Risk & Uncertainity + Asymmetric Info Materials.

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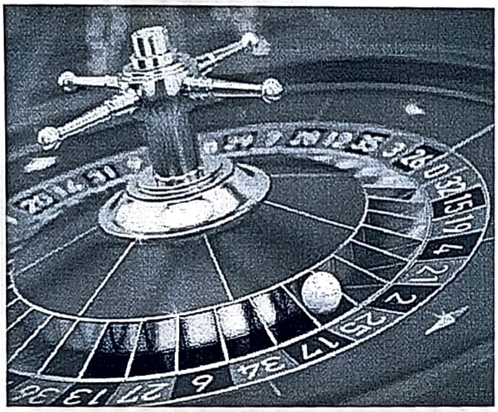
7 DEMAND FOR INSURANCE



Buying health insurance is akin to placing a bet that you will become sick and need medical care.
Credit: © Sashkin – Fotolia.com.

Many people have been told since their youth that gambling is an unwise activity, only to be dabbled in for entertainment purposes, if at all. But buying health insurance is actually a form of gambling. Take life insurance, for instance – a term life insurance contract is a bet that you will die before some fixed date. To win, you must die early.

Despite warnings about the dangers of gambling, life insurance is, in many circumstances, a wise choice. The reason why buying insurance may be wise is that it is a bet that *reduces* uncertainty. Insurance is a hedge against risk, against the possibility of bad outcomes. But nothing is costless: purchasing insurance means forfeiting income in good times. The homeowner who pays monthly for fire insurance for the fire that never occurs might have been better off spending that income elsewhere. The individual who buys health insurance but never visits the hospital loses out on that income.

What drives the demand for insurance seems to be fear of the unknown. We want to understand what causes people to be afraid of the unknown in the first place. The story economists tell has little to do with the psychology or biology of fear. It has more to do with the mundane topic of declining marginal utility of income.

7.1 Declining marginal utility of income

In this section, we introduce the simplest possible model that illustrates the notion of risk aversion and the demand for insurance. In this model, an individual cares about the income she earns and nothing else. As always, we model preferences by defining a utility function, and in this case the utility function will have a single input – income I. While this is certainly unrealistic, it is all that is necessary to demonstrate risk aversion.

What properties should the individual's utility function $U(I)$ have? First, utility should increase with income; that is, the first derivative of the utility function is positive:

$$U'(I) > 0 \tag{7.1}$$

A second property of this individual's preferences is that her marginal utility of income is declining in income. This means that the first dollar the individual has is very valuable to her, because an income of one dollar ($I = 1$) is much better than an income of zero dollars ($I = 0$). But if the individual is already a millionaire, gaining an extra dollar means very little to her. Empirically, these preferences seem to be very common. This second property is equivalent to the second derivative of the utility function being negative:

$$U''(I) < 0 \tag{7.2}$$

Figure 7.1 graphs a utility function with both of these properties. Utility is incre with income, but at a declining rate. While this figure may seem simple, it turns out t the key to understanding why the individual is risk averse, why she might demand ins ance, and what sort of insurance contracts she prefers. Indeed, that there is a relationsh between declining marginal utility of income and risk aversion is a key insight of modern economics.

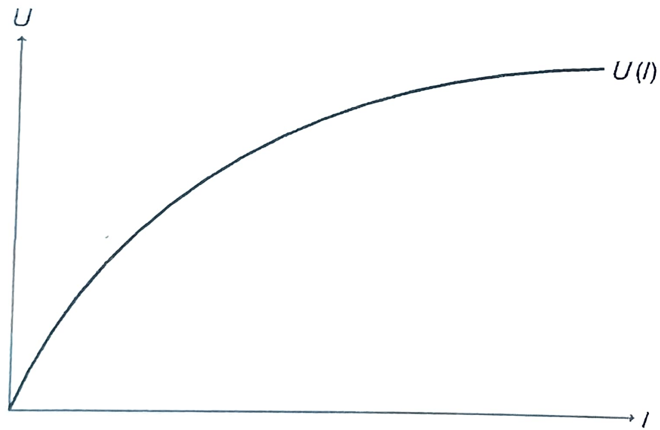
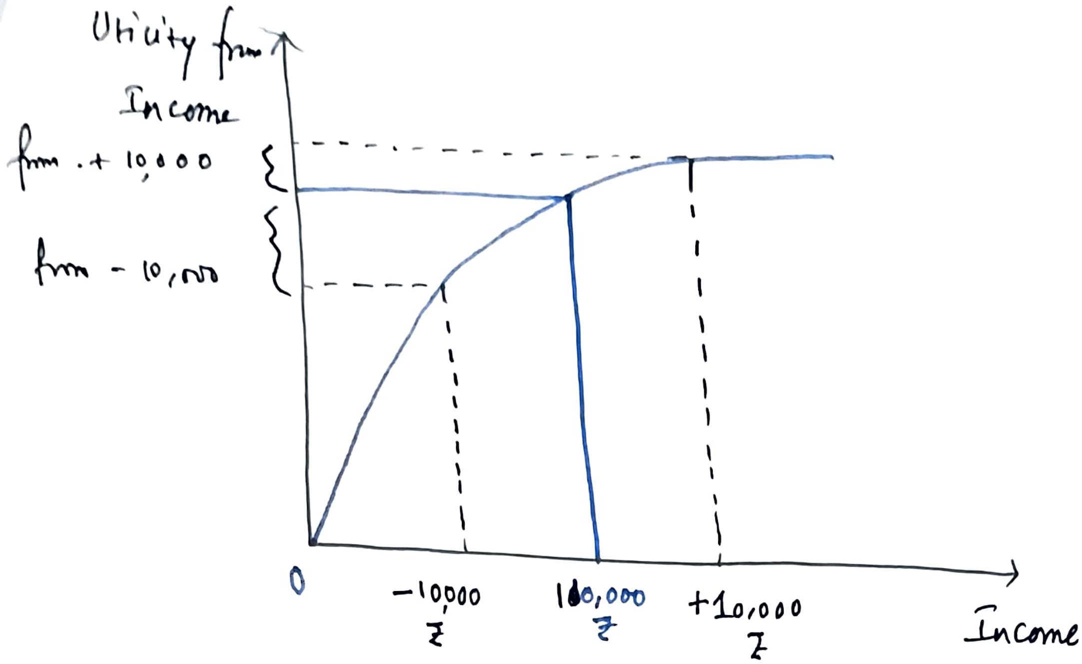


Figure 7.1. *An income–utility diagram.*

7.2 Uncertainty

is more
(I)



Relationship between diminishing marginal utility and Risk Averseness of a person

DMU needs to things → (i) utility increases with income (The first derivative)

$U'(I) > 0$.

(ii) With additional income MU declines.

$U''(I) < 0$.

So the curve ~~is~~ has the both properties. It is increases with income, but is declining in nature.

↓ Because of that, it never goes downward.

Now why this relates to a risk-averse person?

See, ~~for~~ a person has initially an income of ₹100,000. Now, if his income increases 10,000 ₹ more, his utility increases less. Because he gets less utility holding more of this income.

But, see what happens if ~~₹10000~~ income falls by ₹10,000.

See, the utility that lowers in the vertical axis is more (much more) compared to the utility that increased for same amount of increase in income.

i.e., utility decline from same amount of income loss

$>$ utility increase from same amount of income gain.

Given this, a person will always try to insure his/her income as income loss is a hugely negative occassion for him/her.

Try to think this with an example.

A person getting increment of 10,000 rupees. Say earning 1,00,000 initially. He will be indifferent ~~that~~ for that extra 10,000 he got ~~extra~~.

But if it happens that his/her manager due to that person's some wrongdoings penalizes him off 1000 rupees, he may feel that heat.

- He may have some fixed amount of consumption expenditure
- He has some savings fund, emergency fund.
- Has some loans to pay.

Given this a shock of lowering of 10,000 at least may lower his consumption expenditure, say going for cinemas or cricket matches. Which directly lowers his/her utility.

Figure 7.1. *An income–utility diagram.*

7.2 Uncertainty

Our next step is to model uncertainty. Again, our strategy is to build the simplest possible model that accomplishes our task. In this case, suppose that the individual faces a possibility of becoming sick. She does not know whether she will become sick, but she knows the probability of sickness is $p \in (0, 1)$. Consequently, her probability of staying healthy is $1 - p$. She also knows that if she does get sick, medical bills and missed work will reduce her income considerably. Let I_S be her income if she does get sick, and let $I_H > I_S$ be her income if she remains healthy.

$0 < p < 1$. between 0 and 1.

Whenever there is uncertainty, it is important to have ways of summarizing all the possible outcomes in a concise way. One such summary is the **expected value**.

Definition 7.1

The **expected value** of a random variable X, $E[X]$, is the sum of all the possible outcomes of X weighted by each outcome's probability. If the outcomes are $X = x_1$, $X = x_2, \ldots, X = x_n$, and the probabilities for each outcome are $p_1, p_2, \ldots, p_n$ respectively, then

$$E[X] = p_1 x_1 + p_2 x_2 + \cdots + p_n x_n \tag{7.3}$$

$E[X]$ is also sometimes called the **mean** of X.

In the individual's case, the formula for expected value of her income, $E[I]$, is simple. There are only two possible outcomes for I and we know the probabilities associated with each:

$$E[I]_p = pI_S + (1 - p)I_H \tag{7.4}$$

Difference between a Risk-Neutral and Risk-Averse person

: An Example

(includes actuarially fair premium calculation)

Suppose, current income is = 1,00,000.

- There is a 50% chance (probability) you loose 50,000 rupees.
- 50% chance you loose nothing.
- Certain payout is = 75,000.

Risk neutral person would say,

I'm fine between certain income of 75,000 rupees and the gambling situation and getting 75,000.

Jensen's inequality. U(certain

Because $0.5 \times 1{,}00000 + 0.5 \times 50{,}000$

if he doesn't lose — If he loses.

$= 50{,}000 + 25{,}000 = 75{,}000.$

But the Risk-averse would think in the utility terms, not in income terms.

The Risk neutral getting same income in both cases, but as he is a 'cool guy', he doesn't get anxiety issues, so his utility does not change.

But for a risk-averse, a overthinker guy, he will loose utility by being anxious over future income. So he will choose fixed 75,000 rupees over gamble, but gets mental peace.

So, Jensen's inequality holds.

U(Certain payout) > expected utility from gamble.

Given, he was loosing ~~0.5% of~~ 50,000 rupees with a probability of 0.5%.

Actuarially fair premium is

= probability of loss (p) × size of the loss (L)

= 0.5 × 50,000

= 25,000.

So, he will payout 25,000 rupees to an insurance company to get that mental peace from fixed income of 75,000 rupees.

One feature of equation (7.4) is that expected income depends critically on p, the probability of illness. As getting sick becomes more likely, p rises and the weight given to I_S in the formula for $E[I]$ increases. As we would expect, rising p translates to a reduced expected income.

7.3 Risk aversion

Suppose we conduct an experiment where we offer a starving graduate student a choice between two possible options, a lottery and a certain payout:

A: a lottery that awards \$500 with probability 0.5 and \$0 with probability 0.5.
B: a check for \$250 with probability 1.

It is easy to see that the expected value of both the lottery and the certain payout is \$250:

$$E[I]_p = pI_S + (1-p)I_H$$
$$E[I_A] = 0.5(500) + 0.5(0) = \$250 \quad (7.5)$$
$$E[I_B] = 1(250) = \$250.$$

Despite the fact that both lotteries provide the same expected income, studies reliably find that most people prefer certain payouts like (*B*) over uncertain lotteries like (*A*). If a starving graduate student says he prefers option (*B*) in the above example, what does that imply about his utility function? To answer this question, we need to define **expected utility** for a lottery or uncertain outcome. Like expected income, expected utility is an average over all states of the world, weighted by the probability of each state.

Definition 7.2

The **expected utility** from a random payout X, $E[U(X)]$, is the sum of the utility from each of the possible outcomes, weighted by each outcome's probability. If the outcomes are $X = x_1, X = x_2, \ldots, X = x_n$, and the probabilities for each outcome are $p_1, p_2, \ldots, p_n$ respectively, then

$$E[U(X)] = p_1U(x_1) + p_2U(x_2) + \cdots + p_nU(x_n) \quad (7.6)$$

(*) Even though income from the two sources are same (lottery and fixed income)

(*) The starving student's preference for option (*B*) over option (*A*) implies that his expected utility from (*B*), $E[U(B)]$, is greater than his expected utility from (*A*), $E[U(A)]$:

$$E[U(B)] \geq E[U(A)] \quad (7.7)$$
$$U(\$250) \geq 0.5 \cdot U(\$500) + 0.5 \cdot U(\$0)$$

In this case, the starving student prefers the more certain payout over the less certain one, even though the expected value of those two options is equal. We say that the student is acting in a **risk-averse** manner over the choices available.

// The situation that the individual who might get sick faces is similar to the lottery in option (*A*) in that her income I is a random variable. She gains a high income ($I = I_H$) if she stays healthy, and a low income ($I = I_S$) if she is sick. Furthermore, she is uncertain about which outcome will happen, though she knows the probability of becoming sick is p. Her expected utility $E[U(I)]_p$ in this situation is:

$$E[U(I)]_p = pU(I_S) + (1-p)U(I_H) \tag{7.8}$$

Figure 7.2 shows how expected utility changes as the probability of sickness changes. Consider the extreme case where the individual is sick with certainty, so the probability of sickness is $p = 1$. It should be clear from equation (7.8) that when $p = 1$, $E[U(I)] = U(I_S)$. In Figure 7.2, we label this point S. At that point, the individual's expected utility equals the utility she gains from a certain income of I_S. Similarly, if the individual has no chance of becoming sick, $p = 0$, her income is I_H with certainty, and her utility is $U(I_H)$. We label this point H in the figure.

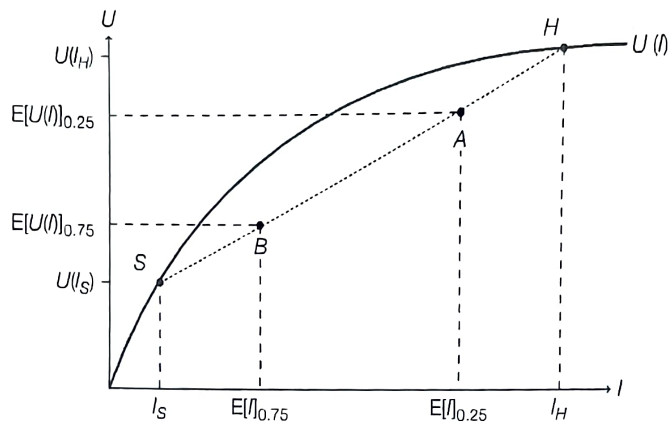


Figure 7.2. *Expected utility from income for different probabilities of sickness.*

What if her probability of illness lies somewhere between 0 and 1? In that case, her expected utility falls on a line segment between S and H in Figure 7.2. One way to see this is to consider equation (7.8) again. Think of $U(I_S)$ and $U(I_H)$ as fixed numbers, since changes in p have no effect on those quantities. Therefore, equation (7.8) is a linear function in p.

downward ↓ As p increases from 0 to 1, the weight placed on $U(I_S)$ increases and the weight placed on $U(I_H)$ decreases.

sickness probability

For instance, when $p = 0.25$, the individual's expected utility is shown at point A, a quarter of the way along the line segment between H to S. The individual's expected income at this point is:

$$E[I]_{0.25} = 0.25 \cdot I_S + (1 - 0.25) \cdot I_H$$

and her utility at this point is $E[U(I)]_{0.25}$. Similarly, point B represents her expected income and expected utility when $p = 0.75$. We can calculate these quantities for any p by moving along the line segment HS.

Expected utility vs. expected income

The important fact to notice is that we do not read her expected utility off the income–utility curve, but instead off the line segment HS. Figure 7.3 illustrates this distinction in

E(U(I)) → expected utility from Income
U(E(I)) → Utility from expected income.

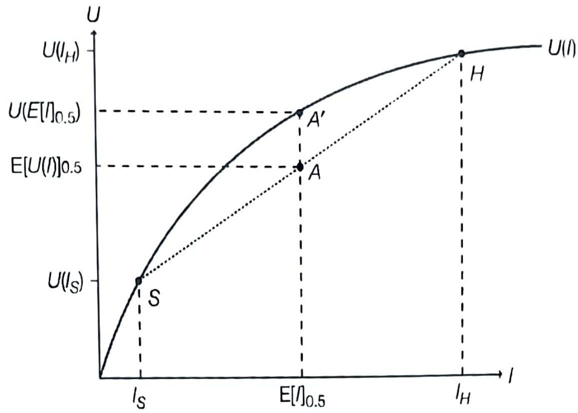


Figure 7.3. *Risk-averse individuals want to limit uncertainty. Achieving* E[I] *with certainty is better than receiving the expected utility of a coin flip between* I_H *or* I_S. *Therefore,* $U(E[I]_{0.5}) > E[U(I)]_{0.5}$.

the case when $p = 0.5$. The individual's expected income and expected utility from the sickness lottery are:

$$E[I]_{0.5} = 0.5 \cdot I_S + (1 - 0.5) \cdot I_H$$

$$E[U(I)]_{0.5} = 0.5 \cdot U(I_S) + (1 - 0.5) \cdot U(I_H)$$

In Figure 7.3, the resulting point is labeled A and falls on the line segment HS. This point corresponds to the *expected utility from income* of $E[U(I)]_{0.5}$. This is not to be confused with the *utility from expected income* $U(E[I]_{0.5})$, which corresponds to point A'. This value is the utility that would result if the individual could earn $E[I]_{0.5}$ with certainty. Just like the starving student, the individual gains more utility from the certain outcome than the uncertain outcome. This statement implies that she is risk-averse.

'This' here is E(U(I))

See, same income as in the previous page $250. But 'certainty' rules over.

At U(I_S), absolute sickness. U(E(I)) = E(U(I))

Similar for being absolutely healthy.

However as the person is risk averse, he likes fixed income (that comes from insurance). So even in absolute situations, he will choose insurance.

Definition	**7.3**

Risk aversion in the utility–income model:

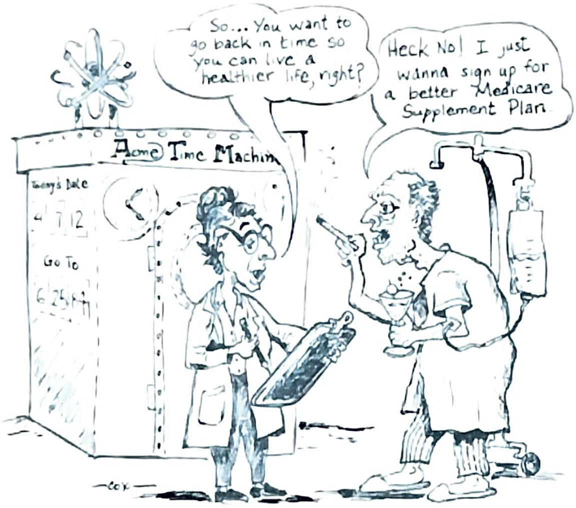
The following statements are equivalent:

- The individual prefers a certain outcome to an uncertain outcome with the same expected income.
- The individual prefers the utility she would get from her expected income to the expected utility she will get from her actual (uncertain) income.
- $U(E[I]) > E[U(I)]$.
- The individual is risk-averse.

Notice that these statements are all true because the utility–income curve is concave. The geometry of the utility–income curve guarantees that the curve always lies above the line segment HS for any value of I. The individual always gains more utility from a certain outcome than an uncertain outcome with the same expected income. This holds true as long as there is some uncertainty; $0 < p < 1$. Recall that we modeled the individual's utility curve as concave in the first place in order to reflect her declining marginal utility from income (see equation (7.2)). We see now that risk aversion follows directly from this assumption.

While the theory we describe here is intuitively appealing since it relies on standard notions from probability theory, even within economics there is considerable controversy over whether the model accurately describes how people make decisions under uncertainty. Perhaps not surprisingly, people often reason in strange ways when they make decisions in face of the unknown. Psychologists have developed an elaborate story, known as prospect theory, that describes the distortions in reasoning that occur when people think about uncertain outcomes. We will leave that part of the story for later, in Chapter 23, because it builds on the simpler model of expected utility maximization that we describe in this chapter.

7.4 Uncertainty and insurance



In a world with affordable time travel, health insurance would serve no purpose.

Credit: Allen Cox.

In our model, a person is either fully well or fully sick but never halfway between. This means that individuals cannot achieve the higher utility at A' from Figure 7.3 on their own, even though risk-averse people would prefer it. A risk-averse individual seeking to achieve A' would need to somehow send money from one potential self in the world where she stays healthy to her other potential self in the world where she becomes sick. She cannot do this herself without some sort of time machine, but she has another option: insurance. As we will see, an insurance contract functions by transferring money from the well state to the sick state.

A basic insurance contract

The individual approaches a health insurance company that offers a policy with the following features:

- The individual pays an upfront cost r regardless of whether she stays healthy or becomes ill. The payment r is known as the *insurance premium.*
- If the individual becomes ill, she receives a payout q.
- If the individual remains healthy, she receives nothing from the insurance company (not even a refund of the insurance premium r).

Here we return to the notion that buying an insurance contract amounts to a bet. The individual is betting the insurance company that she will be sick. If she falls ill, she "wins" the bet and receives payout q. But if she stays healthy, she "loses" the bet and receives nothing in return for the premium paid. For a risk-averse individual, this bet may be wise, because it allows the individual to hedge against illness and reduce uncertainty about her final income. Though she is just as likely to fall ill as before, the financial burden of illness is lower. The insurance does not make her healthier, but it can make her happier.

Let I'_H and I'_S represent the individual's income in the healthy and sick states of the world with the insurance contract. These quantities will be functions of I_H and I_S, as well as the parameters of the insurance contract: the premium r and payout q. Her incomes in the two states are thus

$$\text{Healthy: } I'_H = I_H - r$$
$$\text{Sick: } I'_S = I_S - r + q \tag{7.9}$$

Recall that the individual's goal in buying insurance was to achieve an income of $E[I]_p$ with certainty, whether she is healthy or sick. What the individual would like most is

$$E[I]_p = I'_H = I'_S \tag{7.10}$$

Expected income stays same irrespective of being healthy or sick.

$I_H = I_S + q$.
or, $I_S = I_H - q$.
In sick state, a person looses q amount of income

pq
= price × quantity of difference money income between healthy state and sick state

An insurance contract that fulfills equation (7.10) is said to be *actuarially fair, full insurance*. We discuss these terms in more detail shortly.

Let us consider an insurance contract X with the following parameters. In this contract, assume the individual receives the difference between her healthy income and sick income if she is sick: $q = I_H - I_S$. In addition, assume that the premium is set such that the contract represents a fair bet: $r = pq$. On average, the individual neither gains nor loses income from this contact.

The following algebra shows that with contract X, the individual's income is $E[I]_p$ regardless of whether she turns out to be healthy or sick. In each column we start with equation (7.9) and substitute in the parameters of this insurance contract; in the second line, we substitute $r = pq$; in the third line, we substitute $q = I_H - I_S$.

■ Healthy state

$$\begin{aligned} I'_H &= I_H - r \\ &= I_H - pq \\ &= I_H - p(I_H - I_S) \\ &= pI_S + (1-p)I_H \\ I'_H &= \mathrm{E}[I]_p \end{aligned}$$

■ Sick state

$$\begin{aligned} I'_S &= I_S - r + q \\ &= I_S - pq + q \\ &= I_S - p(I_H - I_S) + (I_H - I_S) \\ &= pI_S + (1-p)I_H \\ I'_S &= \mathrm{E}[I]_p \end{aligned}$$

With this contract, the individual can receive $\mathrm{E}[I]_p$ with certainty. This enables her to achieve points on the utility function, like A', in Figure 7.3, whereas before she was only able to achieve points on line segment HS below the utility–income curve. With the insurance contract, the individual's utility increases even though her income does not. The insurance contract creates utility seemingly out of nowhere; simply by reducing uncertainty, the insurance contract can make the risk-averse individual better off.

The nature of the insurance contract is that the individual loses income in the healthy state ($I_H > I'_H$) and gains income in the sick state ($I_S < I'_S$) relative to the state of no insurance. This is the sense in which the insurance contract acts as an instrument that transfers income from the healthy state of the world to the sick state. The risk-averse individual willingly sacrifices some good times in the healthy state to ease the bad times in the sick state.

Fair and unfair insurance

Consider now the same insurance contract we have been discussing from the point of view of the insurance company. Let $\mathrm{E}[\Pi]$ be the expected profits that the insurer makes from offering a contract with premium r and payout q to any customer with probability of sickness p. If the customer actually stays healthy, the firm earns r dollars. On the other hand, if the customer falls ill, the firm still receives the premium r but loses the payout q. By applying the formula for expected value (see equation (7.3)), we find:

$$\begin{aligned}E[\Pi(p,q,r)] &= (1-p)r + p(r-q)\\ &= r - pq\end{aligned}$$

In a perfectly competitive insurance market, profits will equal zero. Just like in any competitive market, if profits were positive, new entrants would compete away those profits until all the firms left in the market would be making zero profits. If the profits were negative, then the insurer is giving money away to customers in the long run and will go out of business. Firms leave the market until profits reach zero. Setting expected profits to zero in equation (7.11) implies $r = pq$. This condition is known as **actuarial fairness.**

Definition	7.4

Actuarially fair insurance contract: an insurance contract which yields zero profit in expectation; also called **fair insurance:**

$$E[\Pi(p,q,r)] = 0 \qquad \Longrightarrow \qquad r = pq \tag{7.12}$$

An insurance contract which yields positive profits is called **unfair insurance:**

$$E[\Pi(p,q,r)] > 0 \qquad \Longrightarrow \qquad r > pq \tag{7.13}$$

When insurance is fair, in a sense, it is also free. The customer's expected income does not change from buying the contract, so she effectively pays nothing for it. Despite the fact that the premium r is positive in an actuarially fair contract, the *price* is actually zero. Thus, we reach the counter-intuitive conclusion that the premium associated with an insurance contract is not its price.

In the real world, of course, nothing is free, and insurance markets are not perfectly competitive. Insurance companies make some positive profits on the contracts they sell, so there must exist insurance contracts with positive prices that consumers actually purchase. An insurance contract with a positive expected profit for the insurer is called an **actuarially unfair contract**. Applying the firm's profit equation (equation (7.11)), we find that the profit-making insurer must set premiums r above the expected payout pq:

$$E[\Pi(p,q,r)] > 0 \qquad \Longrightarrow \qquad r > pq \tag{7.14}$$

The difference between the premium r and expected payout pq is analogous to the price of the contract and determines the change in expected income. The higher r rises above pq, the pricier the contract is and the more *unfair* it becomes. Risk-averse consumers may still be willing to pay positive prices for unfair insurance contracts if doing so sufficiently reduces their uncertainty. But there is a limit to the price even risk-averse customers will pay for additional certainty, as we discuss in Section 7.5.

Full and partial insurance

So far we have examined insurance contracts where the insured individual ends up with the same income in the sick state and the healthy state, $I'_S = I'_H$. This property is known as **state independence**, because the individual's income no longer depends on her health status. An insurance contract that achieves state independence completely eliminates income uncertainty and is called a **full insurance contract.**

Table 1.5 provides data on the sources of payment for personal health care services for selected years since 1960. In addition to out-of-pocket costs, these payment sources include private insurance; Medicare and Medicaid (the major government programs for the elderly and certain lower income households); and other public and private programs. In 1960, 55 percent of all personal health care expenditures were paid out-of-pocket, meaning that 45 percent was paid by third-party payers (either private or government). Out-of-pocket costs dropped dramatically following the introduction of Medicare and Medicaid in 1966, the continued growth of private insurance, and the introduction of new programs such as the Children's Health Insurance Program (CHIP) established in 1997.

By 2014, 87 percent of personal health care spending was paid by third parties. We will carefully study this phenomenon and its effects for both private and public insurance. It should be clear, even prior to our focused analyses, that the separation of spending from the direct payment for care must weaken some of the price effects that might be expected in standard economic analysis. Insurance changes the demand for care, and it potentially also changes the incentives facing providers.

Changed incentives that face providers concern us more as the insurance portion of the bill increases. How the insurers pay the health care firm thus becomes a critical fact of economic life. Whether insurers cover a procedure, or a professional's services, may determine whether providers use the procedure.

Furthermore, changes in insurance payment procedures can substantially change provider behavior and provider concerns. In the 1980s Medicare, faced with rapidly increasing expenditures, changed its hospital payment system from one based largely on costs (i.e., retrospective reimbursement) to one with fixed payments per admission determined by the resources typically used to treat the medical condition (as classified by Diagnosis Related Groups, or DRGs). With a prospective DRG payment system, an extra day of care suddenly added to the hospital's costs, rather than to its revenues. This reimbursement system, still used today, led to shorter stays, reduced demand for hospital beds, and ultimately the reduction in size and/or closing down of many hospitals.

Problems of Information

Uncertainty can in part be attributed to lack of information. Actual and potential information problems in health care markets raise many economic questions. Sometimes information is unavailable to all parties concerned. For example, neither gynecologists nor their patients may recognize the early stages of cervical cancer without Pap smears. At other times, the information in question is known to some parties but not to all, and then it is the asymmetry of information that is problematic.

The problems of information mean that careful economic analysts must modify their methods. Standard analyses often assume that consumers have the necessary knowledge about the quality of the food or the clothing that they purchase. People purchase beef as opposed to fish, or cotton as opposed to nylon fabrics, basing their decisions on the characteristics of the goods, their prices, and the goods' abilities to bring pleasure.

Health goods and services depart substantively from this model. Consumers may not know which physicians or hospitals are good, capable, or even competent. Consumers may not know whether they themselves are ill or what should be done if they are. This lack of information often makes an individual consumer, sometimes referred to as the *principal*, dependent on the provider, as an *agent*, in a particular way. The provider offers both the information and the service, leading to the possibility of conflicting interests. Newhouse (2002), for example, speaks of a health care "quality chasm" that may be traced to both

Answer

1) A. Adverse selection is a case of hidden knowledge on part of the buyer. Here, principal tries to sort out different type of agents. After nature plays, agent's problem is to choose the optimal contract.

Adverse selection in case of Second hand cars (Market for lemons)

	Buyer's maximum value		Seller's minimum value
In case of Good cars	10 lacs	$\bar{P} \approx 9$ lacs	8 lacs
In case of Bad cars	5 lacs	$\bar{P} \approx 4$ lacs	3 lacs

Suppose in a market of ~~...~~ second hand cars, both the Buyer and Seller has full / complete information about cars. That means what type of car is in the market. Suppose, for the good cars in this complete information case, Buyer's maximum value is 10 lacs and sellers min^m value is 8 lacs. If the car is sold in 9 lacs (say), then Buyer gains 1 lac and Seller also gains 1 lac.

Now in the case of Bad cars (complete information to both), if the car is sold at 4 lacs, then

P.T.O

Now consider the case of uncertainity. In case of uncertainity, We know that both buyer and seller don't know about the quality of cars. So, let probability of good car is 1/2 and probability of bad car is half. That or $P_g = 1/2$ and probability of bad car is half. Now in this case, is $P_b = 1/2$. So, $P_b + P_g = 1$.

Buyer's maximum value		Seller's minimum value
7.5 lacs	$P \approx 6.5$ lacs	5.5 lacs.

So in this case, no problem, if the car is sold at 6.5 lacs, then again they gain by 1 lac

But in case of incomplete information we know at least one agent does not know the quality of the car. ~~and~~ So, in this case, if we take buyer does not know the quality of the car but seller knows the quality of the car, then the problem will be,

Buyer's maximum value in case of $P_g = 1/2$ and $P_b = 1/2$	Seller's min^m value
7.5 lacs	Seller knows the quality. So,

As seller knows the quality, in this case, if the car is of good type, then Seller's minimum value is 8 lacs, which means the car will be not sold. So, seller faces loss.

In other case if the car is of bad type, then Seller gains by $(7.5 - 3)$ lacs $= 4.5$ lacs As in this case seller's minimum value is 3 lacs

P.T.O

Jay Bhattacharya

8 ADVERSE SELECTION: AKERLOF'S MARKET FOR LEMONS

Consider a man who walks into a life insurance office, asking for a million dollar policy against dying tomorrow. He tells the insurance agent that he does not smoke or drink, and by all appearances seems to the agent like a perfectly healthy young man. The policy the man wants will only last a day – if he dies tomorrow, the insurance company will owe his heirs a million dollars. The insurance agent faces two questions. Should the company provide coverage to this man at all, and if so how much should the man be charged as a premium?

The savvy insurance agent realizes that there must be something wrong in this situation. The man insists that he is healthy and wants the policy "just in case," but if that is true, then why does he want such a generous policy over such a short period of time? He must be hiding something important, the insurance agent reasons, something that will put him at significant danger of dying tomorrow. Though the insurance agent can never directly observe the potential customer's risk of dying, the very fact that the customer wants to buy this unusual policy provides evidence that the customer is likely to die tomorrow.

It will be difficult to find a good price for this contract, as well. Suppose the agent offers this insurance for an astronomical price. If the customer is still willing to take the contract at this high price, this is further evidence that the man is sure of his fate, and might cause the agent to retract her offer and demand an even higher price.

The main problem inhibiting trade in this story is that the insurance agent and the potential customer do not have equal access to a key piece of information – the customer's health risks. The customer is in a much better position to observe this fact, and he has a strong incentive to represent himself as healthier than he actually is, since healthier customers will tend to be charged a lower premium for the policy. This asymmetry in the information between the buyer and the seller makes it difficult to write insurance contracts that benefit both the buyer and the seller. As we will see, insurance markets work best when buyers and sellers are identically knowledgeable about the probability of different outcomes but identically ignorant about which outcome will occur.

In Chapter 7, both the insured individual and the insurance company knew in advance the individual's probability of sickness and could set premiums and payouts accordingly. Typically though, insurance firms and customers do not share identical knowledge. Firms, which view customers from a distance, might have trouble judging who is likely to stay healthy and who is likely to get sick. Meanwhile, customers familiar with their own medical history and unhealthy habits have intimate knowledge of their own risk.

There are thus two related concepts to analyze in the market for insurance: uncertainty and information. As we have seen in the last chapter, uncertainty by itself does not impede the market from functioning well. A theme of this chapter is that **asymmetric information** about that uncertainty can pose a more existential threat to the market. The major problem is that the party with more information has incentive to misrepresent himself to obtain better terms in the transaction – in other words, to lie about his position. The party with less information anticipates this dishonesty and takes action to protect herself.

Definition	8.1

Information asymmetry: a situation in which agents in a potential economic transaction do not have the same information about the quality of the good being transacted.

The used-car market is the standard context to start exploring these themes. This market is sometimes known as the "market for lemons," because defective used cars are known colloquially as lemons. Misrepresentation is common in this market, which is notorious for seedy salesmen and suspect merchandise. Even though used cars and insurance contracts are very different things, the lessons about asymmetric information that we learn here can be applied readily to insurance markets.

8.1 The intuition behind the market for lemons

Imagine a well-functioning used-car market. Sellers advertise prices for old cars they no longer want, while potential buyers scour websites and classified ads looking for good deals. If they find a potential match, the buyers visit the sellers and examine the vehicle for sale. They kick the tires, peer under the hood, or take the car for a test drive in hopes of assessing the vehicle's condition.

Let us suppose that these simple diagnostic techniques are sufficient to uncover any problems. Buyers who open the hood of their potential new ride will notice if critical car parts are missing, or are held together with duct tape. Then the seller and buyer have identical information about the quality of each car, so the price of each car adjusts to reflect its specific quality. This market will function well.

Nobel prize-winning economist George Akerlof imagined what would happen if the used-car market described above suffered from information asymmetry (Akerlof 1970). Sellers know all about the problems that their cars have, but crucially *buyers do not*. Buyers can test-drive cars all they want, but they cannot make a confident quality assessment.

If any cars are to sell at all in this market, they must all sell at the same price. To show this, we argue that a market for used cars with two prices must converge to a single price. Suppose that there are two cars in this market, one for sale at a high price P' and one for sale at a low price $P < P'$. Since they cannot tell the difference between the two cars, buyers consider the two cars as identical and they would never pay the higher price. Hence, only the car at the lower price has any chance of selling. And as a result, the seller at P' must lower his price to P to have a chance of finding a buyer.

From the previous paragraph, we can conclude that any cars that do sell must sell at exactly the same price. The next step is to see if any cars sell at all at a single price P. We will show that, under certain conditions, for this P no cars will sell. And since P was selected arbitrarily, we can assert that there is no P under these conditions such that cars will sell.

The lot of used cars do not all have the same quality. The well-maintained ones are worth much more than P, but the rickety ones are worth much less. If P is the market price, not all cars reach the market. The sellers who own cars worth more than P will not want to put their cars on sale at all. Thus, the high-quality cars are withdrawn from the market, leaving only the low-quality ones. This is an example of **adverse selection**, which causes the market to unravel.

Definition	8.2

Adverse selection: the oversupply of low-quality goods, products, or contracts that results when there is asymmetric information. For instance, if a supplier of a product has better information about product quality than a buyer, then the highest-quality products will not be offered.

Now we have price P, where the highest-quality cars have been withdrawn from the market by their sellers. Consider the remaining cars. There is a distribution of value amongst these cars, and the most valuable of them will be worth at most P. Thus, the average value of the remaining cars is less than P. Buyers thus know that they would be purchasing a car worth much less than P, so unless the market price declines, buyers will refuse to purchase any cars.

A typical interaction between an Akerlofian buyer and an Akerlofian seller.

Credit: Allen Cox.

Suppose a new price establishes itself below P. The same exact argument outlined above applies again. Sellers withdraw the top-quality cars, and as a result, the average worth of the cars remaining on the market falls further. Realizing that the market price still exceeds average value, buyers respond by refusing to purchase. With each new price drop and subsequent round of adverse selection, the car quality in this market continues to degrade until only the lowest-quality goods are still on the market. Depending on the exact utility function of buyers and sellers, even those may not sell.

It should be clear, at least at an intuitive level, why the market for lemons can fail under asymmetric information. Sellers cannot guarantee to buyers the quality of the cars they are selling, and sellers of low-quality cars have incentive to masquerade as high-quality sellers. The market fails because of a lack of incentives for honesty; instead, having the information advantage gives the sellers incentive to misrepresent the quality of their cars.

8.2 A formal statement of the Akerlof model

The intuitive story of the market for lemons should be clear at this point, but there are many nuances and limitations to this argument that only become clear with a more formal treatment. For instance, does the market still fall apart if buyers value cars so much that they are willing to pay top dollar for even the lowest-quality cars? Careful study of this formal treatment will help build the reader's intuition about the effects of adverse selection.

The change in a buyer's utility, should she buy a car at price P, is given by equation (8.4):

$$E[\Delta U_B] = \frac{3}{2} \times \frac{P}{2} - P = -\frac{1}{4}P$$

So for any price less than 100, buyers will face the following choice. They can give up P in exchange for a car that can be expected to give them only $\frac{3}{4}P$ worth of utility. No matter the price P, this market unravels.

8.3 The adverse selection death spiral

Now we switch our focus to a health insurance market that actually looks quite similar to the used-car market we just studied. First, we must make a few assumptions about the way this market functions to bring it in line with the very simplified world of the Akerlof model.

Assumptions

- Each customer i has an expected amount of health care costs over the course of the year X_i. (i.e. for each year)
- An insurance company offers a single policy with an annual premium P. This full-insurance policy covers all health care costs incurred during the year.
- Customers are risk-neutral. Customer i will purchase insurance if and only if P is less than his expected health care costs X_i.
- The insurers are not allowed to discriminate between healthy and sick, and must contract with any customer willing to pay the premium. They have no way to exclude more sickly customers from purchasing insurance.
- Expected customer health care costs X_i are distributed independently and uniformly in the population:

$$X_i \sim Uniform[\$0, \$20{,}000]$$

Take a second to compare this market with Akerlof's market for used cars. You will see that an extended analogy can be drawn. The "cars" here are the customers' bodies, and the "sellers" are the customers trying to convince the "buyers" (insurance companies) that the "cars" are healthy and unlikely to break down. Just as a high-quality car is worth paying a high price, a high-quality body should only be charged a low premium. And just as high-quality cars leave the market when a universal price is set, high-quality bodies will leave the market when a universal premium is set.

Suppose that the insurance company offers a contract with a premium $P = \$10{,}000$ in 2013. Half of the customers do not purchase insurance because their expected health costs are less than the premium. Just as it was not worthwhile for sellers with high-quality cars to enter the market in the Akerlof universe, it is not worthwhile for relatively healthy people to buy health insurance in this market. The sickly customers, on the other hand – the ones with expected health care costs exceeding \$10,000 – sign up as quickly as possible (see Figure 8.4). For these high-risk customers, this insurance contract is a great deal.

What happens to the insurance company's books? Adverse selection ensures that the insurer will lose money. The company collects \$10,000 from each customer, but pays an average of \$15,000 for each customer's health care. This means the insurance company suffers an expected loss of \$5,000 per customer.

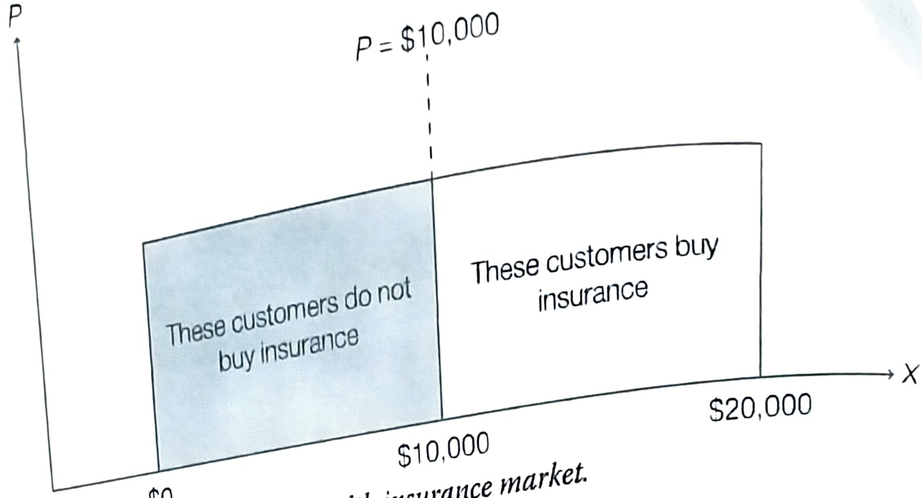


Figure 8.4. *Adverse selection in the health insurance market.*

After a round of mid-level executive downsizing at the insurance firm, consultants recommend raising premiums to $P = \$15{,}000$ for 2014. If each customer costs the insurer \$15,000, the new premium should balance the company's cash flow. Right?

Unfortunately, the consultants are wrong; they neglect the fact that adverse selection will continue. Of the remaining enrollees, the healthier among them exit the plan, while the sicker, more expensive, customers sign on for another year of coverage. This time, the selection is even more adverse than before – only the sickest of the sick enroll. Now prices have risen, fewer people are choosing to buy insurance, and the insurance company is still unprofitable (see Figure 8.5).

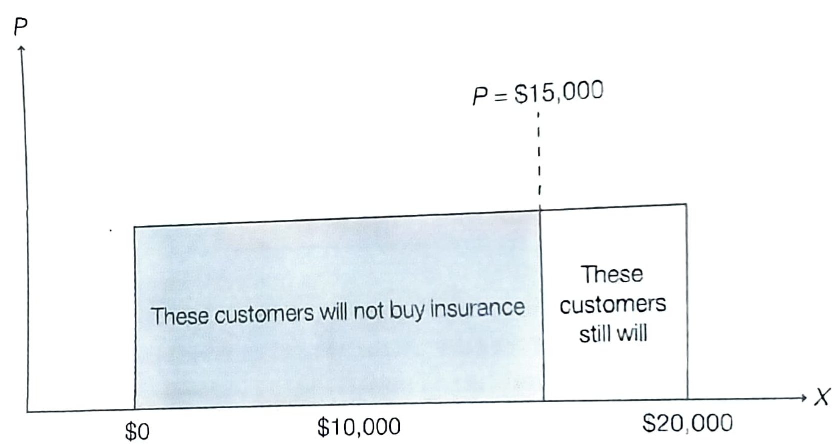


Figure 8.5. *A second round of adverse selection.*

Now the company collects \$15,000 from each customer. And while some customers cost slightly less or more than expected, collectively they average \$17,500 in insurance claims. This means the insurance company still loses \$2,500 per customer.

With each successive correction by the insurance company, the premium increases, subscription drops, and the remaining pool of customers gets smaller and sicker. This cyclical phenomenon is called an **adverse selection death spiral**. It concludes with an Akerlofian market collapse – as the insurance company eventually learns, it cannot make a profit with any premium in this market. In Chapter 10, we will see evidence of real-life adverse selection death spirals that happened just about like this.

Definition	8.4

Adverse selection death spiral: successive rounds of adverse selection that destroy an insurance market.