Chapter 19

Contracts and Moral Hazards

The contracts of at least 33 major league baseball players have incentive clauses providing a bonus if that player is named the Most Valuable Player in a Division Series. Unfortunately, no such award is given for a Division Series.[1]

An employee cruises the Internet for jokes instead of working when the boss is not watching. A driver of a rental car takes it off the highway and ruins the suspension. The dentist caps your tooth, not because you need it, but because he wants a new high-definition, flat-screen TV.

Each of these examples illustrates an inefficient use of resources due to a *moral hazard,* whereby an informed person takes advantage of a less-informed person, often through an *unobserved action* (Chapter 18). In this chapter, we examine how to design contracts that *eliminate inefficiencies* due to moral hazard problems *without shifting risk to people who hate bearing risk*—or contracts that at least reach a good compromise between these two goals.

For example, insurance companies face a trade-off between reducing moral hazards and increasing the risk of insurance buyers. Because an insurance company pools risks, it acts as though it is risk neutral (Chapter 16). The firm offers insurance contracts to risk-averse homeowners so that they can reduce their exposure to risk. If homeowners can buy full insurance so that they will suffer no loss if a fire occurs, some of them fail to take reasonable precautions. They might store flammable liquids and old newspapers in their houses, increasing the chance of a catastrophic fire.

A contract that avoids this moral hazard problem specifies that the insurance company will not pay in the event of a fire if the company can show that the policyholders stored flammable materials in their home. If this approach is impractical, however, the insurance company might offer a contract that provides incomplete insurance, covering only a fraction of the damage from a fire. The less complete the coverage, the greater the incentive for policyholders to avoid dangerous activities but the greater the risk that the risk-averse homeowners must bear.

To illustrate methods of controlling moral hazards and the trade-off between moral hazards and risk, we focus in this chapter on contracts between a principal—such as an employer—and an agent—such as an employee. The *principal* contracts with the *agent* to take some *action* that benefits the principal. Until now, we have assumed that firms can produce efficiently. However, if a principal cannot practically monitor an agent all the time, the agent may steal, not work hard, or engage in other opportunistic behavior that lowers productivity.[2]

Opportunistic behavior by an informed agent harms a less-informed principal. Sometimes the losses are so great that both parties would be better off if both had full information and if opportunistic behavior were impossible.

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[1]Tom FitzGerald, "Top of the Sixth," *San Francisco Chronicle,* January 31, 1997:C6.

[2]Sometimes the principal's problem is not so much one of monitoring as one of legally verifying that opportunistic behavior occurred. For example, an insurance company (principal) might be able to determine that the homeowner (agent) engaged in arson but might have trouble proving it.

In this chapter, we examine six main topics

1. **Principal-Agent Problem:** The way that an uninformed principal contracts with an informed agent determines whether moral hazards occur and how risks are shared.
2. **Production Efficiency:** The agent's output depends on the type of contract used and the ability of the principal to monitor the agent's actions.
3. **Trade-Off Between Efficiency in Production and in Risk Bearing:** A principal and an agent may agree to a contract that does not eliminate moral hazards or optimally share risk but strikes a balance between these two objectives.
4. **Payments Linked to Production or Profit:** Employees work harder if they are rewarded for greater individual or group productivity.
5. **Monitoring:** Employees work harder if an employer monitors their behavior and makes it worthwhile for them to keep from being fired.
6. **Contract Choice:** By observing which type of contract an agent picks when offered a choice, a principal may obtain enough information to reduce moral hazards.

19.1 Principal-Agent Problem

When you contract with people whose actions you cannot observe or evaluate, they may take advantage of you. If you pay someone by the hour to prepare your tax return, you do not know whether that person worked all the hours billed. If you retain a lawyer to represent you in a suit arising from an accident, you do not know whether the settlement that the lawyer recommends is in your best interest or the lawyer's.

Of course, many people behave honorably even if they have opportunities to exploit others. Many people also honestly believe that they are putting in a full day's work even when they are not working as hard as they might. Aiko, who manages Pat's Printing Shop, is paid an hourly wage. She works every hour she is supposed to, even though Pat rarely checks on her. Nonetheless, Aiko may not be spending her time as effectively as possible. She politely (but impersonally) asks everyone who enters the shop, "May I help you?" If she were to receive the appropriate financial incentives—say, a share of the shop's profit—she would memorize the names of her customers, greet them enthusiastically by name when they enter the store, and check with nearby businesses to find out whether they would be interested in new services.

A MODEL

We can describe many principal-agent interactions using the following model. This model stresses that the output or profit from this relationship and the risk borne by the two parties depend on the actions of the agent and the state of nature.

In a typical principal-agent relationship, the principal, Paul, owns some property, such as a firm, or has a property right such as the right to sue for damages from an injury. Paul hires or contracts with an agent, Amy, to take some action a that increases the value of his property or that produces profit, π, from using his property.

The principal and the agent need each other. If Paul hires Amy to run his ice-cream shop, Amy needs Paul's shop and Paul needs Amy's efforts to sell ice cream. The profit from the ice cream sold, π, depends on the number of hours, a, that Amy works. The profit may also depend on the outcome of θ, which represents the *state of nature*:

$$\pi = \pi(a, \theta).$$

For example, profit may depend on whether the ice-cream machine breaks, $\theta = 1$, or does not break, $\theta = 0$. Or it may depend on whether it is a hot day, θ = the temperature.

In extreme cases, the profit function depends only on the agent's actions or only on the state of nature. At one extreme, profit depends only on the agent's action, $\pi = \pi(a)$, if there is only one state of nature: no uncertainty due to random events. In our example, the profit function has this form if demand does not vary with weather and if the ice-cream machine is reliable.

At the other extreme, profit depends only on the state of nature, $\pi = \pi(\theta)$, such as in an insurance market in which profit or value depends only on the state of nature and not on the actions of an agent. For instance, a couple buys insurance against rain on the day of their wedding. The value they place on their outdoor wedding ceremony is $\pi(\theta)$, which depends only on the weather, θ, because no actions are involved.

TYPES OF CONTRACTS

A verbal contract isn't worth the paper it's written on. —Samuel Goldwyn

When a formal market exists, the principal may deal impersonally with an anonymous agent by buying a good or service of known quality at the market price. There is no opportunity for opportunism. In this chapter, we focus on situations in which either a formal market does not exist or a principal and an agent agree on a customized contract that is designed to reduce opportunism.

A contract between a principal and an agent determines how the outcome of their partnership (such as the profit or output) is split between them. Three common types of contracts are fixed-fee, hire, and contingent contracts.

In a *fixed-fee contract,* the payment to the agent, F, is independent of the agent's actions, a, the state of nature, θ, or the outcome, π. The principal keeps the *residual profit,* $\pi(a, \theta) - F$. Alternatively, the principal may get a fixed amount and the agent may receive the residual profit. For example, the agent may pay a fixed rent for the right to use the principal's property.[3]

In a *hire contract,* the payment to the agent depends on the agent's actions as they are observed by the principal. Two common types of hire contracts pay employees an *hourly rate*—a wage per hour—or a *piece rate*—a payment per unit of output produced. If w is the wage per hour (or the price per piece of output) and Amy works a hours (or produces a units of output), then Paul pays Amy wa and keeps the residual profit $\pi(a, \theta) - wa$.

In a *contingent contract,* the payoff to each person depends on the state of nature, which may not be known to the parties at the time they write the contract. For example, Penn agrees to pay Alexis a higher amount to fix his roof if it is raining than if it is not.

[3] Jefferson Hope says in the Sherlock Holmes mystery *A Study in Scarlet,* "I applied at a cab-owner's office, and soon got employment. I was to bring a certain sum a week to the owner, and whatever was over that I might keep for myself."

One type of contingent contract is a *splitting* or *sharing contract*, where the payoff to each person is a fraction of the total profit (which is observable). Alain sells Pamela's house for her for $\pi(a, \theta)$ and receives a commission of 7% on the sales price. He receives $0.07\pi(a, \theta)$, and she keeps $0.93\pi(a, \theta)$.

EFFICIENCY

The type of contract selected depends on what the parties can observe. A principal is more likely to use a hire contract if the principal can easily monitor the agent's actions. A contingent contract may be chosen if the state of nature can be observed after the work is completed. A fixed-fee contract does not depend on observing anything, so it can always be used.

Ideally, the principal and agent agree to an efficient contract: an agreement with provisions that ensure that no party can be made better off without harming the other party. Using an efficient contract results in *efficiency in production* and *efficiency in risk sharing*.

Efficiency in production requires that the principal's and the agent's combined value (profits, payoffs), π, is maximized. We say that production is efficient if Amy manages Paul's firm so that the sum of their profits cannot be increased. In our examples, the moral hazard hurts the principal more than it helps the agent, so total profit falls. Thus achieving efficiency in production requires preventing the moral hazard.

Efficiency in risk bearing requires that risk sharing is optimal in that the person who least minds facing risk—the risk-neutral or less-risk-averse person—bears more of the risk. In Chapter 16 we saw that risk-averse people are willing to pay a risk premium to avoid risk, whereas risk-neutral people do not care if they face fair risk or not. Suppose that Arlene is risk averse and is willing to pay a risk premium of $100 to avoid a particular risk. Peter is risk neutral and would bear the risk without a premium. Arlene and Peter can strike a deal whereby Peter agrees to bear *all* of Arlene's risk in exchange for a payment between $0 and $100. For simplicity, we concentrate on situations in which one party is risk averse and the other is risk neutral. (Generally, if both parties are risk averse, with one more risk averse than the other, both can be made better off if the less-risk-averse person bears more but not all of the risk.)

If everyone has full information—there is no uncertainty and no asymmetric information—efficiency can be achieved. The principal contracts with the agent to perform a task for some specified reward and observes whether the agent completes the task properly before paying, so no moral hazard problem arises.

Throughout the rest of this chapter, we examine what happens when the parties do not have full information. Production inefficiency is more likely when either the agent has more information than the principal or both parties are uncertain about the state of nature.

When the agent has more information than the principal and there is no risk because there is only one state of nature, contracts are used to achieve efficiency in production by conveying adequate information to the principal to eliminate moral hazard problems. Alternatively, incentives in the contract may discourage the informed person from engaging in opportunistic behavior. The contracts do not have to address efficiency in risk bearing because there is no risk.

Given that they face both asymmetric information and risk, the parties try to contract to achieve efficiency in production and efficiency in risk bearing. Often, however, both objectives cannot be achieved, so the parties must trade off between them.

19.2 Production Efficiency

The type of contract that an agent and principal use affects production efficiency. In the following example, production efficiency is achieved by maximizing *total* or *joint profit:* the sum of the principal's and the agent's individual profits. To isolate the production issues from risk bearing, we initially assume that there is only one state of nature, so the parties face no risk due to random events: Total profit, $\pi(a)$, is solely a function of the agent's action, a.

EFFICIENT CONTRACT

To be efficient and to maximize joint profit, the contract that a principal offers to an agent must have two properties. First, the contract must provide a large enough payoff that the agent is willing to *participate* in the contract. We know that the principal's payoff is adequate to ensure the principal's participation because the principal offers the contract.

Second, the contract must be incentive compatible in that it provides inducements such that the agent wants to perform the assigned task rather than engage in opportunistic behavior. That is, it is in the agent's best interest to take an action that maximizes joint profit. If the contract is not incentive compatible—so the agent tries to maximize personal profit rather than joint profit—efficiency can be achieved only if the principal monitors the agent and forces the agent to act so as to maximize joint profit.

We use an example to illustrate why some types of contracts lead to efficiency and others do not. Paula, the principal, owns a store called Buy-A-Duck (located near a canal) that sells wood carvings of ducks. Arthur, the agent, manages the store. Paula and Arthur's joint profit is

$$\pi(a) = R(a) - ma, \tag{19.1}$$

where $R(a)$ is the sales revenue from selling a carvings, and ma is the cost of the carvings. Arthur has a constant marginal cost m to obtain and sell each duck, including the amount he pays a local carver and the opportunity value (best alternative use) of his time.

Because Arthur bears the full marginal cost of selling one more carving, he wants to sell the joint-profit-maximizing output only if he also gets the full marginal benefit from selling one more duck. To determine the joint-profit-maximizing solution, we can ask what Arthur would do if he owned the shop and received all the profit, giving him an incentive to maximize total profit.

How many ducks must Arthur sell to maximize the parties' joint profit, Equation 19.1? To obtain the first-order condition to maximize profit, we set the derivative of Equation 19.1 equal to zero:

$$\frac{d\pi(a)}{da} = \frac{dR(a)}{da} - m = 0. \tag{19.2}$$

According to Equation 19.2, joint profit is maximized by choosing the number of ducks to sell, a, such that marginal revenue, $dR(a)/da$, equals marginal cost, m.

Suppose, for example, that $m = 12$, the inverse demand curve they face is $p = 24 - \frac{1}{2}a$, and hence the revenue function is $R(a) = 24a - \frac{1}{2}a^2$. The marginal revenue function is $MR(a) = dR(a)/da = 24 - a$. Substituting the marginal revenue function and the marginal cost into Equation 19.2, we find that $MR = 24 - a = 12 = m = MC$, or $a = 12$. Panel a of Figure 19.1 illustrates this result: The marginal revenue curve, MR, intersects

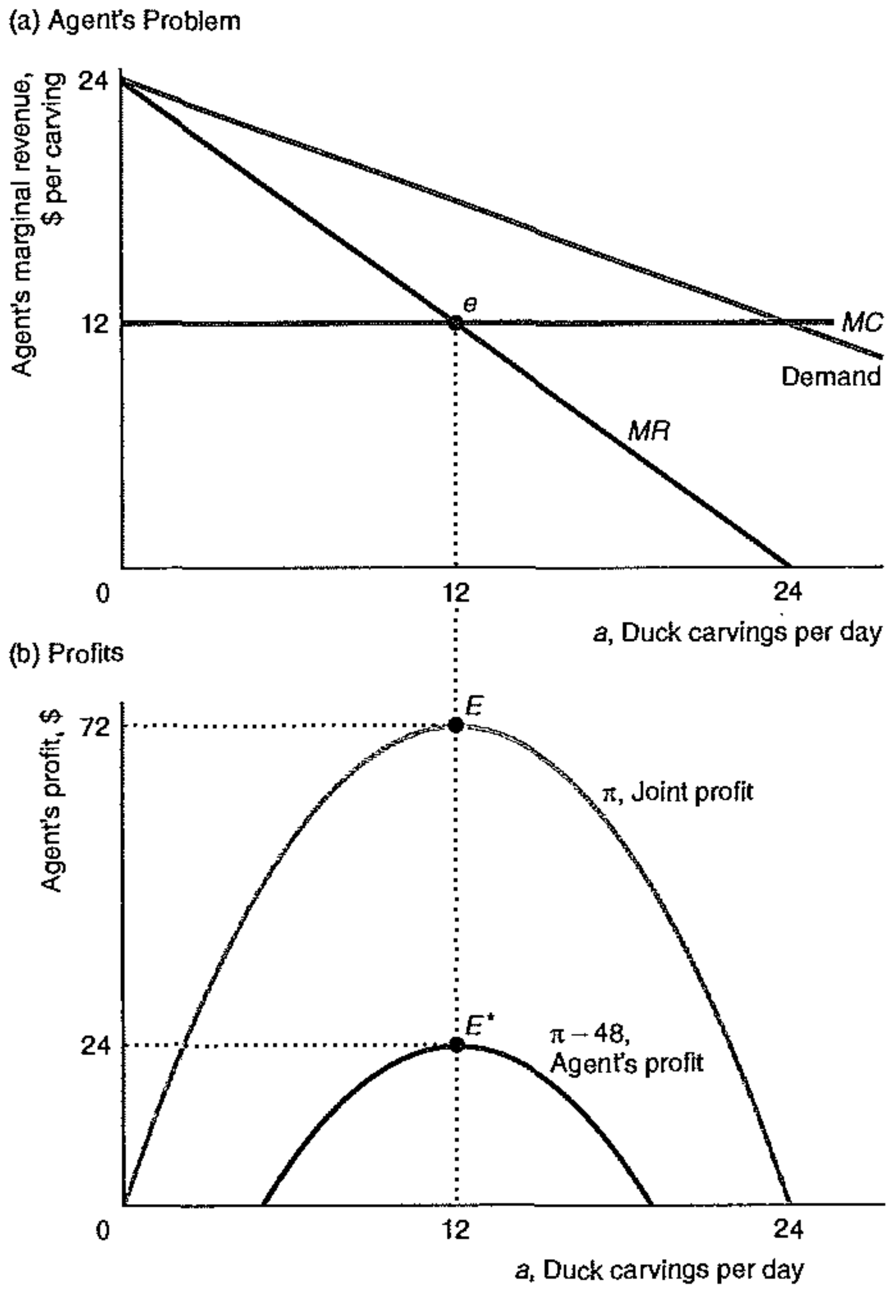


Figure 19.1 Maximizing Joint Profit when the Agent Gets the Residual Profit. (a) If the agent, Arthur, gets all the joint profit, π, he maximizes his profit by selling 12 carvings at e, where the marginal revenue curve intersects his marginal cost curve: $MR = MC = 12$. If he pays the principal, Paula, a fixed rent of \$48, he maximizes his profit by selling 12 carvings. (A fixed rent does not affect either his marginal revenue or his marginal cost.) (b) Joint profit at 12 carvings is \$72, point E. If Arthur pays a rent of \$48 to Paula, Arthur's profit is $\pi - \$48$. By selling 12 carvings and maximizing joint profit, Arthur also maximizes his profit.

the marginal cost curve, $MC = m = \$12$, at the equilibrium point e. Panel b shows that total profit, π, reaches a maximum of \$72 at point E.

Which types of contracts lead to production efficiency? To answer this question, we first examine which contracts yield that outcome when both parties have full information and then consider which contracts bring the desired result when the principal is relatively uninformed. It is important to remember that we are considering a special case: Contracts that work here may not work in some other settings, whereas contracts that do not work here may be effective elsewhere.

FULL INFORMATION

Suppose that both Paula and Arthur have full information. Each knows the actions Arthur takes—the number of carvings sold—and the effect of those actions on profit. Because she has full information, Paula can dictate exactly what Arthur is to do.

Are there incentive-compatible contracts that do not require such monitoring and supervision? To answer this question, we consider four kinds of contracts: a fixed-fee rental contract, a hire contract, and two types of contingent contracts.

Fixed-Fee Rental Contract. If Arthur contracts to rent the store from Paula for a fixed fee, F, joint profit is maximized. Arthur earns a residual profit equal to the joint profit minus the fixed rent he pays Paula, $\pi(a) - F$. Because the amount that Paula makes is fixed, Arthur gets the entire marginal profit from selling one more duck. As a consequence, the amount, a, that maximizes Arthur's profit,

$$\pi(a) - F = R(a) - ma - F, \tag{19.3}$$

also maximizes joint profit, $\pi(a)$. To show this result, we note that his first-order condition based on Equation 19.3,

$$\frac{\mathrm{d}[\pi(a) - F]}{\mathrm{d}a} = \frac{\mathrm{d}R(a)}{\mathrm{d}a} - m - \frac{\mathrm{d}F}{\mathrm{d}a} = \frac{\mathrm{d}R(a)}{\mathrm{d}a} - m = 0, \tag{19.4}$$

is identical to the first-order condition in Equation 19.2.

This result is illustrated in Figure 19.1, where Arthur pays Paula $F = \$48$ rent. This fixed payment does not affect his marginal cost. As a result, he maximizes his profit after paying the rent, $\pi - \$48$, by equating his marginal revenue to his marginal cost: $MR = MC = 12$ at point e in panel a.

Because Arthur pays the same fixed rent no matter how many units he sells, the agent's profit curve in panel b lies $48 below the joint-profit curve at every quantity. As a result, Arthur's net-profit curve peaks (at point E^*) at the same quantity, 12, where the joint-profit curve peaks (at E). Thus the fixed-fee rental contract is incentive compatible. Arthur participates in this contract because he earns $24 after paying for the rent and the carvings (point E^*).

Hire Contract. Now suppose that Paula contracts to pay Arthur for each carving he sells. If she pays him $12 per carving, Arthur just breaks even on each sale. He is indifferent between participating and not. Even if he chooses to participate, he does not sell the joint-profit-maximizing number of carvings unless Paula supervises him. If she does supervise him, she instructs him to sell 12 carvings, and she gets all the joint profit of $72.

For Arthur to want to participate and to sell carvings without supervision, he must receive more than $12 per carving. If Paula pays Arthur $14 per carving, for example, he makes a profit of $2 per carving. He now has an incentive to sell as many carvings as he can (even if the price is less than the cost of the carving), which does not maximize joint profit, so this contract is not incentive compatible.

Even if the Paula can control how many carvings he sells, joint profit is not maximized. Paula keeps the revenue minus what she pays Arthur, $14 times the number of carvings,

$$R(a) - 14a.$$

Thus her objective differs from the joint-profit-maximizing objective, $\pi(a) = R(a) - 12a$. Joint profit is maximized when marginal revenue equals the marginal cost of $12. Because Paula's marginal cost, $14, is larger, she directs Arthur to sell fewer than the optimal number of carvings. Paula maximizes $R - 14a = (24a - \frac{1}{2}a^2) - 14a = 10a - \frac{1}{2}a^2$. Given her first-order condition, where the derivative of Paula's profit with respect to a equals zero, $10 - a = 0$, she maximizes her profit by selling 10 carvings. Joint profit is only $70 at 10 carvings, compared to $72 at the optimal 12 carvings.

Revenue-Sharing Contract. If Paula and Arthur use a *contingent contract* whereby they share the *revenue*, joint profit is not maximized. Suppose that Arthur receives three-quarters of the revenue, $\frac{3}{4}R$, and Paula gets the rest, $\frac{1}{4}R$. Panel a of Figure 19.2 shows the marginal revenue that Arthur obtains from selling an extra carving, $MR^* = \frac{3}{4}MR$. He maximizes his profit at \$24 by selling 8 carvings, for which $MR^* = MC$ at e^*. Paula gets the remaining profit of \$40, which is the difference between their total profit from selling 8 ducks per day, $\pi = \$64$, and Arthur's profit.

Thus their joint profit in panel b at $a = 8$ is \$64, which is \$8 less than the maximum possible profit of \$72 (point E). Arthur has an incentive to sell fewer than the optimal number of ducks because he bears the full marginal cost of each carving he sells, \$12, but gets only three-quarters of the marginal revenue.

Even if Paula controls how many carvings are sold, joint profit is not maximized. Because the amount she makes, $\frac{1}{4}R$, depends only on revenue and not on the cost of obtaining the carvings, she wants the revenue-maximizing quantity sold. Revenue is

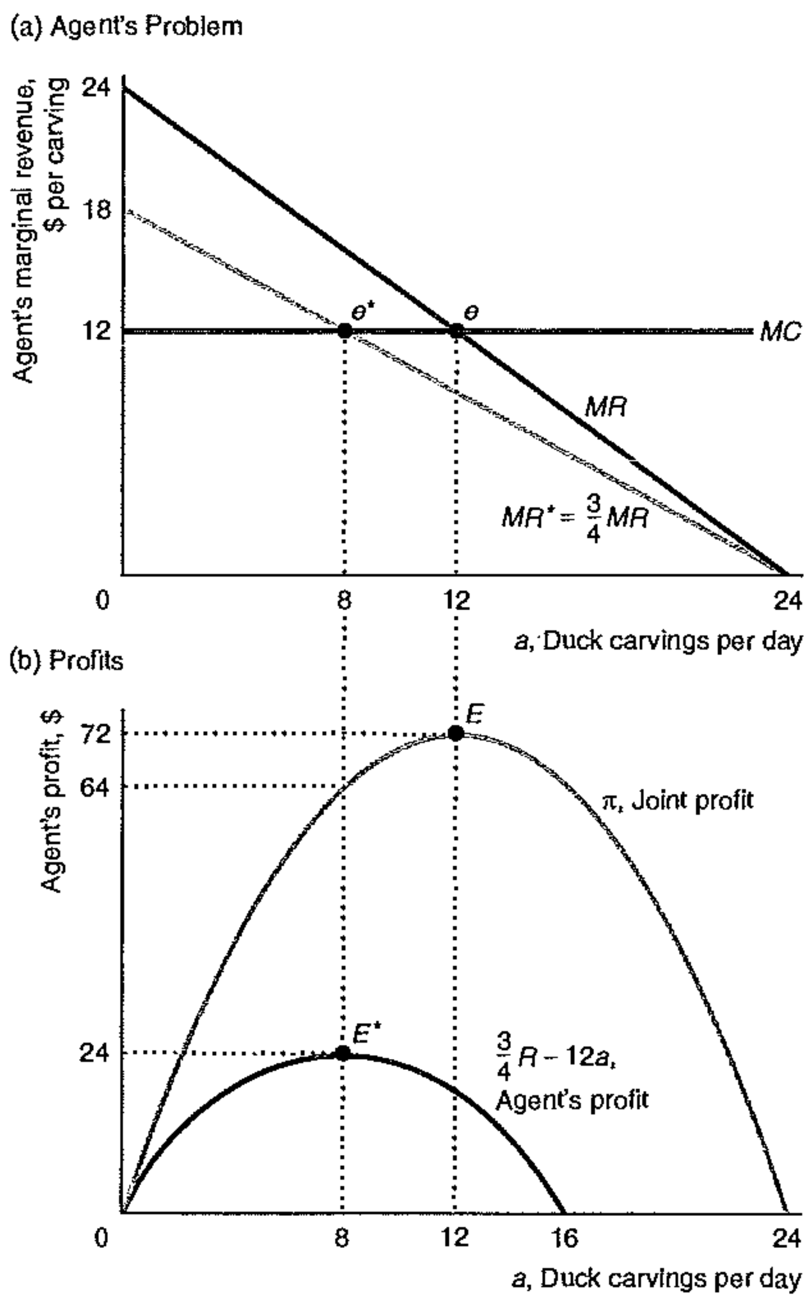


Figure 19.2 **Why Revenue Sharing Reduces Agent's Efforts.** (a) Joint profit is maximized at 12 carvings, where $MR = MC = 12$ at equilibrium point e. If Arthur gets three-quarters of the revenue and Paula gets the rest, Arthur maximizes his profit by selling 8 carvings, where his new marginal revenue curve, $MR^* = \frac{3}{4}MR$, equals his marginal cost at point e^*. (b) Joint profit reaches a maximum of \$72 at E, where they sell 12 carvings per day. If they split the revenue, Arthur sells 8 ducks per day and gets \$24 at E^*, and Paula receives the residual, \$40 (= \$64 − \$24).

maximized where marginal revenue is zero at $a = 24$ (panel a). Arthur would not participate if the contract granted him only three-quarters of the revenue but required him to sell 24 carvings, because he would lose money.

SOLVED PROBLEM 19.1

Use calculus to show that, if Arthur receives three-quarters of the revenue, $\frac{3}{4}R$, and Paula gets the rest, he does not sell the joint-profit-maximizing quantity.

Answer

1. *Write Arthur's profit function, calculate his first-order condition, and solve for his profit-maximizing output:* Arthur's profit is $\frac{3}{4}R(a) - 12a = \frac{3}{4}(24a - \frac{1}{2}a^2) - 12a$. To maximize his profit, he needs to choose a such that his marginal profit with respect to a equals zero: $\frac{3}{4}dR(a)/da - 12 = \frac{3}{4}(24 - a) - 12 = 0$. Thus the output that maximizes his profit is $a = 8$.

2. *Compare this solution to the joint-profit-maximizing output:* We know that the joint profit is maximized at 72, where $a = 12$. With revenue sharing, $a = 8$ and joint profits are only 64.

Comment: Arthur produces too little output because he bears the full marginal cost, 12, but earns only three-quarters of the marginal benefit (marginal revenue), $\frac{3}{4}(24 - a)$, from the joint-profit-maximizing problem, $24 - a$.

Profit-Sharing Contract. Paula and Arthur may instead use a *contingent contract* by which they divide the *economic profit*, π. If they can agree that the true marginal and average cost is $12 per carving (which includes Arthur's opportunity cost of time), the contract is incentive compatible because Arthur wants to sell the optimal number of carvings. Only by maximizing total profit can he maximize his share of profit. As Figure 19.3 illustrates, Arthur receives one-third of the joint profit and chooses to

Figure 19.3 Why Profit Sharing Is Efficient. If the agent, Arthur, gets a third of the joint profit, he maximizes his profit, $\frac{1}{3}\pi$, by maximizing joint profit, π.

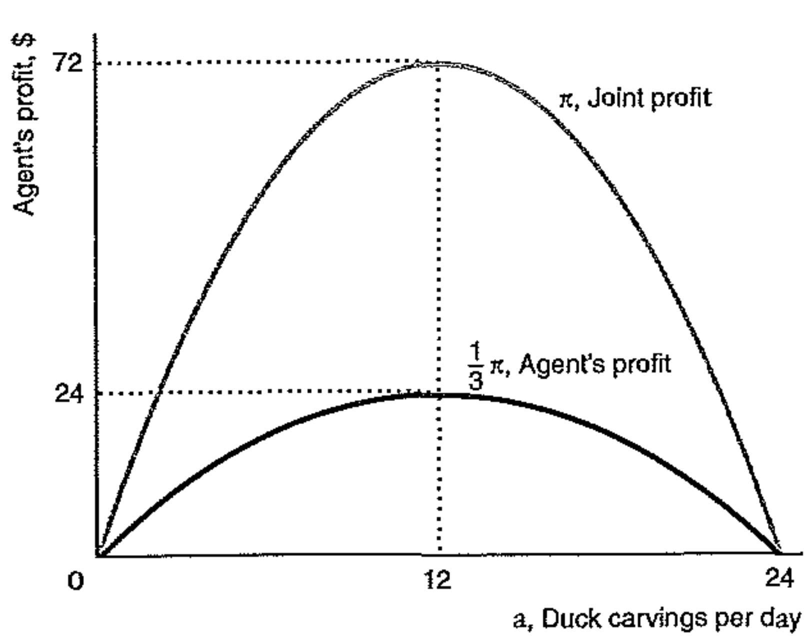


TABLE 19.1 Production Efficiency and Moral Hazard Problems for Buy-A-Duck

	Full Information	Asymmetric Information	
Contract	*Production Efficiency*	*Production Efficiency*	*Moral Hazard Problem*
Fixed-fee rental contract			
Rent (to principal)	Yes	Yes	No
Hire contract, per unit pay			
Pay equals marginal cost	No[a]	No[b]	Yes
Pay is greater than marginal cost	No[c]	No	Yes
Contingent contract			
Share revenue	No	No[b]	Yes
Share profit	Yes	No[b]	Yes

[a]The agent may not participate and has no incentive to sell the optimal number of carvings. Efficiency can be achieved only if the principal supervises.

[b]Unless the agent steals all the revenue (or profit) from an extra sale, inefficiency results.

[c]The agent sells too many or the principal directs the agent to sell too few carvings.

produce the level of output, $a = 12$, that maximizes joint profit. Arthur gets one-third of profit, $\frac{1}{3}\pi = \frac{1}{3}(R - C) = \frac{1}{3}R - \frac{1}{3}C$, where R is revenue and C is cost. He maximizes his profit where $\frac{1}{3}MR = \frac{1}{3}MC$. Although he gets only one-third of the marginal revenue, $\frac{1}{3}MR$, he bears ouly one-third of the marginal cost. Dividing both sides of the equation by $\frac{1}{3}$, we find that this condition is the same as the one for maximizing total profit: $MR = MC$. Arthur earns $24, so he is willing to participate.

The second column of Table 19.1 summarizes our analysis. Whether efficiency in production is achieved depends on the type of contract that the principal and the agent use. If the principal has full information (knows the agent's actions), the principal achieves production efficiency without having to supervise by using one of the incentive-compatible contracts: fixed-fee rental or profit-sharing.

ASYMMETRIC INFORMATION

Now suppose that the principal, Paula, has less information than the agent, Arthur. She cannot observe the number of carvings he sells or the revenue. Due to this asymmetric information, Arthur can steal from Paula without her detecting the theft.

As Table 19.1 shows, with asymmetric information, *the only contract that results in production efficiency and no moral hazard problem is the one whereby the principal gets a fixed rent.* All the other contracts result in inefficiency, and Arthur has an opportunity to take advantage of Paula.

Fixed-Fee Rental Contract. Arthur pays Paula the fixed rent that she is due because Paula would know if she were paid less. Arthur receives the residual profit, joint profit minus the fixed rent, so he wants to sell the joint-profit-maximizing number of carvings.

Hire Contract. If Paula offers to pay Arthur the actual marginal cost of $12 per carving and he is honest, he may refuse to participate in the contract because he makes no profit. Even if he participates, he has no incentive to sell the optimal number of carvings.

If he is dishonest, he may underreport sales and pocket some of the extra revenue. Unless he can steal all the extra revenue from an additional sale, he sells less than the joint-profit-maximizing quantity.

If Paula pays him more than the actual marginal cost per carving, he has an incentive to sell too many carvings, whether or not he steals. If he also steals, he has an even greater incentive to sell too many carvings.

Revenue-Sharing Contract. Even with full information, the revenue-sharing contract is inefficient. Asymmetric information adds a moral hazard problem: The agent may steal from the principal. If Arthur can steal a larger share of the revenues than the contract specifies, he has less of an incentive to undersell than he does with full information. Indeed, if the agent can steal all the extra revenue from an additional sale, the agent acts efficiently to maximize joint profit, all of which the agent keeps.

Profit-Sharing Contract. If they use a contingent contract by which they agree to split the economic profit, Arthur has to report both the revenue and the cost to Paula so that they can calculate their shares. If he can overreport cost or underreport revenue, he has an incentive to produce a nonoptimal quantity. Only if Arthur can appropriate all the profit does he produce efficiently.

APPLICATION

Contracts and Productivity in Agriculture

In agriculture, landowners (principals) contract with farmers (agents) to work their land. Farmers may work on their own land (the principal and agent are the same person), work on land rented from a landowner (fixed-fee rental contract), work as employees for a time rate or a piece rate (hire contract), or sharecrop (contingent contract). A sharecropper splits the output (crop) with the landowner at the end of the growing season.[4]

Our analysis tells us that farmers' willingness to work hard depends on the type of contract that is used. Farmers who keep all the marginal profit from additional work—those who own the land or rent it for a fixed fee—work hard and maximize (joint) profit. Sharecroppers, who bear the full marginal cost of working an extra hour and get only a fraction of the extra revenue, put in too little effort. Hired farmworkers who are paid by the hour may not work hard unless they are very carefully supervised. That is, they may engage in shirking: a moral hazard in which agents do not provide all the services they are paid to provide.

[4]If a farmer is someone who is out standing in his field, a sharecropper is someone who is out standing in someone else's field.

These predictions about contract type and agent effort were tested by using data on farmers in the Philippines. Foster and Rosenzweig (1994) could not directly monitor the work effort—any more than most landowners can. Rather, they ingeniously measured the effort indirectly. They contended that the harder people work, the more they eat and the more they use up body mass (defined as weight divided by height squared), holding calorie intake constant.

Foster and Rosenzweig estimated the effect of each compensation method on body mass and consumption (after adjusting for gender, age, type of activity, and other factors). They found that people who work for themselves or are paid by the piece use up 10% more body mass, holding calorie consumption constant, than time-rate workers and 13% more than sharecroppers. Foster and Rosenzweig also discovered that piece-rate workers consume 25% more calories per day and that people who work on their own farms consume 16% more than time-rate workers.

19.3 Trade-Off Between Efficiency in Production and in Risk Bearing

Writing an efficient contract is extremely difficult if the agent knows more than the principal, the principal never learns the truth, and both face risk. Usually, a contract does not achieve efficiency in production *and* in risk bearing. Contract clauses that increase efficiency in production may reduce efficiency in risk bearing, and vice versa. If these goals are incompatible, the parties may write imperfect contracts that reach a compromise between the two objectives. To illustrate the trade-offs involved, we consider a common situation in which it is difficult to achieve efficiency: contracting with an expert such as a lawyer.

We illustrate how contracts affect the outcome by using an example in which Pam, the principal, is injured in a traffic accident and is a plaintiff in a lawsuit, and Alfredo, the agent, is her lawyer. Pam faces uncertainty due to risk and to asymmetric information. The jury award at the conclusion of the trial, $\pi(a, \theta)$, depends on a, the number of hours Alfredo works before the trial, and θ, the state of nature due to the (unknown) attitudes of the jury. All else the same, the more time Alfredo spends working on the case, a, the larger the amount, π, that the jury is likely to award. Pam never learns the jury's attitudes, θ, so she cannot accurately judge Alfredo's efforts even after the trial. For example, if she loses the case, she won't know whether she lost because Alfredo didn't work hard (low a) or because the case was weak and the jury was prejudiced against her (bad θ).

CONTRACTS AND EFFICIENCY

How hard Alfredo works depends on his attitudes toward risk and his knowledge of the payoff for his trial preparations. For any hour that he does not devote to Pam's case, Alfredo can work on other cases. The most lucrative of these forgone opportunities is his marginal cost of working on Pam's case.

The beneficiary of the extra payoff that results if Alfredo works harder depends on his contract with Pam. If Alfredo is risk neutral and gets the entire marginal benefit from any extra work, he puts in the optimal number of hours that maximizes their

TABLE 19.2 Efficiency of Client-Lawyer Contracts

Type of Contract	Fixed Fee to Lawyer	Fixed Payment to Client	Lawyer Paid by the Hour	Contingent Contract
Lawyer's payoff	F	$\pi(a, \theta) - F$	wa	$\alpha\pi(a, \theta)$
Client's payoff	$\pi(a, \theta) - F$	F	$\pi(a, \theta) - wa$	$(1 - \alpha)\pi(a, \theta)$
Production efficiency?	No*	Yes	No*	No*
Who bears risk?	Client	Lawyer	Client	Shared

*Production efficiency is possible if the client can monitor and enforce optimal effort by the lawyer.

expected joint payoff. Alfredo collects the marginal benefit from the extra work and bears the marginal cost, so he sets his expected marginal benefit equal to his marginal cost, thus maximizing the expected joint payoff.

The choice of various possible contracts between Pam and Alfredo affects whether efficiency in production or in risk bearing is achieved. They choose among fixed-fee, hire (hourly wage), and contingent contracts. Table 19.2 summarizes the outcomes under each of these contracts.

Lawyer Gets a Fixed Fee. If Pam pays Alfredo a fixed fee, F, he gets paid the same no matter how much he works. Thus he has little incentive to work hard on this case, and his production is inefficient.[5] Production efficiency can be achieved only if Pam can monitor Alfredo and force him to act optimally. However, most individual plaintiffs cannot monitor a lawyer and thus cannot determine whether the lawyer is behaving appropriately.

Whether the fixed-fee contract leads to efficiency in risk bearing depends on the attitudes toward risk on the part of the principal and the agent. Pam, the principal, bears all the risk. Alfredo's pay, F, is certain, while Pam's net payoff, $\pi(a, \theta) - F$, varies with the unknown state of nature, θ.

A lawyer who handles many similar cases may be less risk averse than an individual client whose financial future depends on a single case. If Alfredo has had many cases like Pam's and if Pam's future rests on the outcome of this suit, their choice of this type of contract leads to inefficiency in both production and risk bearing. Not only is Alfredo not working hard enough, but Pam bears the risk, even though she is more risk averse than Alfredo.

In contrast, suppose that Alfredo is a self-employed lawyer working on a major case for Pam, who runs a large insurance company with many similar cases. Alfredo is risk averse and Pam is risk neutral (because she is able to pool many similar cases). Here, having the principal bear all the risk is efficient. If the insurance company can monitor Alfredo's behavior, it is even possible to achieve production efficiency. Indeed, many insurance companies employ lawyers in this manner.

[5]His main incentive to work hard (other than honesty) is to establish a reputation as a good lawyer so as to attract future clients. For simplicity, we will ignore this effect, because it applies for all types of contracts.

Plaintiff Gets a Fixed Payment. Instead, the two parties could agree to a contract by which Alfredo could pay Pam a fixed amount of money, F, for the right to try the case and collect the entire verdict less the payment to Pam, $\pi(a, \theta) - F$. With such a contract, Alfredo has an incentive to put in the optimal number of hours. He works until his marginal cost—the opportunity cost of his time—equals the marginal benefit—the extra amount he gets if he wins at trial. Because he has already paid Pam, all extra amounts earned at trial go to Alfredo.

Under this contract, Alfredo bears all the risk related to the outcome of the trial. However, no matter how risk averse Pam is, she may hesitate to agree to such a contract. Because she is not an expert on the law, she cannot easily predict the jury's likely verdict. Thus she does not know how large a fixed fee she should insist on receiving. There is no practical way in which Alfredo's superior information about the likely outcome of the trial can be credibly revealed to her. She suspects that it is in his best interest to tell her that the likely payout is lower than he truly believes.[6]

Lawyer Is Hired by the Hour. In complicated cases, a lawyer's output is not easily measured, so it is not practical to pay the attorney by the piece. Pam could pay Alfredo a wage of w per hour for the a hours that he works. Doing so would create the potential for a serious moral hazard problem unless Pam could monitor Alfredo to determine how many hours he works. If she could not, Alfredo could bill her for more hours than he actually worked.[7] Even if Pam could observe how many hours he works, she would not know whether Alfredo worked effectively and whether the work was necessary. Thus it would be difficult, if not impossible, for Pam to monitor Alfredo's work.

Here Pam bears all the risk. Alfredo's earnings, wa, are determined before the outcome is known. Pam's return, $\pi(a, \theta) - wa$, varies with the state of nature and is unknown before the verdict.

Fee Is Contingent. Some lawyers offer plaintiffs a contract whereby the lawyer works for "free"—receiving no hourly payment—in exchange for splitting the compensation awarded in court or in a settlement before trial. The lawyer receives a **contingent fee**: a payment to a lawyer that is a share of the award in a court case (usually after legal expenses are deducted) if the client wins and nothing if the client loses. If the lawyer's share of the award is ω and the jury awards $\pi(a, \theta)$, the lawyer receives $\omega\pi(a, \theta)$ and the principal gets $(1 - \omega)\pi(a, \theta)$. This approach is attractive to many plaintiffs because they cannot monitor how hard the lawyer works and are unable or unwilling to make payments before the trial is completed.

How they split the award affects the amount of risk each bears. If Alfredo gets one-quarter of the award, $\omega = \frac{1}{4}$, and Pam gets three-quarters, Pam bears more risk than

[6]Alfredo may be hesitant to offer Pam a fixed fee. Their success in court depends on the merits of her case. Initially, Alfredo does not know how good a case she has, and she has an incentive to try to convince him that the case is very strong. Moreover, a lawyer may worry that if he pays the plaintiff a fixed fee, she will not fully cooperate in preparing the case (an issue that we've ignored in our example, in which only the actions of the lawyer matter).

[7]A lawyer dies in an accident and goes to heaven. A host of angels greet him with a banner that reads, "Welcome Oldest Man!" The lawyer is puzzled: "Why do you think I'm the oldest man who ever lived? I was only 47 when I died." One of the angels replied, "You can't fool us; you were at least 152 when you died. We saw how many hours you billed!"

Alfredo does. Suppose that the award is either 0 or 40 with equal probability. Alfredo receives either 0 or 10, so his average award is 5. His variance (Chapter 16) is

$$\sigma_a^2 = \frac{1}{2}(0 - 5)^2 + \frac{1}{2}(10 - 5)^2 = 25.$$

Pam makes either 0 or 30, so her average award is 15 and her variance is

$$\sigma_p^2 = \frac{1}{2}(0 - 15)^2 + \frac{1}{2}(30 - 15)^2 = 225.$$

Thus the variance in Pam's payoff is greater than Alfredo's.

Whether splitting the risk in this way is desirable depends on how risk averse each party is. If one is risk neutral and the other is risk averse, it is efficient for the risk-neutral person to bear all the risk. If they are equally risk averse, a splitting rule in which $\omega = \frac{1}{2}$ and they face equal risk may be optimal.[8]

A sharing contract encourages shirking: Alfredo is likely to put in too little effort. He bears the full cost of his labors—the forgone use of his time—but gets only ω share of the returns from this effort. Thus this contract results in production inefficiency and may or may not lead to inefficient risk bearing.

CHOOSING THE BEST CONTRACT

Which contract is best depends on the parties' attitudes toward risk, the degree of risk, the difficulty in monitoring, and other factors. If Alfredo is risk neutral, they can achieve both efficiency goals if Alfredo gives Pam a fixed fee. He has the incentive to put in the optimal amount of work and does not mind bearing the risk.

However, if Alfredo is risk averse and Pam is risk neutral, they may not be able to achieve both objectives. Contracts that provide Alfredo a fixed fee or a wage rate allocate all the risk to Pam and lead to inefficiency in production because Alfredo has too little incentive to work hard.

Often when the parties find that they cannot achieve both objectives, they choose a contract that attains neither goal. For example, they may use a contingent contract that fails to achieve efficiency in production and may not achieve efficiency in risk bearing. The contingent contract strikes a compromise between the two goals. Alfredo has more of an incentive to work if he splits the payoff than if he receives a fixed fee. He is less likely to work excessive hours with the contingent fee than if he were paid by the hour. Moreover, neither party has to bear all the risk—they share it under the contingent contract.

Lawyers usually work for a fixed fee only if the task or case is very simple, such as writing a will or handling an uncontested divorce. The client has some idea of whether the work is done satisfactorily, so monitoring is relatively easy and little risk is involved.

In riskier situations, the other types of contracts are more commonly used. When the lawyer is relatively risk averse or when the principal is very concerned that the lawyer works hard, an hourly wage may be used.

Contingent fee arrangements are particularly common for plaintiffs' lawyers who specialize in auto accidents, medical malpractice, product liability, and other *torts*: wrongful acts in which a person's body, property, or reputation is harmed and for which the injured party is entitled to compensation. Because these plaintiffs' lawyers can

[8]If Pam and Alfredo split the award equally and each receives either 0 or 20 with equal probability, each has a variance of $\frac{1}{2}(0 - 10)^2 + \frac{1}{2}(20 - 10)^2 = 100$.

typically pool risks across clients, they are less concerned than their clients are about risk. As a consequence, these attorneys are willing to accept contingent fees (and might agree to pay a fixed fee to the plaintiff). Moreover, accident victims often lack the resources to pay for a lawyer's time before winning at trial, so they often prefer contingent contracts.

APPLICATION

Contingent Fees Versus Hourly Pay

Some jurisdictions restrict lawyers' contingent fees. California limits medical malpractice contingent fees to 40% of the first $50,000 of compensation, one-third of the next $50,000, 25% of the next $100,000, and 10% of anything over $200,000. All provinces of Canada except Ontario permit contingent fees, while most European countries ban them.

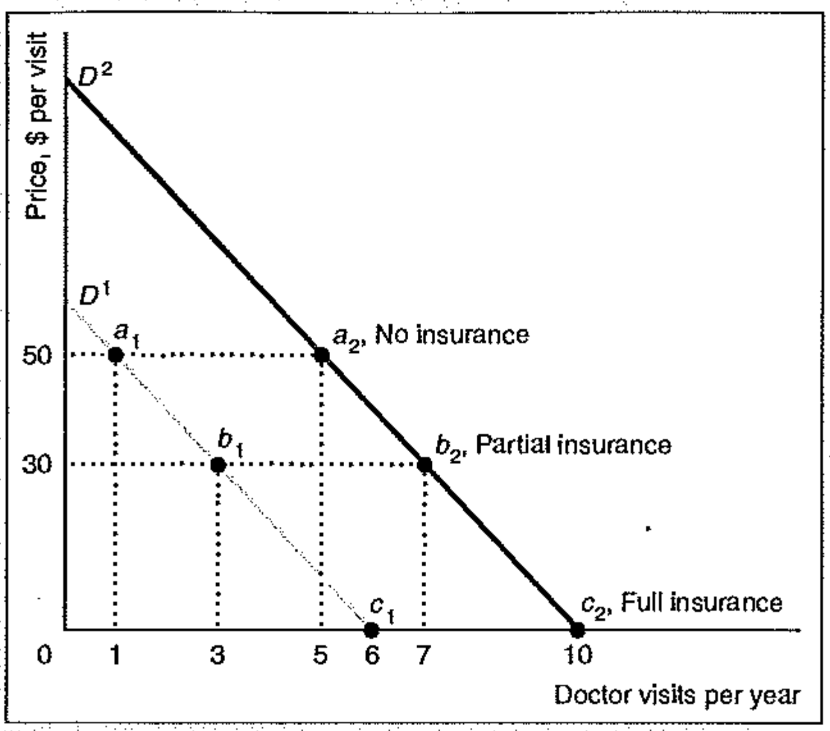
Historically, lawyers in personal injury cases have been paid a contingent fee. Increasingly, some states are banning or limiting such fees, and lawyers are paid hourly. One justification given for banning contingent fees is that they encourage "frivolous" lawsuits by lawyers looking for a big payout; however, this result is not obvious on the basis of economic theory. Helland and Tabarrok (2003) measured low-quality cases by the probability that the plaintiff dropped the case before a settlement or trial. They compared states that outlaw or severely limit contingent fees to those states that permit them. They also looked specifically at the record in Florida before and after a limit on contingent fees. They found that the use of hourly fees encourages lawyers to take poor cases and to delay the time to settle relative to what happens with contingent fees.

SOLVED PROBLEM 19.2

Gary's demand for medical services (visits to his doctor) depends on his health. Half the time his health is good and his demand is D^1 in the graph. When his health is less good, his demand is D^2. Without medical insurance, he pays $50 a visit. Because Gary is risk averse, he wants to buy medical insurance. With full insurance, Gary pays a fixed fee at the beginning of the year, and the insurance company pays the full cost of any visit. Alternatively, with a contingent contract, Gary pays a smaller premium at the beginning of the year, and the insurance company covers only $20 per visit, with Gary paying the remaining $30. How likely is a moral hazard problem to occur with each of these contracts? What is Gary's risk (variance of his medical costs) with no insurance and with each of the two types of insurance? Compare the contracts in terms of the trade-offs between risk and moral hazards.

Answer

1. *Describe the moral hazard for each demand curve for each contract:* If Gary's health is good, he increases from 1 visit, a_1, with no insurance (where he pays $50 a visit) to 6 visits, c_1, with full insurance (where he pays nothing per visit). Similarly, if his health is poor, he increases his visits from 5, a_2, to 10, c_2. Thus regardless of his health, he makes 5 extra visits a year with full insurance. These extra visits are the moral hazard. With a contingent contract whereby Gary pays $30 a visit, the moral hazard is less because he makes only 2 extra visits instead of 5 (the difference between the number of visits at b_1 and a_1 and between b_2 and a_2).



2. *Calculate the variance of Gary's medical expenses for no insurance and for the two insurance contracts:* Without insurance, his average number of visits is $3[= (\frac{1}{2} \times 1) + (\frac{1}{2} \times 5)]$, so his average annual medical cost is \$150. Thus the variance of his medical expenses without insurance is

$$\begin{aligned}\sigma_n^2 &= \tfrac{1}{2}[(1 \times \$50) - \$150]^2 + \tfrac{1}{2}[(5 \times 50) - \$150]^2 \\ &= \tfrac{1}{2}(\$50 - \$150)^2 + \tfrac{1}{2}(\$250 - \$150)^2 \\ &= \$10{,}000.\end{aligned}$$

If he has full insurance, he makes a single fixed payment each year, so his payments do not vary with his health: His variance is $\sigma_f^2 = 0$. Finally, with partial insurance, he averages 5 visits with an average cost of \$150, so his variance is

$$\sigma_p^2 = \tfrac{1}{2}(\$90 - \$150)^2 + \tfrac{1}{2}(\$210 - \$150)^2 = \$3{,}600.$$

Thus $\sigma_n^2 > \sigma_p^2 > \sigma_f^2$.

3. *Discuss the trade-offs:* Because Gary is risk averse, efficiency in risk bearing requires the insurance company to bear all the risk, as with full insurance. Full insurance, however, results in the largest moral hazard. Without insurance, there is no moral hazard, but Gary bears all the risk. The contingent contract is a compromise whereby both the moral hazard and the degree of risk lie between the extremes.

19.4 Payments Linked to Production or Profit

We now examine how additional clauses are added to a contract to eliminate or reduce moral hazards. For simplicity, we ignore risk bearing. We focus on employer-employee contracts. Under most such contracts, employees are paid by the hour or given a fixed salary. The problem with such agreements is that the workers are not directly rewarded for productive, profit-enhancing actions, so they tend to shirk. Here, rewarding agents for productive activities leads to greater efficiency.

There are two main ways to reward productive effort directly. One method is to link a worker's pay to his or her individual output. Another is to link a worker's pay to the firm's output or profitability. However, employers who cannot monitor workers do not use incentive-compatible contracts.

PIECE-RATE HIRE CONTRACTS

One direct approach to getting employees to work hard is to pay them by the *piece*—the output they produce—rather than by *time*—the number of hours they work. Piece rates are usually effective in increasing output, but they are not practical in all markets.

Greater Effort. Piece rates—by explicitly rewarding productivity—provide a greater incentive to employees to work hard than hourly wages do. For example, Billikopf (1995) found that employees who are paid by the piece prune a vineyard in only 19 hours of work per acre compared to 26 hours for employees paid by the hour. Shearer (2004) found that when tree planters were randomly assigned piece-rate pay or fixed hourly wages, they were 19% more productive when paid by the piece.

The increase in joint profit due to this greater productivity may be shared between the firm and the employees. Many workers, because they earn more with piece rates than they would earn with hourly pay, are pleased to be paid by the piece.

Problems with Piece Rates. Piece rates are not always practical, however. There are three chief difficulties with this system: measuring output, eliciting the desired behavior, and persuading workers to accept piece rates.

Paying piece rates is practical only if the employer can easily measure the output produced, such as the number of pieces of fruit picked or windshields installed. Employers do not use piece rates to compensate teachers, managers, and others whose output is difficult to measure. Thus piece rates are more common for blue-collar jobs than for white-collar jobs. Roughly 15% of the labor force receives pay based on individual productivity, but most piecework is concentrated in a handful of low-paying industries such as agriculture (in which about a third of workers are paid by the piece) and apparel manufacturing or is confined to sales personnel, individual contractors, and other similar occupations.

Piece rates backfire if they encourage undesirable behavior. Sears, Roebuck & Company used to reward auto shop employees on the basis of the size of customers' repair bills. This system apparently led to the overbilling of customers, which resulted in government actions and lawsuits.[9]

Some workers object to piece rates because they do not like to work hard or because they are concerned that firms will ratchet down workers' compensation after a while by lowering the pay per piece. In addition, piecework has a negative connotation in

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[9]Buchholz, Barbara B., "The Bonus Isn't Reserved for Big Shots Anymore," *New York Times*, October 27, 1996.

many people's minds because of its association with sweatshops, where workers toil at repetitive tasks for 12 or more hours a day.

CONTINGENT CONTRACT REWARDS LINKED TO A FIRM'S SUCCESS

Although companies can use piece rates with workers who produce easily measured output, they need alternative incentive schemes for managers, corporate directors, and others whose productivity is difficult to quantify, especially those who work as part of a team. Such workers may be rewarded if their team or the firm does well in general. Frequently, year-end bonuses are based on increases in the firm's profit or the value of its stock.

A common type of incentive is a lump-sum year-end bonus based on the firm's performance or that of a group of workers within the firm. Another incentive is a stock option, which gives managers (and, increasingly, other workers) the option of buying a certain number of shares of stock in the firm at a prespecified *exercise price*. If the stock's market price exceeds the exercise price during that period, an employee can exercise the option—buy the stock—and then sell it at the market price, in this way making an immediate profit. But if the stock's price stays below the exercise price, the option is worthless. Beyond motivating employees to work hard, these incentives also act as *golden handcuffs*: a deterrent to taking a job at a competing firm and forfeiting the stock option. See www.aw-bc.com/perloff, Chapter 19, "Increasing Use of Incentives."

19.5 Monitoring

When a firm cannot use piece rates or reward workers for the firm's success, an employer usually pays fixed-fee salaries or hourly wages. Employees who are paid a fixed salary have little incentive to work hard if the employer cannot observe shirking. And if an employer pays employees by the hour but cannot observe how many hours they work, employees may inflate the number of hours they report working.

A firm can reduce such shirking by intensively supervising or monitoring its workers. Monitoring eliminates the asymmetric information problem: Both the employee and the employer know how hard the employee works. If the cost of monitoring workers is low enough, it pays to prevent shirking by carefully monitoring and firing employees who do not work hard.

Firms have experimented with various means of lowering the cost of monitoring. Requiring employees to punch a time clock or installing video cameras to record employees' work efforts are examples of firms' attempts to use capital to monitor job performance. Similarly, by installing assembly lines that force employees to work at a pace dictated by the firm, employers can control employees' work rate.

According to a recent survey by the American Management Association, nearly two-thirds of employers record employees' voice mail, e-mail, or phone calls; review their computer files; or videotape workers. A quarter of the firms that use surveillance don't tell their employees. The most common types of surveillance are tallying phone numbers called and recording the duration of the calls (37%), videotaping employees' work (16%), storing and reviewing e-mail (15%), storing and reviewing computer files (14%), and taping and reviewing phone conversations (10%). Monitoring and surveillance are most common in the financial sector, in which 81% of firms use these techniques. Rather than watching all employees all the time, companies usually monitor selected workers using spot checks.

For some jobs, however, monitoring is counterproductive or not cost effective. Monitoring may lower employees' morale, which in turn reduces productivity. Several years ago, Northwest Airlines took the doors off bathroom stalls to prevent workers from slacking off there. When new management eliminated this policy (and made many other changes as well), productivity increased.

It is usually impractical for firms to monitor how hard salespeople work if they spend most of their time away from the main office. As telecommuting increases, monitoring workers may become increasingly difficult.

When direct monitoring is very costly, firms may use various financial incentives, which we consider in the next section, to reduce the amount of monitoring that is necessary. Each of these incentives—bonding, deferred payments, and efficiency (unusually high) wages—acts as a *hostage* for good behavior (Williamson, 1983). Workers who are caught shirking or engaging in other undesirable acts not only lose their jobs but give up the hostage too. The more valuable the hostage, the less monitoring the firm needs to use to deter bad behavior.

BONDING

A direct approach to ensuring good behavior by agents is to require that they deposit funds guaranteeing their good behavior, just as a landlord requires tenants to post security deposits to ensure that they will not damage an apartment. An employer may require an employee to provide a performance *bond*, an amount of money that will be given to the principal if the agent fails to complete certain duties or achieve certain goals. Typically, the agent *posts* (leaves) this bond with the principal or another party, such as an insurance company, before starting the job.

Many couriers who transport valuable shipments (such as jewels) or guards who watch over them have to post bonds against theft and other moral hazards. Similarly, bonds may be used to keep employees from quitting immediately after receiving costly training (Salop and Salop, 1976). Most of the other approaches that we will examine as strategies for controlling shirking can be viewed as forms of bonding.

Bonding to Prevent Shirking. Some employers require a worker to post a bond that is forfeited if the employee is discovered shirking. For example, a professional athlete faces a specified fine (the equivalent of a bond) for skipping a meeting or game. The higher the bond, the less frequently the employer needs to monitor to prevent shirking.

Suppose that the value a worker puts on the gain from taking it easy on the job is G dollars. If a worker's only potential punishment for shirking is dismissal if caught, some workers will shirk.

Suppose, however, that the worker must post a bond of B dollars that the worker forfeits if caught not working. Given the firm's level of monitoring, the probability that a worker is caught is θ. Thus a worker who shirks expects to lose θB.[10] A risk-neutral

[10] The expected penalty is $\theta B + (1 - \theta)0 = \theta B$, where the first term on the left-hand side is the probability of being caught times the fine of B and the second term is the probability of not being caught and facing no fine.

worker chooses not to shirk if the certain gain from shirking, G, is less than or equal to the expected penalty, θB, from forfeiting the bond if caught: $G \leq B$. Thus the minimum bond that discourages shirking is

$$B = \frac{G}{\theta}. \tag{19.5}$$

Equation 19.5 shows that the bond must be larger, the higher the value that the employee places on shirking and the lower the probability that the worker will be caught.

Trade-Off Between Bonds and Monitoring. Thus the larger the bond, the less monitoring is necessary to prevent shirking. Suppose that a worker places a value of $G =$ \$1,000 a year on shirking. A bond that is large enough to discourage shirking is \$1,000 if the probability of the worker's being caught is 100%, \$2,000 at 50%, \$5,000 at 20%, \$10,000 at 10%, and \$20,000 if the probability of being caught is only 5%.

SOLVED PROBLEM 19.3

Workers post bonds of B that are forfeited if they are caught stealing (but no other punishment is imposed). Each extra unit of monitoring, M, raises the probability that a firm catches a worker who steals, θ, by 5%. A unit of M costs \$10. A worker can steal a piece of equipment and resell it for its full value of G dollars. What is the optimal M that the firm uses if it believes that workers are risk neutral? In particular, if $B =$ \$5,000 and $G =$ \$500, what is the optimal M?

Answer

1. *Determine how many units of monitoring are necessary to deter stealing:* The least amount of monitoring that deters stealing is the amount at which a worker's gain from stealing equals the worker's expected loss if caught. A worker is just deterred from stealing when the gain, G, equals the expected penalty, θB. Thus the worker is deterred when the probability of being caught is $\theta = G/B$. The number of units of monitoring effort is $M = \theta/0.05$, because each extra unit of monitoring raises θ by 5%.

2. *Determine whether monitoring is cost effective:* It pays for the firm to pay for M units of monitoring only if the expected benefit to the firm is greater than the cost of monitoring, \$10 $\times M$. The expected benefit if stealing is prevented is G, so monitoring pays if $G >$ \$10 $\times M$, or $G/M >$ \$10.

3. *Solve for the optimal monitoring in the special case:* The optimal level of monitoring is

$$M = \frac{\theta}{0.05} = \frac{G/B}{0.05} = \frac{500/5{,}000}{0.05} = \frac{0.1}{0.05} = 2.$$

It pays to engage in this level of monitoring because $G/M =$ \$500/2 = \$250 > \$10.

Problems with Bonding. Employers like the bond-posting solution because it reduces the amount of employee monitoring that is necessary to discourage moral hazards such as shirking and thievery. Nonetheless, firms use explicit bonding only occasionally to prevent stealing, and they rarely use it to prevent shirking.

Two major problems are inherent in posting bonds. First, to capture a bond, an unscrupulous employer might falsely accuse an employee of stealing. An employee who fears such employer opportunism might be unwilling to post a bond. One possible solution to this problem is for the firm to develop a reputation for not behaving in this manner. Another possible approach is for the firm to make the grounds for forfeiture of the bond objective and thus verifiable by others.

A second problem with bonds is that workers may not have enough wealth to post them. In our example, if the worker could steal $10,000, and if the probability of being caught were only 5%, shirking would be deterred only if a risk-neutral worker were required to post a bond of at least $200,000.

Principals and agents use bonds when these two problems are avoidable. Bonds are more common in contracts between firms than in those between an employer and employees. Moreover, firms have fewer problems than typical employees do in raising funds to post bonds.

Construction contractors sometimes post bonds to guarantee that they will satisfactorily finish their work by a given date. It is easy to verify whether the contract has been completed on time, so there is relatively little chance of opportunistic behavior by the principal.

DEFERRED PAYMENTS

Effectively, firms can post bonds for their employees through the use of deferred payments. For example, a firm pays new workers a low wage for some initial period of employment. Then, over time, workers who are caught shirking are fired, and those who remain get higher wages. In another form of deferred wages, the firm provides a pension that rewards only hard workers who stay with the firm until their retirement. *Deferred payments serve the same function as bonds.* They raise the cost of being fired, so less monitoring is necessary to deter shirking.

Workers care about the present value (see Chapter 15) of their earnings stream over their lifetime. A firm may offer its workers one of two wage payment schemes. In the first, the firm pays w per year for each year that the worker is employed by the firm. In the second arrangement, the starting wage is less than w but rises over the years to a wage that exceeds w.

If employees can borrow against future earnings, those who work for one company their entire careers are indifferent between the two wage payment schemes if those plans have identical present values. The firm, however, prefers the second payment method because employees work harder to avoid being fired and losing the high future earnings.

Reduced shirking leads to greater output. If the employer and the employee share the extra output in the form of higher profit and lifetime earnings, both the firm and workers prefer the deferred-payment scheme that lowers incentives to shirk.

A drawback of the deferred-payment approach is that, like bond posting, it can encourage employers to engage in opportunistic behavior. For example, an employer might fire nonshirking senior workers to avoid paying their higher wages, and then replace them with less expensive junior workers. However, if the firm can establish a reputation for not firing senior workers unjustifiably, the deferred-payment system can help prevent shirking.

EFFICIENCY WAGES

As we've seen, the use of bonds and deferred payments discourages shirking by raising an employee's cost of losing a job. An alternative is for the firm to pay an efficiency wage: an unusually high wage that a firm pays workers as an incentive to avoid shirking.[11] If a worker who is fired for shirking can immediately go to another firm and earn the same wage, the worker risks nothing by shirking. However, a high wage payment raises the cost of getting fired, so it discourages shirking.[12]

How Efficiency Wages Act Like Bonds. Suppose that a firm pays each worker an efficiency wage w, which is more than the *going wage* $\underline{w}$ that an employee would earn elsewhere after being fired for shirking. We now show that the less frequently the firm monitors workers, the greater the wage differential must be between w and $\underline{w}$ to prevent shirking.

An efficiency wage acts like a bond to prevent shirking. A risk-neutral worker decides whether to shirk by comparing the expected loss of earnings from getting fired to the value, G, that the worker places on shirking. An employee who never shirks is not fired and earns the efficiency wage, w. A fired worker goes elsewhere and earns the lower, going wage, $\underline{w}$. Consequently, a shirking worker expects to lose $\theta(w - \underline{w})$, where θ is the probability that a shirking worker is caught and fired and where the term in parentheses is the lost earnings from being fired. Thus the expected value to a shirking employee is

$$\theta\underline{w} + (1 - \theta)w + G,$$

where the first term is the probability of being caught shirking, θ, times earnings elsewhere if caught and fired; the second term is the probability of not being caught times the efficiency wage; and the third term, G, is the value that a worker derives from shirking. The worker chooses not to shirk if the certain high wage from not shirking exceeds the expected return from shirking:

$$w \geq (1 - \theta)w + \theta\underline{w} + G.$$

Rearranging this expression, we find that a worker does not shirk if the expected loss from being fired is greater than or equal to the gain from shirking:

$$\theta(w - \underline{w}) \geq G. \tag{19.6}$$

The smallest amount by which w can exceed $\underline{w}$ and prevent shirking is determined when this expression holds with equality, $\theta(w - \underline{w}) = G$, or

$$w - \underline{w} = \frac{G}{\theta}. \tag{19.7}$$

The extra earnings, $w - \underline{w}$, in Equation 19.7 serve the same function as the bond, B, in Equation 19.5 in discouraging bad behavior.

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[11]The discussion of efficiency wages is based on Yellen (1984), Stiglitz (1987), and especially Shapiro and Stiglitz (1984).

[12]There are other explanations for why efficiency wages lead to higher productivity. Some economists claim that in less-developed countries, employers pay an efficiency wage—more than they need to hire workers—to ensure that workers can afford to eat well enough that they can work hard. Other economists (Akerlof, 1982) and management experts contend that the higher wage acts like a gift, making workers feel beholden or loyal to the firm, so less (or no) monitoring is needed.

Suppose that the worker gets $G = \$1{,}000$ pleasure a year from not working hard and $\underline{w}$ is \$20,000 a year. If the probability that a shirking worker is caught is $\theta = 20\%$, then the efficiency wage w must be at least \$25,000 to prevent shirking. With greater monitoring, so that θ is 50%, the minimum w that prevents shirking is \$22,000. From the possible pairs of monitoring levels and efficiency wages that deter shirking, the firm picks the combination that minimizes its labor cost.

AFTER-THE-FACT MONITORING

So far we've concentrated on monitoring by employers looking for bad behavior as it occurs. If shirking or other bad behavior is detected after the fact, the offending employee is fired or otherwise disciplined. This punishment discourages shirking in the future.

Punishment. It is often very difficult to detect bad behavior as it occurs but relatively easy to determine it after the fact. As long as a contract holds off payment until after the principal checks for bad behavior, after-the-fact monitoring discourages bad behavior. For example, an employer can check the quality of an employee's work. If it is substandard, the employer can force the employee to make it right.

Insurance companies frequently use this approach in contracts with their customers. Insurance firms try to avoid extreme moral hazard problems by offering contracts that do not cover spectacularly reckless, stupid, or malicious behavior. If an insurance company determines after the fact that a claim is based on reckless behavior rather than chance, the firm will refuse to pay.

For example, an insurance company will not pay damages for a traffic accident if the insured driver is shown to have been drunk at the time. A house insurance company disallows claims due to an explosion that is found to result from an illegal activity such as making methamphetamine. It will certainly disallow claims by arsonists who torch their own homes or businesses. Life insurance companies may refuse to pay benefits to the family of someone who commits suicide (as in the play *Death of a Salesman*).

APPLICATION

Abusing Leased Cars

Because drivers of fleet automobiles such as rental cars do not own them, they do not bear all the cost from neglecting or abusing the vehicles, resulting in a moral hazard problem. These vehicles are driven harder and farther and depreciate faster than owner-operated vehicles. In 2005, about 14% of car shoppers leased their vehicles.

Using data from sales at used-car auctions, Dunham (2003), after controlling for mileage, found that fleet vehicles (not including taxis or police cars) depreciate 10% to 13% more rapidly than owner-driven vehicles.[13] The average auction price for a Pontiac 6000 was \$5,200 for a fleet car and \$6,500 for a nonfleet car. This \$1,300 difference, which was one-fourth of the fleet car's price, reflects the increased depreciation of fleet cars.

[13]According to National Public Radio's *Car Talk*—one of the world's most reliable sources of information—police cars have very few miles on them, but their engines are quickly shot because cops spend untold hours sitting in their cruisers in front of donut shops with the engine running and the air conditioner on high.

To deal with this moral hazard, an automobile-leasing firm commonly writes contracts—open-ended leases—in which the driver's final payment for the vehicle depends on the selling price of the car. In this way, the contract makes the leasing driver responsible for at least some of the harm done to the car, to encourage the lessee to take greater care of the vehicle. Given the difference in auction prices, however, such leases apparently are not the full solution to this moral hazard.

No Punishment. Finding out about moral hazards after they occur is too late if wrongdoers cannot be punished at that time. Indeed, there's no point in monitoring after the fact if punishment is then impossible or impractical. Although it's upsetting to find that you've been victimized, there's nothing you can do beyond trying to prevent the situation from happening again.

APPLICATION

Mortgaging Our Future

Moral hazard played an important role in causing the bankruptcies of many savings and loans (S&Ls) in the late 1980s and early 1990s—and it threatens another disaster today. Individuals loan their money to an S&L because they know that federal or state agencies insure their deposits against an S&L failure. If the S&L defaults, the government must make good on lenders' losses.

To prevent S&L employees from engaging in moral hazards that lead to bankruptcies, government agencies traditionally required these institutions to invest primarily in relatively safe, local residential mortgage loans. However, in the early 1980s, the government changed its rules to allow S&Ls to invest more easily in other assets so that they could diversify their portfolios of investments. With this change, the percentage of investments in nontraditional assets by federally insured S&Ls increased from 11.5% in 1982 to 20.2% in 1985.

To keep S&L officers from engaging in extremely risky behavior or committing fraud, government agencies examined their records. Unfortunately, just when S&Ls were given greater latitude in investment, the number of examinations of S&Ls fell, from 3,210 in 1980 to 2,347 in 1984, and the examinations per billion dollars of assets dropped from 5.4 to 2.4.

After the rules changed, many S&L managers made extremely risky investments, reasoning that they would make a lot of money if these investments paid off, and believing—correctly—that if the S&L went bankrupt, they could walk away with impunity. They anticipated that the federal government would make good on the losses and not punish them (unless fraud was involved—and, apparently, not always even then). The combination of government insurance, greater freedom to invest, and slack monitoring created a moral hazard problem from bad investments.

The fastest-growing S&Ls tended to be those that took the largest risks. Whereas S&Ls that grew less than 15% in 1984 had 68% of their assets in traditional residential mortgages and mortgage-backed securities, S&Ls that were growing at more than 50% had only 53% in traditional assets. In 1985, shaky S&Ls had more commercial (rather than residential) mortgage loans, 13.4% versus 8.1%;

more land loans, 7.7% versus 1.2%; more commercial loans, 2.2% versus 1.3%; and more direct equity (stock) investments, 5.0% versus 1.7%. Many S&Ls that had invested heavily in these relatively risky investments went into bankruptcy when the investments failed.

To bail out the failed S&Ls, the federal government made huge payouts—much larger than those of earlier periods. In 1979, the federal government had had to dispose of only three failed S&Ls through liquidating their assets—about 0.1% of all S&L assets—or finding a new owner. By 1988, however, the federal government had to deal with 205 disposals, representing 7.45% of all S&L assets.

The present discounted value of the government's cost for 1988 alone was $38 billion. By 1990, a conservative estimate of the present value of costs for the financial disasters was about $150 billion, or nearly $600 for every man, woman, and child in the United States. The estimates of losses continue to rise, and taxpayers are still paying for cleaning up the losses created by moral hazards.

To minimize future moral hazard problems among S&Ls, government insurers raised the capital requirements that govern how much money the S&L owners and managers must provide. Now the owners and managers of S&Ls are investing more of their own money and less of account holders' money that is insured by the government. A capital requirement acts like an insurance deductible. It forces S&L managers and owners to put more of their own money (and less of account holders' money) at risk when making investments. As a consequence, the feds hoped that the S&L managers would invest more conservatively.

SOLVED PROBLEM 19.4

An S&L can make one of two types of loans. It can loan money on home mortgages, where it has a 75% probability of earning $100 million and a 25% probability of earning $80 million. Alternatively, it can loan money to oil speculators, where it has a 25% probability of earning $400 million and a 75% probability of losing $160 million (due to loan defaults by the speculators). The manager of the S&L, who will make the lending decision, receives 1% of the firm's earnings. He believes that if the S&L loses money, he can walk away from his job without repercussions, although without compensation. The manager and the shareholders of the company are risk neutral. What decision will the manager make if all he cares about is maximizing his personal expected earnings, and what decision do the stockholders prefer that he make?

Answer

1. *Determine the S&L's expected return on the two investments:* If the S&L makes home mortgage loans, its expected return is

$$(0.75 \times 100) + (0.25 \times 80) = 95$$

million dollars. Alternatively, if it loans to the oil speculators, its expected return is

$$(0.25 \times 400) + [0.75 \times (-160)] = -20$$

million dollars, an expected loss.

2. *Compare the S&L manager's expected profits on the two investments:* The manager expects to earn 1% of $95 million, or $950,000, from investing in mortgages. His take from investing in oil is 1% of $400 million, or $4 million, with a probability of 25% and no compensation with a probability of 75%. Thus he expects to earn

$$(0.25 \times 4) + (0.75 \times 0) = 1$$

million dollars from investing in oil. Because he is risk neutral and does not care a whit about anyone else, he invests in oil.

3. *Compare the shareholders' expected profits on the two investments:* The shareholders expect to receive 99% of the profit from the mortgages, or 0.99 × $95 million = $94.05 million. With the oil loans, they earn 99% of the $400 million, or $396 million, if the investment is good, and bear the full loss in the case of defaults, $160 million, so their expected profit (loss) is

$$(0.25 \times 396) + [0.75 \times (-160)] = -21$$

million dollars. Thus the shareholders would prefer that the S&L invest in mortgages.

Comment: Given that the manager has the wrong incentives (and no integrity), he makes the investment that is not in the shareholders' interest. One possible solution to the problem of their diverging interests is to change the manager's compensation scheme.

19.6 Contract Choice

We have examined how to construct a single contract so as to prevent moral hazards. Often, however, a principal gives an agent a choice of contracts. By observing the agent's choice, the principal obtains enough information to prevent agent opportunism.

Firms want to avoid hiring workers who will shirk. Employers know that not all workers shirk, even when given an opportunity to do so. So rather than focusing on stopping lazy workers from shirking, an employer may concentrate on hiring only industrious people. With this approach, the firm seeks to avoid *moral hazard* problems by preventing *adverse selection,* whereby lazy employees falsely assert that they are hardworking.

As discussed in Chapter 18, employees may *signal* to employers that they are productive. For example, if only nonshirking employees agree to work long hours, a commitment to working long hours serves as a reliable signal. In addition, employees can signal their productiveness by developing a reputation as hard workers. To the degree that employers can rely on this reputation, sorting is achieved.

When workers cannot credibly signal, firms may try to *screen out* bad workers. One way in which firms can determine which prospective employees will work hard and which will shirk is to give them a choice of contracts. Job candidates, by selecting a contingent contract in which their pay depends on how hard they work, signal that they are hard workers. In contrast, if job applicants choose a fixed-fee contract, they

TABLE 19.3 Firm's Spreadsheet

	Contingent Contract (30% of Sales), $	Fixed-Fee Contract ($25,000 Salary), $
Hard Worker		
Sales	100,000	100,000
− Salesperson's pay	−30,000	−25,000
= Firm's net revenue	70,000	75,000
− Office expenses	−50,000	−50,000
= Firm's profit	20,000	25,000
Lazy Worker		
Sales	60,000	60,000
− Salesperson's pay	−18,000	−25,000
= Firm's net revenue	42,000	35,000
− Office expenses	−50,000	−50,000
= Firm's profit	−8,000	−15,000

signal that they are lazy workers. Thus the firm can tell the applicants apart by their choices.

Suppose that a firm wants to hire a salesperson who will run its Cleveland office and that the potential employees are risk neutral. A hardworking salesperson can sell $100,000 worth of goods a year, but a lazy one can sell only $60,000 worth (see Table 19.3). A hard worker can earn $30,000 from other firms, so the firm considers using a contingent contract that pays a salesperson a 30% commission on sales.

If the firm succeeds in hiring a hard worker, the salesperson makes $30,000 = $100,000 × 0.30. The firm's share of sales is $70,000. The firm has no costs of production (for simplicity), but maintaining this branch office costs the firm $50,000 a year. The firm's profit is therefore $20,000. If the firm hires a lazy salesperson under the same contract, the salesperson makes $18,000, the firm's share of sales is $42,000, and the firm loses $8,000 after paying for the office.

Thus the firm wants to hire only a hard worker. Unfortunately, the firm does not know in advance whether a potential employee is a hard worker. To acquire this information, the firm offers a potential employee a choice of contracts:

- *Contingent contract:* No salary and 30% of sales
- *Fixed-fee contract:* Annual salary of $25,000, regardless of sales

A prospective employee who doesn't mind hard work would earn $5,000 more by choosing the contingent contract. In contrast, a lazy candidate would make $7,000 more from a salary than from commissions. If an applicant chooses the fixed-fee contract, the firm knows that the person does not intend to work hard and decides not to hire that person.

The firm learns what it needs to know by offering this contract choice as long as the lazy applicant does not pretend to be a hard worker and chooses the contingent contract. Under the contingent contract, the lazy person makes only $18,000, but that offer may dominate others available in the market. If this pair of contracts fails to sort workers, the firm may try different pairs. If all these choices fail to sort the potential employees, the firm must use other means to prevent shirking.

Summary

1. Principal-Agent Problem: A principal contracts with an agent to perform some task. The size of their joint profit depends on any assets that the principal contributes, the actions of the agent, and the state of nature. If the principal cannot observe the agent's actions, the agent may engage in opportunistic behavior. This moral hazard reduces the joint profit. An efficient contract leads to efficiency in production (joint profit is maximized by eliminating moral hazards) and efficiency in risk bearing (the less-risk-averse party bears more of the risk). Three common types of contracts are *fixed-fee contracts*, whereby one party pays the other a fixed fee and the other keeps the rest of the profits; *hire contracts*, in which the principal pays the agent a wage or by the piece of output produced; and *contingent contracts*, wherein the payoffs vary with the amount of output produced or in some other way. Because a contract that reduces the moral hazard may increase the risk for a relatively risk-averse person, a contract is chosen to achieve the best trade-off between the twin goals of efficiency in production and efficiency in risk bearing.

2. Production Efficiency: Whether efficiency in production is achieved depends on the type of contract that the principal and the agent use and on the degree to which their information is asymmetric. For the agent in our example to put forth the optimal level of effort, the agent must get the full marginal profit from that effort or the principal must monitor the agent. When the parties have full information, an agent with a fixed-fee rental or profit-sharing contract gets the entire marginal profit and produces optimally without being monitored. If the principal cannot monitor the agent or does not observe profit and cost, only a fixed-fee rental contract prevents moral hazard problems and achieves production efficiency.

3. Trade-Off Between Efficiency in Production and in Risk Bearing: A principal and an agent may agree to a contract that strikes a balance between reducing moral hazards and allocating risk optimally. Contracts that eliminate moral hazards require the agent to bear the risk. If the agent is more risk averse than the principal, the parties may trade off a reduction in production efficiency to lower risk for the agent.

4. Payments Linked to Production or Profit: To reduce shirking, employers may reward employees for greater individual or group productivity. Piece rates, which reward individuals who work unusually fast, are practical only when individual output can be easily measured and the quality of work is not critical. Bonuses and stock options that reward workers for increases in group effort provide less of an incentive than piece rates but still may reduce shirking.

5. Monitoring: Because of asymmetric information, an employer must normally monitor workers' efforts to prevent shirking. Less monitoring is necessary as the employee's interest in keeping the job increases. The employer may require the employee to post a large bond that is forfeited if the employee is caught shirking, stealing, or otherwise misbehaving. If an employee cannot afford to post a bond, the employer may use deferred payments or efficiency wages—unusually high wages—to make it worthwhile for the employee to keep the job. Employers may also be able to prevent shirking by engaging in after-the-fact monitoring. However, such monitoring works only if bad behavior can be punished after the fact.

6. Contract Choice: A principal may be able to prevent moral hazard problems from adverse selection by observing choices made by potential agents. For example, an employer may present potential employees with a choice of contracts, prompting hardworking job applicants to choose a contract that compensates the worker for working hard and lazy candidates to choose a different contract that provides a guaranteed salary.

Questions

** = answer at the back of this book; W = audio-slide show answers by James Dearden at* www.aw-bc.com/perloff

*1. In the duck-carving example with full information (which the second column of Table 19.1 summarizes), is a contract efficient if it requires Paula to give Arthur a fixed-fee salary of $168 and leaves all the decisions to Arthur? If so, why? If not, are there additional steps that Paula can take to ensure that Arthur sells the optimal number of carvings?

2. The state of California set up its own earthquake insurance program in 1997. Because the state agency in charge has few staff members, it pays private insurance carriers to handle claims for earthquake damage. These insurance firms receive 9% of each approved claim. Is this compensation scheme likely to lead to opportunistic behavior by insurance companies? Explain. What would be a better way to handle the compensation?

3. Two students are given an assignment to produce a joint report for which they will receive the same grade. What problems, if any, are likely to arise?

4. In the duck-carving example with limited information (summarized in the third and fourth columns of Table 19.1), is a fixed-fee contract efficient? If so, why? If not,

are there additional steps that Paula can take to ensure efficiency?

5. A health insurance company tries to prevent the moral hazard of "excessive" dentist visits by limiting the number of visits each person can have per year. How does such a restriction affect moral hazard and risk bearing? Show in a graph.

*6. Some sellers offer to buy back a good later at some prespecified price. Why would a firm make such a commitment?

7. Traditionally, doctors have been paid on a fee-for-service basis. Now doctors are increasingly paid on a capitated basis: They get paid for treating a patient for a year, regardless of how much treatment is required. In this arrangement, doctors form a group and sign a capitation contract whereby they take turns seeing a given patient. What are the implications of this change in compensation for moral hazards and for risk bearing?

8. Fourteen states have laws that limit a franchisor's ability to terminate a franchise agreement. What effects do such laws have on production efficiency and risk bearing?

*9. A promoter arranges for many different restaurants to set up booths to sell Cajun-Creole food at a fair. Appropriate music and other entertainment are provided. Customers can buy food using only "Cajun Cash," which is scrip that has the same denominations as actual cash and is sold by the promoter at the fair. Why aren't the food booths allowed to sell food directly for cash?

10. Many law firms consist of partners who share profits. On being made a partner, a lawyer must post a bond, a large payment to the firm that will be forfeited on bad behavior. Why?

11. According to a flyer from Schwab's *Advisor-Source*, "Most personal investment managers base their fees on a percentage of assets managed. We believe this is in your best interest because your manager is paid for investment management, not solely on the basis of trading commissions charged to your account. You can be assured your manager's investment decisions are guided by one primary goal—increasing your assets." Is this policy in a customer's best interest? Why or why not?

12. Is shirking more likely to be a problem when employees are paid by the piece or by the hour? Explain.

*13. Zhihua and Pu are partners in a store in which they do all the work. They split the store's *business profit* equally (ignoring the opportunity cost of their own time in calculating this profit). Does their business profit-sharing contract give them an incentive to maximize their joint economic profit if neither can force the other to work? (*Hint:* Imagine Zhihua's thought process late one Saturday night when he is alone in the store, debating whether to keep the store open a little later or go out on the town.)

*14. When I was in graduate school, I shared an apartment with a fellow who was madly in love with a woman who lived in another city. They agreed to split the costs of their long-distance phone calls equally, regardless of who placed the calls. What is the implication of this fee-sharing arrangement on their total phone bill? Why?

15. In 2005, the co-founders of Google, Larry Page and Sergey Brin, asked that their annual pay be reduced to \$1 (from \$150,000 with bonuses of \$206,556 in 2003, and \$43,750 plus bonuses of \$1,556 in 2004). Chief executive Eric Schmidt made the same request (Verne Kopytoff, "Google's Execs Paid \$1 a Year," *San Francisco Chronicle*, April 9, 2005:C1, C2). Their compensation would be based on increases in the value of the vast amounts of Google stock that each owned (as of March 28, 2005, Page had 36.5 million Google shares; Brin, 36.4 million; and Schmidt, 13.9 million). How would you feel about this offer if you were a shareholder? What are the implications for moral hazard, efficiency, and risk sharing?

Problems

16. Book retailers can return unsold copies to publishers. Effectively, retailers pay for the books they order only after they sell the books. Dowell's Books believes that it will sell, with 1/2 probability each, either 0 or 1 copy of *The Fool's Handbook of Macroeconomics*. The bookstore also believes that it will sell, with 1/2 probability each, either 0 or 1 copy of *The Genius's Handbook of Microeconomics*. The retail price of each book is \$25. Suppose that the marginal cost of manufacturing another copy of a book is \$6. The publisher's value of a returned copy is zero. The *Microeconomics* publisher charges a \$13 wholesale price and offers a full refund if an unsold book is returned. While the *Macroeconomics* publisher charges a low \$10.50 wholesale price, it pays a retailer only \$8 if it returns an unsold book. Dowell's places an order for one copy of each title. When the two books arrive, Dowell's has space to shelve only one. Which title does Dowell's return? Comment on how Dowell's decision about which title to return depends on the books' wholesale prices and on the compensation from the publishers for returned unsold books. **W**

17. In the National Basketball Association (NBA), the owners share revenue but not costs. Suppose that one team, the L.A. Clippers, sells only general-admission seats to a home

game with the visiting Philadelphia 76ers (Sixers). The inverse demand for the Clippers-Sixers tickets is $p = 100 - 0.004Q$. The Clippers' cost function of selling Q tickets and running the franchise is $C(Q) = 10Q$.

a. Find the Clippers' profit-maximizing number of tickets sold and the price if the Clippers must give 50% of their revenue to the Sixers. At the maximum, what are the Clippers' profit and the Sixers' share of the revenues?
b. Instead, suppose that the Sixers set the Clippers' ticket price based on the same revenue-sharing rule. What price will the Sixers set, how many tickets are sold, and what revenue payment will the Sixers receive? Explain why your answers to parts a and b differ.
c. Now suppose that the Clippers must share their profit rather than their revenue. The Clippers keep 45% of their profit and share 55% with the Sixers. The Clippers set the price. Find the Clippers' profit-maximizing price and determine how many tickets the team sells and its share of the profit.
d. Compare your answers to parts a and c using marginal revenue and marginal cost in your explanation. **W**

18. Warner Bros. Studios sells DVD copies of its films to Blockbuster, and the studio has revenue-sharing arrangements with the rental chain for VCR tapes of its films (Bruce Orwall, Martin Peers, and Ann Zimmerman, "DVD Gains on Tape, but Economics Have Hollywood in a Tizzy," *Wall Street Journal*, February 5, 2002, A1.) Suppose that Blockbuster is the only place where Perkasie, Pennsylvania, residents can rent videos and that the Saturday-night demand function to rent *L.A. Confidential* on either DVD or VHS is $p = 10 - Q/2$.
    a. Suppose that the Perkasie Blockbuster purchased 10 copies of *L.A. Confidential* under the studio sales arrangement. What is Blockbuster's optimal rental price?
    b. Suppose that Blockbuster pays the studio \$2 per copy rented under the revenue-sharing arrangement, and that the store has 10 copies in stock. What is Blockbuster's optimal rental price?
    c. Compare your answers to parts a and b. **W**

19. Suppose that a textbook author is paid a royalty of ω share of the revenue from sales, where the revenue is $R = pq$, p is the competitive market price for textbooks, and q is the number of sold copies of this textbook (which is similar to others on the market). The publisher's cost of printing and distributing the book is $C(q)$. Determine the equilibrium, and compare it to the outcome that maximizes the sum of the payment to the author plus the firm's profit. Answer using both math and a graph.

20. Suppose now that the textbook publisher in Problem 19 faces a downward-sloping demand curve. The revenue is $R(Q)$, and the publisher's cost of printing and distributing the book is $C(Q)$. Compare the equilibria for the following compensation methods in which the author receives the same total compensation from each method:
    a. The author is paid a lump sum, $\mathcal{L}$.
    b. The author is paid α share of the revenue.
    c. The author receives a lump-sum payment and a share of the revenue.

    Why do you think that authors are usually paid a share of the revenue?

*21. In Solved Problem 19.3, a firm calculated the optimal level of monitoring to prevent stealing. If $G = \$500$ and $\theta = 20\%$, what is the minimum bond that deters stealing?

22. In Problem 21, suppose that, for each extra \$1,000 of bonding the firm requires a worker to post, the firm must pay that worker \$10 more per period to get the worker to work for the firm. What is the minimum bond that deters stealing?

23. John manages Rachel's used CD music store. To provide John with the incentive to sell CDs, Rachel offers him 50% of the store's profit. John has the opportunity to misrepresent sales by fraudulently recording sales that actually did not take place. Let t represent his fraudulent profit. John's expected earnings from reporting the fraudulent profit is $0.5t$. Rachel tries to detect such frauds and either detects all or none of the fraud. The probability that Rachel detects the entire fraud is $t/(1 + t)$ and the probability that Rachel does not detect the fraud is $1 - t/(1 + t)$. Hence, Rachel's probability of detecting fraud is zero if John reports no fraudulent profit, increases with the amount of fraudulent profit he reports, and approaches 1 as the amount of fraud approaches infinity. If Rachel detects the fraud, then $x > 0.5$ is the fine that John pays Rachel per dollar of fraud. John's expected fine of reporting fraudulent profit t is $t^2x/(1 + t)$. In choosing the level of fraud, John's objective is to maximize his expected earnings from the fraud, $0.5t$, less his expected fine, $t^2x/(1 + t)$. As a function of x, what is John's optimal fraudulent profit? (*Hint:* check the second-order condition.) Show that $\partial t/\partial x < 0$. Also show that as $x \to \infty$, John's optimal reported fraudulent profit goes to zero. **W**