In this chapter, we discuss the fundamental problem of adverse selection in health insurance. This discussion is on asymmetric information between the consumer and the insurer. Consumers possess private information about their health status. Insurance companies do not have access this information. All of us know our own medical histories, which presumably will yield some information about our medical experiences in the future. Thus, we likely know something about our own medical expenses, and this information is unknown to the insurer, although this is an important piece of information for the determination of insurance premium.

In the economics literature, it is well recognized that asymmetric information is a friction that prevents trades between economic agents who otherwise might benefit from each other. If a consumer’s likelihood of falling ill is his private information, then an insurer may fear that its policy only is bought by those consumers whose illness likelihood is high. Risk sharing may become impossible. Without asymmetric information, there can be mutually beneficial trade between an insurer and a risk-averse consumer.

We now describe a model where asymmetric information does impose frictions on market transactions, but such frictions still allow some trade in the market. This phenomenon, restricted trade, is indicative of the sort of problems due to asymmetric information and adverse selection. There is a set of consumers. We will start with a continuous model; later we will use a discrete model. The total mass of these consumers is normalized to 1. It is common knowledge that each consumer becomes sick with probability $p$, where $0 < p < 1$. A consumer is characterized by his medical expenditure $c$, which is distributed according to the density function $f(c)$ and cumulative density function $F(c)$ on the interval $[0, \infty]$. Without any insurance, a consumer’s expected utility is

$$EU(\text{no insurance}) = (1 - p)U(W) + p \int_0^\infty U(W - c)f(c) \, dc,$$  

where $U$ is a concave utility function and $W$ is a consumer’s wealth or income.

1 Symmetric Information

Suppose that there is a competitive insurance market. An insurance contract consists of a premium, and an insurer’s promise to reimburse the consumer for all medical expenditure if the consumer becomes sick. Each
firm in the competitive insurance market therefore sets a premium. Because there are many firms, each firm
must make zero expected profit.

There is symmetric information when consumers and insurers share the same information. Let us suppose
that consumers do not know the his medical expenditure $c$ when he becomes sick. He does know that it
follows the distribution described above. The insurer has exactly the same information as the consumers.

The competitive equilibrium can be described as follows. Each firm will fully insure the consumers. The
consumers are risk averse, so the best outcome will be for the insurer to bear all the risks. If a consumer
incurs a medical expense $c$ ex post, that gives rise to income fluctuations. A risk averse consumer would
prefer to smooth out these fluctuations. An insurer can do that. The equilibrium contract will simply be
defined by an actuarially fair premium, $\pi^*$, given by the probability of consumers falling ill, $p$, multiplied by
the expected cost of medical expenses:

$$\pi^* = p \int_0^c cf(c) \, dc.$$  

(2)

Under this premium, an insurer will break even, and all consumers receive full insurance.

2 Asymmetric Information

Suppose now that a consumer knows his medical expenditure $c$ before he purchases an insurance contract.
We continue to assume that each consumer falls ill with probability $p$. Now consumers are different. Some
are more healthy; they will have a lower medical expense even if they fall ill. Others are less healthy;
they will have a higher medical expense if they fall ill. Asymmetric information is when this information
about medical expense is only available to the consumer, not any insurance company. In the literature, a
consumer with a medical expenditure $c$ is often abbreviated to a type-$c$ consumer. All consumers do still
face the uncertainty of falling ill or not. There is a probability that each consumer may become ill, and this
probability, $p$, is common knowledge.

We first consider a consumer’s expected utility if he does not have an insurance contract. This expected
utility for a type-$c$ consumer is

$$\text{EU}(\text{no insurance}|c) = (1 - p)U(W) + pU(W - c).$$  

(3)
Here, consumers who are more healthy (lower values of $c$) have higher expected utilities. The expression in (3) is decreasing in $c$. The expected utility of type-$c$ consumer also establishes his reservation utility. If a premium is too high, a consumer may forgo insurance; if it is low enough, he may purchase. In fact, suppose that the premium of insurance contracts in the market is $\pi$.

Recall that an insurance contract will shield the consumer from all medical expenses, so if a type-$c$ consumer buys this contract, his medical expense $c$ will be reimbursed when he falls ill. A type-$c$ consumer will purchase the contract at premium $\pi$ if

$$EU(\text{no insurance}|c) = (1 - p)U(W) + pU(W - c) \geq U(W - \pi).$$

(4)

Now suppose that some type, say $\tilde{c}$, is just indifferent between purchasing insurance or not:

$$EU(\text{no insurance}|\tilde{c}) = (1 - p)U(W) + pU(W - \tilde{c}) = U(W - \pi).$$

(5)

What will other types of consumers do? A type-$c$ consumer with $c < \tilde{c}$ is more healthy, so this consumer is less willing than type-$\tilde{c}$ to purchase insurance. Because type-$\tilde{c}$ is just indifferent, a type-$c$ consumer with $c < \tilde{c}$ will not purchase insurance. Conversely, a type-$c$ consumer with $c > \tilde{c}$ is less healthy, so this consumer is more willing than type-$\tilde{c}$ to purchase insurance. All consumers with costs above $\tilde{c}$ will purchase insurance.

This is the adverse selection issue. A full-insurance contract will always attract only those who are less healthy. Given any premium $\pi$, those who purchase the insurance policy will be those with costs above a threshold, $\tilde{c}$. Less healthy consumers are those who are most willing to purchase insurance. The total demand for insurance therefore is given by the total density of all consumers with cost $c$ above $\tilde{c}$. The total number of consumers therefore is $1 - F(\tilde{c})$.

A firm offering the full insurance contract at a premium $\pi$ realizes that only those consumers with $c > \tilde{c}$ will purchase. Therefore to breakeven, the level of the premium must be equal to the expected cost of those consumers with $c > \tilde{c}$. This expected cost is

$$\pi = p \int_{\tilde{c}}^{\infty} cf(c)dc \times \frac{1}{1 - F(\tilde{c})}.$$ 

(6)

In the expression (6), the right-hand side consists of the product of probability of illness, $p$, and the average cost of those with costs above $\tilde{c}$. The denominator, $1 - F(\tilde{c})$, is needed to renormalize the total density of
those consumers with costs above \( \hat{c} \).

A competitive equilibrium consists of the premium \( \pi \) and the cost of the consumer who is just indifferent between buying and not buying insurance, \( \hat{c} \), that satisfy (5) and (6). The competitive equilibrium \( \hat{c} \) will always be below \( \bar{c} \). This means that the insurance market must be active. Consumers who will have very high costs must purchase insurance, and the equilibrium premium must not be exceedingly high. The following argument substantiates this claim.

The highest ever premium in this model is \( p\bar{c} \). The value \( \bar{c} \) is the highest cost level, and it only happens with probability \( p \). So a premium equal to \( p\bar{c} \) must allow an insurer to break even. Now a premium equal to \( p\bar{c} \) is an actuarially fair premium. The type-\( \bar{c} \) consumer must accept it. His utility from this contract is \( U(W - p\bar{c}) \), and because he is risk averse, we have

\[
U(W - p\bar{c}) > (1 - p)U(W) + p(U(W - \bar{c})),
\]

the right-hand side expression being the expected utility when he has no insurance.

Furthermore, because the consumer is risk averse, a type-\( c \) consumer with \( c \) very close to \( \bar{c} \) must also prefer to purchase insurance at premium \( p\bar{c} \). Because (7) is a strict inequality, it implies

\[
U(W - p\bar{c}) > (1 - p)U(W) + p(U(W - \bar{c} + \epsilon))
\]

for any \( \epsilon \) sufficiently small. This means that a type-\( (\bar{c} - \epsilon) \) must also prefer to purchase insurance at premium \( p\bar{c} \). Therefore, the firm actually makes a strictly positive profit with the premium \( p\bar{c} \). This violates the requirement that firms must make zero profit in a competitive equilibrium. We therefore conclude that the equilibrium premium must be strictly lower than \( p\bar{c} \). In order words, in equilibrium, a competitive firm must insure some consumers, those with high costs.

Adverse selection does lead to inefficiency. Those consumers with low costs will find the equilibrium premium too high, and they refuse to purchase insurance. There is a deadweight loss; if the cost \( c \) were common knowledge, a full-insurance contract with premium \( pc \) would be offered to the type-\( c \) consumer. But this information is unavailable, so such a contract would be attracting too many consumers with higher costs, and the contract with premium \( pc \) will not let an insurer break even.
Adverse selection does not make the insurance market collapse entirely. Because of risk aversion, even when consumers are offered a premium higher than their expected loss, they may still find it better than staying uninsured. There is some potential gain in trade, and this will be realized in equilibrium.

2.1 An Example

The following simple example illustrates the idea. Suppose that the cost $c$ is uniformly distributed on 50, 100, 150, and 200. A consumer's loss of illness can be one of these four values, and each happens with probability $1/4$. A competitive equilibrium can take the following form. The premium is equal to $175p$. The average of 150 and 200 is 175, so the premium is equal to the probability of illness $p$ multiplied by 175. Given this premium at $175p$, type-50 and type-100 find that the premium is too expensive:

$$(1 - p)U(W) + pU(W - 100) > U(W - 175p),$$

so they do not buy insurance. But type-150 and type-200 prefer to buy insurance:

$$U(W - 175p) > (1 - p)U(W) + pU(W - 150).$$

Notice that $175p > 150p$ so in fact the type-150 consumer is being charged more than his expected cost. However, if he is sufficiently risk averse, then he may still find this preferred to being uninsured. Put differently, if his risk premium is high, then he buys the insurance. In this equilibrium, type-50 and type-100 do not buy insurance. Adverse selection implies a high premium. The low cost types choose to bear than risk than buying insurance at the elevated premium.

If the consumer is not very risk averse, then even the type-150 consumer may not find it attractive to take the insurance. In that case, the competitive equilibrium will be one where the premium is equal to $200p$, and only the type-200 consumer will buy insurance.