

Law & Economics
Lecture 3: Risk & Insurance

I. Why Risk & Insurance Are Important.

In everything we've done so far, we've assumed that everything happens with certainty. If the steel mill operates at the same time as the ski lodge, the ski lodge definitely suffers \$200,000 in damage. If a train without a spark catcher goes by a wheat field, the wheat catches fire; if the train puts on a spark catcher, fires are eliminated. These types of damage caused with certainty usually fall within the law of nuisance, which is a part of the law of property.

But there are numerous problems encountered in the law that involves probabilities instead of certainties. When you drive your car, it is not a certainty that you will hit another car or a pedestrian, but it's a possibility. When a company produces soft drink bottles, it's not a certainty that any given bottle will explode, but there's a probability that any given bottle will explode (and also a certainty that some fraction of all the bottles will explode). If you're a surgeon operating on a patient, it's (we hope) not a certainty that you'll make a fatal error, but you might. If your company's janitor mops the lobby floor and fails to put out a "caution: slippery floor" sign, maybe no one will get injured, but someone might -- and more importantly, the probability of an injury is higher than if he had put up the sign. All of these examples fall within the law of tort, one of the most important and controversial parts of the common law. To deal with situations like these from an economic perspective, we need an understanding of risk and how people respond to it.

But why talk about insurance? Because one thing that legal rules relating to risky situations do, in some instances, is to insure people against risk. For example, a legal rule that holds firms responsible for medical damages caused by their products allocates the risk of those damages to the firm. A different legal rule, one that lets the damages fall on the customers, would allocate risk differently. By the way, don't assume that it's necessarily better to place the risk on the firm, because (to point out just one objection) the cost of assuming that risk will be factored into the price of the good. So the question is whether the gains to the consumer from being shielded from risk are worth the added price. (This is actually simplifying things a good deal, as we will see later.)

II. The Basic Theory of Risk & Insurance.

A "gamble" is defined as a risky situation with a probability for each possible outcome, such that all the probabilities add up to 1. For example, a coin toss is a gamble that assigns a probability $1/2$ to heads, $1/2$ to tails. Or suppose you have a \$10,000 that has a 5% chance of getting in an accident that reduces its value to \$5000. Then you face a gamble with $p = .95$ of \$10,000 and $p = .05$ of \$5000.

The expected value of any gamble is the average outcome you'd expect to get if you repeated the gamble many, many times. For example, suppose you flip a coin repeatedly,

and you get one point for every head and zero points for every tail. What average score would you expect to get after thousands of tosses? You'd get approximately 1 point for every two throws, or 1/2 point on average, so 1/2 is the expected value of this gamble.

Or consider the car example above. If you had thousands of drivers and cars just like you and yours, you'd expect that 5% of them would get in wrecks and 95% would not. The expected value of this gamble is

$$EV(G) = .95(10,000) + .05(5000) = 9750.$$

In other words, your average driver ends up with \$9750. Of course, there is no single driver who ends up with \$9750; some end up with \$10,000 and some with \$5000. But average them all up, and you get \$9750 per driver. (Another way to think about this: 5% of the time you're going to lose \$5000. So the average driver loses \$250, which we call the expected loss.)

The expected value of a gamble is important for various reasons, but for right now, I bring it up because it's an important benchmark for talking about attitudes toward risk. Your attitude toward risk is essentially your willingness or unwillingness to accept risks. Like your attitudes toward apples and oranges, Hondas and Ferraris, your attitude toward risk is a subjective matter; there is no objectively correct attitude toward risk. Our purpose here is to classify different attitudes toward risk.

Let's say you have a really great lottery ticket that gives you a 50% chance of winning a million dollars and a 50% chance of winning nothing. I offer you \$500,000 for the ticket. Which do you want, the money or the ticket? Most people would choose the money. And indeed, most people would take the money even if it were less than \$500,000 -- maybe as low as \$250,000 or even lower. We call these people "risk averse." That is one attitude toward risk.

Some people, however, would not sell their ticket for \$500,000. They might require a larger payment, like \$600,000. These individuals are called "risk loving." And some people might be willing to accept \$500,000 but nothing less, because they are exactly indifferent between \$500,000 and the ticket. We call these individuals "risk neutral."

More generically, we say that you are

- risk averse if a gamble is worth less to you than its expected value;
- risk loving if a gamble is worth more to you than its expected value;
- and risk neutral if a gamble is worth exactly its expected value to you.

Most people are risk averse, at least with respect to gambles that involves a risk of a large loss. The important thing to realize about risk averters is that they are willing to pay money to avoid risks. Consider an alternative version of the lottery above. Now you start with \$500,000, and you have a 50% chance of losing it and a 50% chance of doubling it. This is really the same gamble. Now, how much would you pay (out of the \$500,000) to be assured of keeping the rest? Let's say the lowest price you were willing to accept for your ticket before was \$300,000. Then you should be willing to pay as

much as \$200,000 in this version of the story. By doing so, you'd be buying a form of insurance.

Let's take the car example again. You are in a risky situation with an expected loss of \$250 (from a 5% chance of a \$5000 loss). How much money would you pay to avoid this risk? If you'd pay more than \$250, you're risk averse. If \$250 is the maximum you'd pay, you're risk neutral. And if you're only willing to pay something less than \$250, you're risk loving.

The fact that many people are risk averse is what allows insurance companies to exist. An insurance company allows you the opportunity to exchange a risk for a certainty. Insurance, put simply, is an exchange in which you make a payment in order to get rid of a gamble. Suppose you'd be willing to pay \$300 to avoid the risk to your car. An insurance company might offer you a policy that will pay you \$5000 in the event of an accident, in return for a premium of \$275.

Buying insurance makes you better off, but what about the insurance company? The insurance company just accepted a payment to acquire a risk. If the company were just one (risk averse) person, that might be a bad thing, because \$275 might not be worth it. But an insurance company usually insures many people. If it insures thousands of people just like you, it knows that 5% of them will get in accidents. On average, the company will have to pay out \$250 per policy. The \$275 premium is presumably enough to cover this expected loss, plus pay off administrative costs and (maybe) make a profit.

Pooling risk allows risks to be converted into actual frequencies. A 5% probability to you is 5% of all clients to the insurance company. Because of the fact that insurance companies can pool risk in this way, they are usually treated as risk neutral agents. And because risk neutral agents are not affected by risk (they don't suffer a loss in utility like a risk averse person does), they are in many cases the most efficient bearers of risk.

III. Risk Allocation and the Law.

We have just observed that some agents are more efficient bearers of risk than others. It makes sense, other things equal, to allocate risk toward less risk averse agents. (We will have to modify this conclusion later, but assume it's true for now.) We have also observed that legal rules allocate risk. It follows that in deciding which legal rules are efficient, we should consider to whom they allocate risk.

Suppose that the law says that firms are not liable for damage caused by exploding bottles. And suppose you buy a \$1 bottle of Coke that has a .01% chance of exploding, causing \$1000 in damage to you. On average, this bottle of Coke will cause ten cents in damage (that's the expected loss), but you're risk averse. You'd probably pay more than a dime to avoid this risk. Now suppose the law changes to require firms to pay for all losses from exploding bottles. The firm sells enough bottles of Coke that it can assume exactly .01% of all bottles it sells will explode. The company now sees that marginal cost of selling a bottle has risen by ten cents, so the price per bottle will rise to \$1.10.

When you buy that bottle of Coke, you're also buying some insurance. You're paying ten cents more than you would have otherwise, in return for being shielded against the risk of explosion. And given the assumptions we've made -- specifically, that the legal rule doesn't affect the probability of explosion -- this is a more efficient situation. Risk has been shifted from a risk averse agent (you) to a risk neutral agent (the firm). Of course, the insurance isn't free -- you had to pay for it in the form of a higher price -- but it's worth it. The firm is no worse off, and you're better off.

But there's one more question here: Does it make sense for the firm to act as an insurance provider? Sure, maybe it's more efficient for the firm to insure than for the customer to bear the risk. But there is another alternative: if customers want insurance, they can buy it elsewhere, from companies that specialize in the handling of risk. This is probably the most efficient outcome of all. At least, it is until we introduce another wrinkle...

IV. Moral Hazard (as a bug)

Unfortunately, the world isn't so simple. Risks do not remain the same regardless of who bears them. Instead, risks are affected by the actions that people take, and what actions people take depend on the incentives they face, including legal rules.

The term "moral hazard" refers to the fact that people tend to engage in riskier behavior when they are shielded against the consequences of the risk. This is particularly relevant in the context of insurance: people tend to be riskier when they are insured.

Take the car example. Suppose that once you're insured, your chance of a \$5000 accident rises to 7%, because you don't drive as carefully (why should you?). So once you're insured, the expected loss is \$350 instead of \$250. The insurance company cannot possibly charge you a premium less than \$350, or else they'll go bankrupt. Now, maybe you'll buy the insurance if you're sufficiently risk averse, i.e., if you're willing to pay more than \$350 to avoid a 5% chance of losing \$5000. But if you're only mildly risk averse, only willing to pay up to \$300 to avoid the risk, then you won't buy the policy.

From an efficiency perspective, what's important is whether or not cost-justified precautions are taken. A cost-justified precaution is one that saves more (in expected value) than it costs to implement. In the case of your car, there are apparently some actions you can take (like driving more slowly) that will reduce the risk of an accident by 2%. In other words, you can reduce the expected loss by $.02(\$5000) = \100 . Now, how valuable is driving fast to you? Suppose it's worth only \$90. The opportunity cost of driving slowly is \$90, and by doing so you reduce the expected loss by \$100. So it's efficient for you to drive slowly. (On the other hand, if driving fast were worth \$110 to you, it would be efficient to drive fast.) In order to make sure the efficient thing happens, you must be exposed to the consequences of your risk-taking behavior. But if you're insured against the risk, you won't. This is the loss in efficiency due to moral hazard.

DDF gives the example of a firm with a plant that may catch on fire. Say that the firm can install a sprinkler system for \$9,000, and doing so will reduce the probability of a \$1 million fire by 1% (e.g., from 4% to 3%). Then the sprinkler system creates expected savings of $.01(\$1,000,000) = \$10,000$, at a cost of only \$9000. Clearly, it makes sense for the firm to install the sprinkler system. But what if the firm insures the plant against fire? From an efficiency perspective, it still makes sense to install the sprinkler system. But the firm no longer has an incentive to do so, because it's insured against the loss.

There are a variety of ways that insurance markets deal with moral hazard problems like this, the most obvious of which is simply writing insurance contracts that require the insured party to take certain precautions. The fire insurance company can make sprinklers a condition of the policy. A health insurance company can require insured customers to get regular physicals and check-ups.

To relate this to the legal system again, let's go back to the Coke bottle example. What if customers have a measurable effect on the probability of Coke bottles exploding? They can be sure not to leave the bottles out on a hot day, they can be careful to not to shake them up, etc. The legal rule that puts responsibility for explosion damage on the firm is, you may recall, a form of insurance. The rule effectively requires customers to buy insurance from the bottling company. But if the situation is as we've described, a moral hazard problem may result. Customers may fail to take cost-justified precautions against bottle explosions.

So we have a potential dilemma here. On the one hand, our analysis of risk bearing tells us that it's more efficient for the risk neutral party to bear risk. On the other hand, our analysis of moral hazard tells us that shifting risk away from someone whose behavior can affect the size of the risk can create inefficiency. Which one of these effects predominates? It all depends on the facts of the situation.

V. Moral Hazard (as a feature)

In the discussion above, I implicitly assumed that only one party had the capacity to affect the size of the risk. In the car example, I assumed that the driver could affect the probability of risk but the insurance company could not. In the Coke bottle example, I assumed the customer could affect the likelihood of explosion, but the firm could not.

In many real-world situations, however, risks are affected by the actions of multiple parties. The likelihood of the Coke bottle exploding is affected by both the manufacturer of the bottle and the actions of the consumer. In a situation like this, the question becomes: who is the more efficient avoider of risk? This turns out to be another version of the question raised in the discussion of externalities: who is the least-cost avoider of damage?

Take the example of the firm insuring its plant against fire. Since the fire insurance company is in the business of dealing with fires, it may employ experts with a great deal of expertise in fire prevention. They may have a better idea of what precautions should

be taken than do the firm's managers. So it might turn out that buying insurance doesn't create a moral hazard problem, but solves one: it gives the insurance company an incentive to use its expertise to reduce the risk of fire in the plant, so long as the insurance contract gives it the right to do so.

The Coke bottle example illustrates the point even better. Suppose that only the firm can affect the likelihood of bottle explosions. In that case, placing responsibility on the firm does not just improve efficiency by shifting risk to the risk-neutral party -- it also improves efficiency by giving the firm an incentive to reduce the risk of explosions. In other words, a legal rule that makes the firm an insurer also solves a moral hazard problem.

Unfortunately, things are rarely so simple. In truth, both the firm and its customers can affect the size of the risk. No matter where you place the responsibility for damages, you have a moral hazard problem. Hold the firm responsible, and customers won't take all cost-justified precautions. Hold the customers responsible, and the firm won't take all cost-justified precautions. So from an efficiency standpoint, the choice is not a clear one. The efficient rule will place responsibility on the better avoider of risk -- that is, the party who can reduce risk the most at the least cost.

VI. Adverse Selection

There's one more problem that arises in insurance situations: adverse selection. While moral hazard arises from the fact that the behavior of a single agent can affect the probability of an accident, adverse selection arises from the fact that some agents are riskier than others. If an insurer cannot tell the difference between them, an adverse selection problem can arise. (Another way of saying the same thing: Adverse selection can arise when insurers cannot tell the difference between people with different degrees of risk.)

Suppose that half of the people in the population have a gene that causes them to have a 10% chance of breaking a bone. People without this gene have only a 5% chance of breaking a bone. Assume that people know whether they have the gene or not. The cost of fixing a broken bone is \$2000. If the firm could tell the difference between the two groups, the minimum premium it could charge for the groups would be \$200 (for those with the gene) and \$100 (for those without).

But what if the firm can't tell the difference between them? Then the insurance company will -- at first -- assume that each customer has a 50% chance of having the gene. The expected loss is \$150, exactly in between the premiums it would charge the groups separately if it could distinguish.

This policy is a great deal for the people with the gene; they are getting \$200 in expected benefits at a price of only \$150. But it's a bad deal for the people without the gene; they are getting \$100 in expected benefits at a price of \$150. Some of them, the most risk averse, will buy the policy anyway. But others will choose not to buy the policy.

Now, the insurance company can predict that people will behave this way. So it knows that even though only half the people in the population have the gene, more than half of the people who want to buy a policy at \$150 have the gene. And that means the price of \$150 is too low, because the \$150 premium was based on the assumption that half the customers don't have the gene. So the firm raises the premium. And then some more healthy people decide it's not worth it, so they drop their policies. And then the firm has to raise its premium again.

The process described above is called adverse selection. Adverse selection is a process in which only the riskiest people get insured as a result of asymmetric information. More broadly, adverse selection occurs whenever asymmetric information causes some mutually beneficial trades not to occur.

Like moral hazard, adverse selection has applications in the law. Here's just one. In the soft drink bottling example, suppose that the law places responsibility for damages on the consumer. Also suppose that there is something the bottling company can do to reduce expected damages by fifteen cents, at a cost of ten cents. Clearly, this is a cost-justified precaution, and consumers should be in favor of it. So, you might ask, why don't they demand it? If Coke takes this precaution, and consumers know it, then they'll be willing to pay more for Coke than for similar soft drinks in less safe bottles. It should be in Coke's interest to do this, because the value to consumers increases more than marginal cost.

That may well happen if there's good information. But what if customers can't tell which company's bottles are safe and which ones are not? They'll know that some bottles are safe and some are not. They'd pay fifteen cents more if they knew for sure, but they'll only pay, say, eight cents more if they can't be sure which kind of bottle they're getting. This situation is great for the unsafe bottlers, but the bottlers using the safe procedure are paying ten cents for only eight cents of benefit. So these bottlers will either stop selling or stop using the procedure. Eventually, only unsafe bottlers remain; this is an instance of adverse selection.

This seems to be an argument for placing responsibility on bottlers, and indeed it is. But we can construct a similar example in which there's adverse selection among the customers. If some customers create a greater risk of explosion than others, and the bottlers can't tell the difference, the bottlers have to sell at the same price to both groups (just as the insurance company has to offer the same premium to all customers who appear the same). But then which customers will be most likely to buy? The less safe customers, of course, and that means the firm will have to charge a higher price because more of its bottles will explode. This may seem like a strange example, but it makes more sense when you think about which customers are most likely to buy sports cars or fireworks.

VII. Ex Post versus Ex Ante Punishment.

When there is no uncertainty, punishing your act and punishing the result of your act are the same thing. If the railroad's sparks always cause wheat to catch fire, then punishing the railroad for throwing sparks and punishing it for the damage caused by its fires are exactly the same thing.

But when outcomes result only probabilistically from acts, there is a distinction. If I speed on the freeway, that doesn't directly harm anyone, but it increases the probability that I'll get into a wreck that damages someone else's car. There are two ways I can be punished in this situation: first, I can be penalized for the act of speeding; second, I can be penalized for the actual damage that results from the accidents I cause. Or I can be punished in both ways. What are the advantages and disadvantages of each mode of punishment?

Here's one unsatisfactory answer: that ex ante punishment stops accidents before they occur. But this answer doesn't make sense, because ex post punishment does that, too. Both ex ante and ex post punishments have the purpose of deterring me from doing dangerous things. Let's say that some action I could take stands a 10% chance of causing \$10,000 in damage. And let's say I derive only \$500 of benefit from doing it, so it's an inefficient action. If I have to pay the damages ex post, that means I stand a 10% chance of having to pay \$10,000, which is an expected loss of \$1000. I compare that to \$500 of benefit and decide not to do it. And an ex ante punishment of \$1000 for taking the action would have exactly the same effect. (Indeed, for a risk averse person, the deterrent effect of the ex post punishment would be greater.)

So what's the correct answer?

Advantage #1 of Ex Post over Ex Ante: Ex post takes advantage of private information about how to reduce risk. DDF gives the example of a car driver who gets distracted by the radio, or other people in the car, or plain old daydreaming. It's very difficult to punish these things ex ante. Only observable actions can be punished ex ante. But an ex post punishment holds you responsible for the damages regardless of the reason for your carelessness, thereby giving you an incentive to take all cost-justified precautions.

Advantage #2 of Ex Post over Ex Ante: Ex post typically involves lower administrative costs. Why? Because when something happens with low probability, ex post punishments allow the system to deal only with the few situations where the event actually happens. Ex ante punishments, on the other hand, have to be meted out in every instance where the risk-creating activity occurs (or at least a large fraction of the time).

Advantage #1 of Ex Ante over Ex Post: Ex ante provides incentives based on the beliefs of the law makers rather than the people the law applies to. The vast majority of drivers think they are better than average, although that's clearly false. People who think they can drive faster (or drunker) without substantially affecting the probability of an accident will not change their behavior in response to an ex post punishment. But they will change their behavior in response to an ex ante punishment, since that punishment applies whether or not the accident takes place.

Advantage #2 of Ex Ante over Ex Post: Ex ante gives risk averse people the same incentives at lower cost. Ex post punishment puts you in the position of having to pay a very large amount with a low probability; risk averse people would rather pay a smaller amount with certainty. In a sense, ex ante punishment is a form of insurance. Of course, you can buy insurance privately as well, so this is not a great argument for having the legal system use ex ante punishments.

Advantage #3 of Ex Ante over Ex Post: Ex post punishments create a problem of judgment-proof defendants. Most people are capable of paying small fines over time, but they are unlikely to have thousands of dollars in their bank accounts for paying large ex post judgments. If you only have to pay as much as you can and no more, then ex post punishment doesn't give a great enough incentive to take care. The only other alternative is to punish you in some other way that's motivationally equivalent to making the payment, such as imprisonment or death. But unlike a monetary payment, which is a transfer from injurer to victim, punishments like imprisonment or execution are costly on net. You lose life or liberty, and society has to use up resources to take it. Nobody gains the life or liberty that you lose.

We therefore predict that ex post punishments will be used most often when it's beneficial to utilize private information and/or the damages are small enough that judgment-proofness is not a problem. Ex ante will be used otherwise. Do current legal rules fit with our predictions?

- Traffic accidents cause lots of damage, and they are punished both ways.
- Most activities causing small amounts of damage (DDF refers to broken windows from baseballs) are punished ex post in the tort system. This avoids huge administrative costs, without a risk of judgment-proofness.
- Corporations with deep pockets (hence unlikely to be judgment-proof) are dealt with primarily through the tort system, although they are also regulated through OSHA, EPA, CPSC, etc.
- Attempted crimes are punished, but attempted torts are not. Why? Punishing attempts is a form of ex ante punishment, which makes more sense when costly punishments must be used.

DDF observes that it makes sense, in many situations, to have both ex ante and ex post punishment. This is because small ex post payments induce people to use private information, without imposing large costs of other kinds. But what he doesn't mention that deserves thought is that using both punishments can create a problem of taking too much care. The possibility of ex ante fines plus large damage payments in the event of an accident may cause some people to take non-cost-justified precautions. It may also deter people from taking actions that impose cost-justified risks -- e.g., someone doesn't speed to the hospital when it really would make sense to do so.