imperfect information about individual worker productivity. You might find it helpful to read the references in Footnote 20. While Yellen's article is concise, Stiglitz's is more general, discussing shirking on page 20 and the relationship between efficiency wage theory and unemployment on pages 33–37.

■ Questions for Review

1. **Why can asymmetric information between buyers and sellers lead to market failure when a market is otherwise perfectly competitive?**

   Asymmetric information leads to market failure because the transaction price does not reflect either the marginal benefit to the buyer or the marginal cost of the seller. The competitive market fails to achieve an output with a price equal to marginal cost. In some extreme cases, if there is no mechanism to reduce the problem of asymmetric information, the market collapses completely. For example, in the used car case buyers do not know for sure if they will be getting a high or low quality car, and as a result they tend to be willing to pay less for a car than high quality owners are willing to accept. As a result, not many high quality cars will be offered for sale and this leads to market failure.

2. **If the used car market is a "lemons" market, how would you expect the repair record of used cars that are sold to compare with the repair record of those not sold?**

   In the market for used cars, the seller has a better idea of the quality of the used car than does the buyer. The repair record of a used car is one indicator of its quality. We would expect that, at the margin, cars with good repair records would be kept while cars with poor repair records would be sold. Thus, you would expect repair records of used cars that are sold to be worse than those of used cars not sold, i.e., kept by owners.

3. **Explain the difference between adverse selection and moral hazard in insurance markets. Can one exist without the other?**

   In insurance markets, both adverse selection and moral hazard exist. Adverse selection refers to the self-selection of individuals who purchase insurance policies. That is, people who are less risky than average will, at the margin, choose not to insure, while people more risky than the population as a whole will choose to insure. As a result, the insurance company is left with a riskier pool of

policy holders. The problem of moral hazard occurs after the insurance is purchased. Once insurance is purchased, less risky individuals might engage in behavior characteristic of more risky individuals. If policy holders are fully insured, they have little incentive to avoid risky situations.

An insurance firm may reduce adverse selection, without reducing moral hazard, and vice versa. Collecting information such as a medical history to determine the riskiness of a *potential* customer helps insurance companies reduce adverse selection. Insurance companies also reevaluate premiums (sometimes canceling policies) when many claims are made, thereby reducing moral hazard. Copayments also reduce moral hazard by creating a disincentive for policyholders to engage in risky behavior.

4. Describe several ways in which sellers can convince buyers that their products are of high quality. Which methods apply to the following products: Maytag washing machines, Burger King hamburgers, large diamonds?

Some sellers signal the quality of their products to buyers through (1) investment in a good reputation, (2) the standardization of products, (3) certification (e.g., the use of educational degrees in the labor market), (4) guarantees, and (5) warranties. Maytag signals the high quality of its washing machines by offering one of the best warranties in the market. Burger King relies on the standardization of its hamburgers, e.g., the Whopper. The sale of a large diamond is accompanied by a certificate that verifies the weight and shape of the stone and discloses any flaws.

5. Why might a seller find it advantageous to signal the quality of a product? How are guarantees and warranties a form of market signaling?

Firms producing high-quality products would like to charge higher prices, but to do this successfully, potential consumers must be made aware of the quality differences among brands. One method of providing product quality information is through guarantees (i.e., the promise to return what has been given in exchange if the product is defective) and warranties (i.e., the promise to repair or replace if defective). Since low-quality producers are unlikely to offer costly signaling devices, consumers can correctly view a guarantee or an extensive warranty as a signal of high quality, thus confirming the effectiveness of these measures as signaling devices.

6. Joe earned a high grade point average during his four years of college. Is this achievement a strong signal to Joe's future employer that he will be a highly productive worker? Why or why not?

Yes, for the most part a high grade point average is a strong signal to the employer that the employee will perform at an above-average level. Regardless of what he actually learned, it indicates that Joe is able to outperform the majority of students. On the other hand, Joe could have padded his schedule with easy classes, and/or classes taught by easy professors.

7. Why might managers be able to achieve objectives other than profit maximization, which is the goal of the firm's shareholders?

It is difficult and costly for shareholders (the firm's owners) to constantly monitor the actions of the firm's managers, so managers' behavior is never scrutinized 100% of the time. Therefore, managers have some leeway to pursue their own objectives and not just profit maximization.

8. How can the principal-agent model be used to explain why public enterprises, such as post offices, might pursue goals other than profit maximization?

Managers of public enterprises can be expected to act in much the same way as managers of private enterprises, in terms of having an interest in power and other perks, in addition to profit maximization. The problem of overseeing a public enterprise is one of asymmetric information. The manager (agent) is more familiar with the cost structure of the enterprise and the benefits to the customers than the

principal, an elected or appointed official, who must elicit cost information controlled by the manager. The costs of eliciting and verifying the information, as well as independently gathering information on the benefits provided by the public enterprise, can be more than the difference between the agency's potential net returns ("profits") and realized returns. This difference provides room for slack, which can be distributed to the management as personal benefits, to the agency's workers as greater-than-efficient job security, or to the agency's customers in the form of greater-than-efficient provision of goods or services.

9. Why are bonus and profit-sharing payment schemes likely to resolve principal-agent problems, whereas a fixed-wage payment will not?

With a fixed wage, the agent-employee has no incentive to maximize productivity. If the agent-employee is hired at a fixed wage equal to the marginal revenue product of the average employee, there is no incentive to work harder than the least productive worker. Bonus and profit-sharing schemes involve a lower fixed wage than fixed-wage schemes, but they include a bonus wage. The bonus can be tied to the profitability of the firm, to the output of the individual employee, or to that of the group in which the employee works. These schemes provide a greater incentive for agents to maximize the objective function of the principal.

10. What is an efficiency wage? Why is it profitable for the firm to pay it when workers have better information about their productivity than firms do?

An efficiency wage, in the context of the shirking model, is the wage at which no shirking occurs. If employers cannot monitor employees' productivity, then employees may shirk (work less productively), which will affect the firm's output and profits. It therefore pays the firm to offer workers a higher-than-market wage, thus reducing the workers' incentive to shirk, because they know that if they are fired and end up working for another firm, their wage will fall. Firms may also pay efficiency wages in order to reduce turnover among employees. If employees are paid a higher wage, all else the same, they will tend to be happier at their jobs and less likely to leave and find new jobs. High turnover rates can be costly for the firm in terms of having to continually train new employees.

■ Exercises

1. Many consumers view a well-known brand name as a signal of quality and will pay more for a brand-name product (e.g., Bayer aspirin instead of generic aspirin, Birds Eye frozen vegetables instead of the supermarket's own brand). Can a brand name provide a useful signal of quality? Why or why not?

A brand name can provide a useful signal of quality for several reasons. First, when information asymmetry is a problem, one solution is to create a "brand-name" product. Standardization of the product produces a reputation for a given level of quality that is signaled by the brand name. Second, if the development of a brand-name reputation is costly (i.e., advertising, warranties, etc.), the brand name is a signal of higher quality. Finally, pioneer products, by virtue of their "first-mover" status, enjoy consumer loyalty if the products are of acceptable quality. The uncertainty surrounding newer products inhibits defection from the pioneering brand-name product.

2. Gary is a recent college graduate. After six months at his new job, he has finally saved enough to buy his first car.

a. Gary knows very little about the differences between makes and models. How could he use market signals, reputation, or standardization to make comparisons?

Gary's problem is one of asymmetric information. As a buyer of a first car, he will be negotiating with sellers who know more about cars than he does. His first choice is to decide between a new or

used car. If he buys a used car, he must choose between a professional used-car dealer and an individual seller. Each of these three types of sellers (the new-car dealer, the used-car dealer, and the individual seller) uses different market signals to convey quality information about their products.

The new-car dealer, working with the manufacturer (and relying on the manufacturer's reputation) can offer standard and extended warranties that guarantee the car will perform as advertised.

Because few used cars carry a manufacturer's warranty, and because the used-car dealer is not intimately familiar with the condition of the cars on his or her lot (because of their wide variety and disparate previous usage), it is not in his or her self-interest to offer extensive warranties. The used-car dealer, therefore, must rely on reputation, particularly on a reputation of offering "good values." Since the individual seller neither offers warranties nor relies on reputation, purchasing from such a seller could make it advisable to seek additional information from an independent mechanic or from reading the used-car recommendations in *Consumer Reports*. Given his lack of experience, Gary should gather as much information about these market signals, reputation, and standardization as he can afford.

b. You are a loan officer in a bank. After selecting a car, Gary comes to you seeking a loan. Because he has only recently graduated, he does not have a long credit history. Nonetheless, the bank has a long history of financing cars for recent college graduates. Is this information useful in Gary's case? If so, how?

The bank's problem in lending money to Gary is also one of asymmetric information. Gary has a much better idea than the bank about the quality of the car and his ability to pay back the loan. While the bank can learn about the car through the reputation of the manufacturer and through inspection (if it is a used car), the bank has little information on Gary's ability to handle credit. Therefore, the bank must infer information about Gary's credit worthiness from easily available information, such as his recent graduation from college, how much he borrowed while in school, and the similarity of his educational and credit profile to that of college graduates currently holding car loans from the bank. If recent graduates have built a good reputation for paying off their loans, Gary can use this reputation to his advantage, but poor repayment patterns by this group will lessen his chances of obtaining a car loan from this bank.

3. A major university bans the assignment of D or F grades. It defends its action by claiming that students tend to perform above average when they are free from the pressures of flunking out. The university states that it wants all its students to get A's and B's. If the goal is to raise overall grades to the B level or above, is this a good policy? Discuss this policy with respect to the problem of moral hazard.

By eliminating the lowest grades, the university creates a moral hazard problem similar to that which is found in insurance markets. Since they are protected from receiving a low grade, some students will have little incentive to work at above-average levels. The policy only addresses the pressures facing below-average students, i.e., those who flunk out. Average and above-average students do not face the pressure of failing. For these students, the pressure of earning top grades (instead of learning a subject well) remains. Their problems are not addressed by this policy. Therefore, the policy creates a moral hazard problem primarily for the below-average students who are its intended beneficiaries.

4. Professor Jones has just been hired by the economics department at a major university. The president of the Board of Regents has stated that the university is committed to providing top-quality education for undergraduates. Two months into the semester, Jones fails to show up for his classes. It seems he is devoting all his time to research rather than to teaching. Jones argues

that his research will bring prestige to the department and the university. Should he be allowed to continue exclusively with research? Discuss with reference to the principal-agent problem.

The Board of Regents and its president can be thought of as the principals of the university, while faculty are the agents. The dual purpose of most universities is teaching students and producing research, and most faculty are hired to perform both tasks.

The problem is that teaching effort can be easily monitored (particularly if Jones does not show up for class), while the benefits of establishing a prestigious research reputation are uncertain and are realized only over time. While the quantity of research is easy to see, determining research quality is more difficult. The university should not simply take Jones' word regarding the benefits of his research and allow him to continue exclusively with his research without altering his payment scheme. One alternative would be to tell Jones that he does not have to teach if he is willing to accept a lower salary. On the other hand, the university could offer Jones a bonus if, due to his research reputation, he is able to bring prestige to the department and university, particularly if this results in a lucrative grant or donations to the university.

5. Faced with a reputation for producing automobiles with poor repair records, a number of American companies have offered extensive guarantees to car purchasers (e.g., a seven-year warranty on all parts and labor associated with mechanical problems).

a. In light of your knowledge of the lemons market, why is this a reasonable policy?

At one time, American companies enjoyed a reputation for producing high-quality cars. More recently, faced with competition especially from Japanese car manufacturers, their products appeared to customers to be of lower quality. As this reputation spread, customers were less willing to pay high prices for American cars. To reverse this trend, American companies invested in quality control, improving the repair records of their products. Consumers, however, still considered American cars to be of lower quality (lemons, in some sense), and would not buy them, American companies were forced to signal the improved quality of their products to their customers. One way of providing this information is through improved warranties that directly address the issue of poor repair records. This was a reasonable reaction to the "lemons" problem that they faced.

b. Is the policy likely to create a moral hazard problem? Explain.

Moral hazard occurs when the insured party (here, the owner of an American automobile with an extensive warranty) can influence the probability of the event that triggers payment (the repair of the automobile). The coverage of all parts and labor associated with mechanical problems reduces the incentive to maintain the automobile. Hence, a moral hazard problem is created by the offer of extensive warranties. To avoid this problem, manufacturers often stipulate that their warranties will not be honored unless the owner has all recommended routine maintenance done and has proof that the maintenance was performed.

6. To promote competition and consumer welfare, the Federal Trade Commission requires firms to advertise truthfully. How does truth in advertising promote competition? Why would a market be less competitive if firms advertised deceptively?

Truth in advertising promotes competition by providing the information necessary for consumers to make optimal decisions. Competitive forces function properly only if consumers are aware of all prices (and qualities), so comparisons may be made. In the absence of truthful advertising, buyers are unable to make these comparisons because goods priced identically can be of different quality. Hence there will be a tendency for buyers to stick with proven products, reducing competition between existing firms and discouraging entry. Note that monopoly rents may result when consumers stick with proven products.

7. An insurance company is considering issuing three types of fire insurance policies: (i) complete insurance coverage, (ii) complete coverage above and beyond a $10,000 deductible, and (iii) 90% coverage of all losses. Which policy is more likely to create moral hazard problems?

Moral hazard problems arise with fire insurance when the insured party can influence the probability of a fire and the magnitude of loss from a fire. The property owner can engage in behavior that reduces the probability of a fire by, for example, inspecting and replacing faulty wiring, and by making sure oily rags and other flammable items are not stored indoors. The magnitude of losses can be reduced by the installation of fire extinguishers and warning systems like smoke alarms and by the storage of valuables away from areas where fires are likely to start.

After purchasing complete insurance, the insured has little incentive to reduce either the probability or the magnitude of the loss, and the moral hazard problem will be worst with this coverage. In order to compare a $10,000 deductible to 90% coverage, we would need information on the value of the potential loss. Both policies reduce the moral hazard problem posed by complete coverage. If the property is worth less (more) than $100,000, the total loss to the owner will be less (more) with 90% coverage than with the $10,000 deductible. So, for example, if the value of the property is above $100,000, the owner is more likely to engage in fire prevention efforts under the policy that offers 90% coverage than under the one that offers the $10,000 deductible.

8. You have seen how asymmetric information can reduce the average quality of products sold in a market, as low-quality products drive out high-quality products. For those markets in which asymmetric information is prevalent, would you agree or disagree with each of the following? Explain briefly:

a. The government should subsidize *Consumer Reports*.

Asymmetric information implies unequal access to information by either buyers or sellers, a problem that leads to inefficient markets or market collapse. Encouraging the gathering and publishing of information can be advantageous in general because it helps consumers make better decisions and promotes honesty on the part of sellers. It is not clear, however, that subsidizing *Consumer Reports* would be appropriate. Currently, people who find the information useful pay for it, and those who do not want the information (perhaps because they can judge the quality of products themselves) do not have to pay for it. If *Consumer Reports* were subsidized, everyone would pay for it. Also, if the government subsidized it, the government might require it to use particular quality tests or treat U.S. manufacturers differently from foreign manufacturers, compromising the magazine's objectivity. Note, though, that the government does provide an indirect subsidy to the publication; it has granted Consumers Union (the publisher of *Consumer Reports*) nonprofit status.

b. The government should impose quality standards—e.g., firms should not be allowed to sell low-quality items.

This is a bad idea. First of all, some people prefer low-quality goods if they are sufficiently inexpensive. Banning low-quality goods would reduce consumers' choices and reduce utility. Secondly, after imposing quality standards, the government would have to monitor the quality of all items sold, and this would be very costly.

c. The producer of a high-quality good will probably want to offer an extensive warranty.

Agree. This option provides the least-cost solution to the problems of asymmetric information. It allows the producer to distinguish its product from low-quality goods because it is more costly for the low-quality producer to offer an extensive warranty than for the high-quality producer to offer one.

d. The government should require *all* firms to offer extensive warranties.

Disagree. By requiring *all* firms to offer extensive warranties, the government would drive most low-quality products out of the market, because it would be too costly for low-quality producers to service such warranties. The effect is similar to a ban on low-quality products as in part b. Such a requirement would also negate the market signaling value of warranties offered by producers of high-quality goods. Thus, to the extent that some low-quality goods were still being sold, high-quality producers would have a more difficult time signaling the quality of their products.

9. Two used car dealerships compete side by side on a main road. The first, Harry's Cars, always sells high-quality cars that it carefully inspects and, if necessary, services. On average, it costs Harry's $8000 to buy and service each car that it sells. The second dealership, Lew's Motors, always sells lower-quality cars. On average, it costs Lew's only $5000 for each car that it sells. If consumers knew the quality of the used cars they were buying, they would pay $10,000 on average for Harry's cars and only $7000 on average for Lew's cars.

Without more information, consumers do not know the quality of each dealership's cars. In this case, they would figure that they have a 50-50 chance of ending up with a high-quality car, and are thus willing to pay $8500 for a car.

Harry has an idea: He will offer a bumper-to-bumper warranty for all cars he sells. He knows that a warranty lasting *Y* years will cost $500*Y* on average, and he also knows that if Lew tries to offer the same warranty, it will cost Lew $1000*Y* on average.

a. Suppose Harry offers a one-year warranty on all of the cars he sells.

i. What is Lew's profit if he does not offer a one-year warranty? If he does offer a one-year warranty?

Without offering the warranty, consumers will know that Lew's cars are of low quality, so Lew would make a profit of $2000 per car ($7000 – 5000). If he were to offer the warranty, each car would cost Lew $6000 (including repairs under warranty), but as consumers would then not be able to determine the quality of the cars (since both dealers would offer the same warranty) they will be willing to pay only $8500 for all cars, and Lew's will make $2500 per car ($8500 – 6000).

ii. What is Harry's profit if Lew does not offer a one-year warranty? If he does offer a one-year warranty?

If Lew does not offer a one-year warranty then Harry's can buy its cars for $8000, sell the cars for $10,000, and make a profit of $1500 per car after the $500 warranty cost. If Lew does offer a one-year warranty then Harry's will be able to sell its cars for only $8500, and the company will not make any profit.

iii. Will Lew's match Harry's one-year warranty?

Lew's will match Harry's warranty because, if it does, its profit increases from $2000 to $2500 per car.

iv. Is it a good idea for Harry to offer a one-year warranty?

No. Harry should not offer the one-year warranty unless he thinks that Lew will act irrationally and not offer a one-year warranty. Given that Lew will match the warranty, Harry is better off not offering the warranty.

b. What if Harry offers a two-year warranty? Will this offer generate a credible signal of quality? What about a three-year warranty?

If Harry offers a two-year warranty, each car will cost $9000. Harry will earn $1000 per car, as consumers will recognize the higher quality of its cars. Lew's will not offer a two-year warranty, because if they do, they will earn a profit of only $1500 per car, which is less than the $2000 they would earn without offering the warranty. So the two-year warranty is a credible signal.

With a three-year warranty Harry would be making $500 per car, the same that he would have made had it not signaled the higher quality of its cars with a warranty. Therefore, Harry would not offer a three-year warranty.

c. If you were advising Harry, how long a warranty would you urge him to offer? Explain why.

Harry needs to offer a warranty of sufficient length so that Lew's will not find it profitable to match the warranty, and such that Harry's profit is at least as high as it is without offering a warranty. Let t denote the number of years of the warranty, then Lew's will offer a warranty according to the following inequality:

$$7000 - 5000 \leq 8500 - 5000 - 1000t, \text{ or } t \leq 1.5.$$

Therefore, Harry should offer a 1.5-year warranty on his cars. Lew will not find it profitable to match this warranty, and Harry's profit will be $10,000 − 8000 − 500(1.5) = $1250.

10. As chairman of the board of ASP Industries, you estimate that your annual profit is given by the table below. Profit (Π) is conditional upon market demand and the effort of your new CEO. The probabilities of each demand condition occurring are also shown in the table.

Market Demand	Low Demand	Medium Demand	High Demand
Market Probabilities	0.30	0.40	0.30
Low Effort	Π = $ 5 million	Π = $10 million	Π = $15 million
High Effort	Π = $10 million	Π = $15 million	Π = $17 million

You must design a compensation package for the CEO that will maximize the firm's expected profit. While the firm is risk neutral, the CEO is risk averse. The CEO's utility function is

Utility = $W^{0.5}$ when making low effort

Utility = $W^{0.5}$ – 100 when making high effort

where W is the CEO's income. (The –100 is the "utility cost" to the CEO of making a high effort.) You know the CEO's utility function, and both you and the CEO know all of the information in the preceding table. You do *not* know the level of the CEO's effort at time of compensation or the exact state of demand. You do see the firm's profit, however.

Of the three alternative compensation packages below, which do you as chairman of ASP Industries prefer? Why?

Package 1: Pay the CEO a flat salary of $575,000 per year

Package 2: Pay the CEO a fixed 6% of yearly firm profits

Package 3: Pay the CEO a flat salary of $500,000 per year and then 50% of any firm profits *above* $15 million

The issue here is how to get your CEO to make high effort but not give away too much in profits. For each package, first calculate whether the executive will make high or low effort. Then calculate firm profits under each effort level to determine which package maximizes your profits. The CEO's expected utility under the three packages:

Package 1: The CEO will give low effort to maximize utility:

Low Effort: $E(U) = (\$575{,}000)^{0.5} = 758.29$

High Effort: $E(U) = (\$575{,}000)^{0.5} - 100 = 658.29$.

Package 2: The CEO will give high effort to maximize utility:

Low Effort: $E(U) = 0.3(0.06 \times 5{,}000{,}000)^{0.5} + 0.4(0.06 \times 10{,}000{,}000)^{0.5} + 0.3(0.06 \times 15{,}000{,}000)^{0.5} = 758.76$

High Effort: $E(U) = 0.3[(0.06 \times 10{,}000{,}000)^{0.5} - 100] + 0.4[(0.06 \times 15{,}000{,}000)^{0.5} - 100] + 0.3[(0.06 \times 17{,}000{,}000)^{0.5} - 100] = 814.84$

Package 3: The CEO will give high effort to maximize utility:

Low Effort: $E(U) = 0.3(500{,}000)^{0.5} + 0.4(500{,}000)^{0.5} + 0.3(500{,}000)^{0.5} = 707.11$

High Effort: $E(U) = 0.3[(500{,}000)^{0.5} - 100] + 0.4[(500{,}000)^{0.5} - 100] + 0.3[(1{,}500{,}000)^{0.5} - 100] = 762.40$

The firm's expected profit with each effort level before deducting the CEO's expected compensation is:

Low Effort: $0.30 \times \$5\text{m} + 0.40 \times \$10\text{m} + 0.30 \times \$15\text{m} = \$10\text{m}$

High Effort: $0.30 \times \$10\text{m} + 0.40 \times \$15\text{m} + 0.30 \times \$17\text{m} = \$14.1\text{m}$

Now calculate the firm's expected profit under each package net of expected CEO compensation:

Package 1: Low Effort: $E(\Pi) = \$10\text{m} - \$0.575\text{m} = \$9.425$ million

Package 2: High Effort: $E(\Pi) = \$14.1 - (0.30 \times \$0.6\text{m} + 0.40 \times \$0.9\text{m} + 0.30 \times \$1.02\text{m}) = \$13.254\text{m}$

Package 3: High Effort: $E(\Pi) = \$14.1\text{m} - (0.30 \times \$0.5\text{m} + 0.40 \times \$0.5\text{m} + 0.30 \times \$1.5\text{m}) = \$13.3\text{m}$

To maximize the expected profits of ASP Industries, you should recommend compensation Package 3 that uses a flat salary and then a large bonus when the firm does exceptionally well and makes $17 million. This package is best because it maximizes ASP's expected profit net of compensation – here at a value of $13.3 million.

Notice that if you gave only a huge bonus when the firm did exceptionally well, the CEO's risk aversion might lead him or her to make low effort, or more likely, leave the company to work elsewhere. The flat salary offsets the disincentive effects of a risky but motivating package. This is the usual form of executive compensation. Notice too that compensation is tied to firm profitability.

11. A firm's short-run revenue is given by $R = 10e - e^2$, where e is the level of effort by a typical worker (all workers are assumed to be identical). A worker chooses his level of effort to maximize wage less effort $w - e$ (the per-unit cost of effort is assumed to be 1). Determine the level of effort and the level of profit (revenue less wage paid) for each of the following wage arrangements. Explain why these different principal-agent relationships generate different outcomes.

a. $w = 2$ for $e \geq 1$; otherwise $w = 0$.

There is no incentive for the worker to provide an effort that exceeds 1, as the wage received by the worker will be 2 if the worker provides one unit of effort but will not increase if the worker provides more effort.

The profit for the firm will be revenue minus the wages paid to the worker:

$$\pi = (10)(1) - 1^2 - 2 = \$7.$$

In this principal-agent relationship there is no incentive for the worker to increase his or her effort, as the wage is not related to the revenues of the firm.

b. $w = R/2$.

The worker will maximize the wage net of the effort required to obtain that wage; that is, the worker will maximize:

$$w - e = \frac{10e - e^2}{2} - e, \quad \text{or} \quad 4e - 0.5e^2.$$

To find the maximum effort that the worker is willing to put forth, take the first derivative with respect to effort, set it equal to zero, and solve for effort:

$$\frac{d(4e - 0.5e^2)}{de} = 4 - e = 0, \quad \text{or} \quad e = 4.$$

The wage the worker will receive will be

$$w = \frac{R}{2} = \frac{10(4) - 4^2}{2} = 12.$$

The profits for the firm will be

$$\pi = ((10)(4) - 4^2) - 12 = \$12.$$

With this principal-agent relationship, the wage that the individual worker receives is related to the revenue of the firm. Therefore, we see greater effort on the part of the worker, and as a result, greater profits for the firm.

c. $w = R - 12.5$.

Again, the worker will maximize the wage net of the effort required to obtain that wage; that is, the worker will maximize:

$$w - e = (10e - e^2) - 12.50 - e, \quad \text{or} \quad 9e - e^2 - 12.50.$$

To find the maximum effort that the worker is willing to put forth, take the first derivative with respect to effort, set it equal to zero, and solve for effort:

$$\frac{d(9e - e^2 - 12.50)}{de} = 9 - 2e = 0, \quad \text{or} \quad e = 4.5.$$

The wage the worker will receive is

$$w = R - 12.50 = ((10)(4.5) - 4.5^2) - 12.5 = 12.25.$$

The profits for the firm will be

$$\pi = ((10)(4.5) - 4.5^2) - 12.25 = \$12.50.$$

With this principal-agent relationship, the wage of the worker is more directly related to the performance of the firm than in either a or b. Therefore, compared to the first two wage arrangements, the worker is willing to supply more effort resulting in higher profits for the firm.

12. UNIVERSAL SAVINGS & LOAN has $1000 to lend. Risk-free loans will be paid back in full next year with 4% interest. Risky loans have a 20% chance of defaulting (paying back nothing) and an 80% chance of paying back in full with 30% interest.

a. How much profit can the lending institution expect to earn? Show that the expected profits are the same whether the lending institution makes risky or risk-free loans.

UNIVERSAL SAVINGS & LOAN earns $40 in interest on a risk-free loan and $300 on a risky loan that is paid back. Therefore, expected profits are

Risk-free: $E(\pi) = \$40$ and

Risky: $E(\pi) = 0.80(300) + 0.20(-1000) = \$40$.

b. Now suppose that the lending institution knows that the government will "bail out" UNIVERSAL if there is a default (paying back the original $1000). What type of loans will the lending institution choose to make? What is the expected cost to the government?

Now the expected profit on risky loans is $E(\pi) = 0.80(300) + 0.20(0) = \$240$.

UNIVERSAL is much better off making risky loans because the expected profit of $240 is much greater than the $40 expected profit from risk-free loans.

The cost to the government is $1000 for each loan that defaults, so the expected cost is $0.80(0) + 0.20(1000) = \$200$ per loan.

c. Suppose that the lending institution doesn't know for sure that there will be a bail out, but one will occur with probability *P*. For what values of *P* will the lending institution make risky loans?

UNIVERSAL's expected profit on risky loans is $40 with a bail out and $240 with a bail out. If the probability of a bail out is P, then the probability of no bail out is $1 - P$. Therefore UNIVERSAL's expected profit on risky loans is $240P + 40(1 - P) = 40 + 200P$.

As long as the expected profit on risky loans is greater than on risk-free loans, UNIVERSAL will want to make risky loans. So as long as $40 + 200P > 40$, UNIVERSAL will want to make risky loans. This is true as long as $P > 0$. So as long as there is even a tiny chance (like $P = 0.01$) that the government will bail out the lending institution, UNIVERSAL will make risky loans.