



Chapter 11

Uncertainty, Insurance, and Information

1. An Example of Uncertainty

- Suppose that David owns a house worth of \$1M
- With a probability of 0.1, the house will catch a fire, which will cause a economic loss of \$0.8M
- The uncertainty faced by David

	Wealth	Probability
$w = \begin{cases}$	w_0	$1-p=0.9$
	$w_0 - L$	$p=0.1$



2. Concepts Regarding “Risk”

- Expected Value of the uncertainty

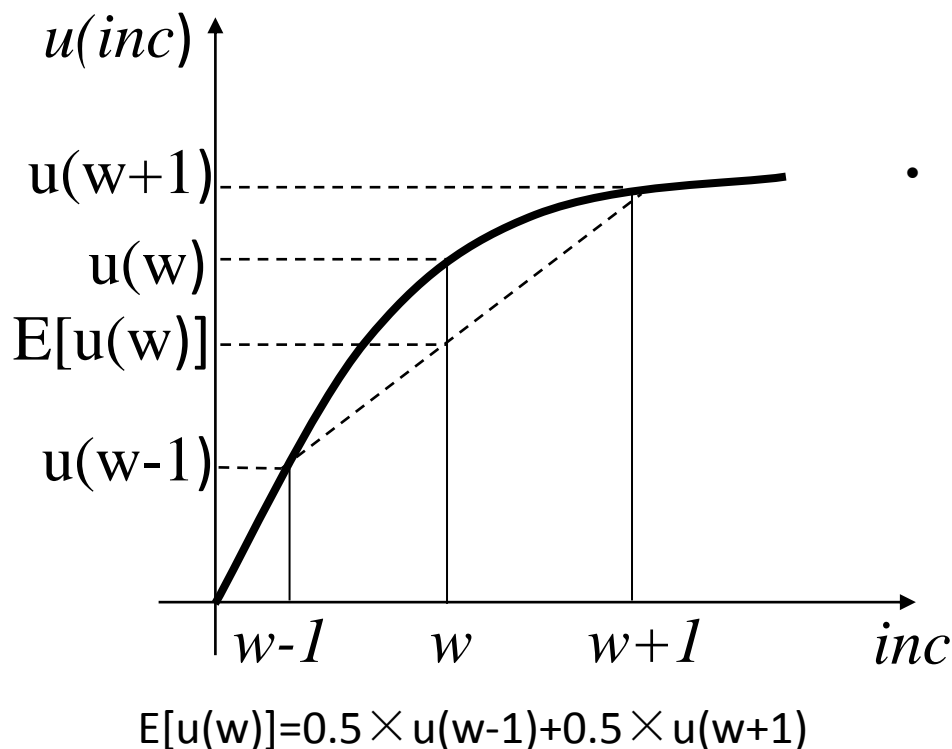
$$E(w) = w \times (1-p) + (w-L) \times p = w - pL$$
$$= 1 - 0.1 \times 0.8 = 0.92$$

- **Risk Aversion**: Preferring a sure amount of \$0.92M to a risky prospect with and expected value of \$0.92M
- In the previous example, if David can choose from the following two options
 1. Get \$0.92M for sure
 2. Get \$0.2M with a probability of 0.1; get \$1M with a probability of 0.9

He always chooses option #1, then David is risk averse



Risk Aversion with Marginal Utility of Income



- In Economics terms, **risk averse** consumers obtain higher level of pleasure (utility) under a certain outcome relative to the uncertain outcome, even if they have the same expected value
- Risk-aversion is the same as diminishing marginal utility of income:
 - Compare (1) a certain outcome of w , with (2) a uncertain outcome with equal probability of $w+1$ and $w-1$
 - **Diminishing marginal utility of income** implies that the pain from losing \$1 is greater in magnitude than the pleasure from gaining \$1
 - With equal probability, the consumer will be worse off moving from (1) to (2)



Certainty Equivalent

- ***Certainty Equivalent (CE)***: A certain payoff level at which the consumer obtain the same level of utility/pleasure as he would obtain facing an given uncertain outcomes
- In our example, CE measures how much David would like to pay for a house that might be born down with probability 0.1。
- Apparently, if $CE < E(w)$, then consumer is risk averse
- Lets assume that facing a potential fire accident, David's CE is \$0.9M
 - Put in another way, the uncertain fire accident causes a welfare/utility/pleasure loss of \$0.1M ($=1-0.9$) to David



基本概念小结

- 消费者面临财富的不确定性 (Uncertainty):

$$W = \begin{cases} W_0 & 1-p=0.9 \\ W_0 - L & p=0.1 \end{cases}$$

- 基于财富值的效用函数 (Utility):

- $U(x)$

- 财富的期望值 (Expected Wealth):

- $E(W) = (1-p) \cdot W_0 + p \cdot (W_0 - L)$

- 财富效用的期望值 (Expected Utility of Wealth):

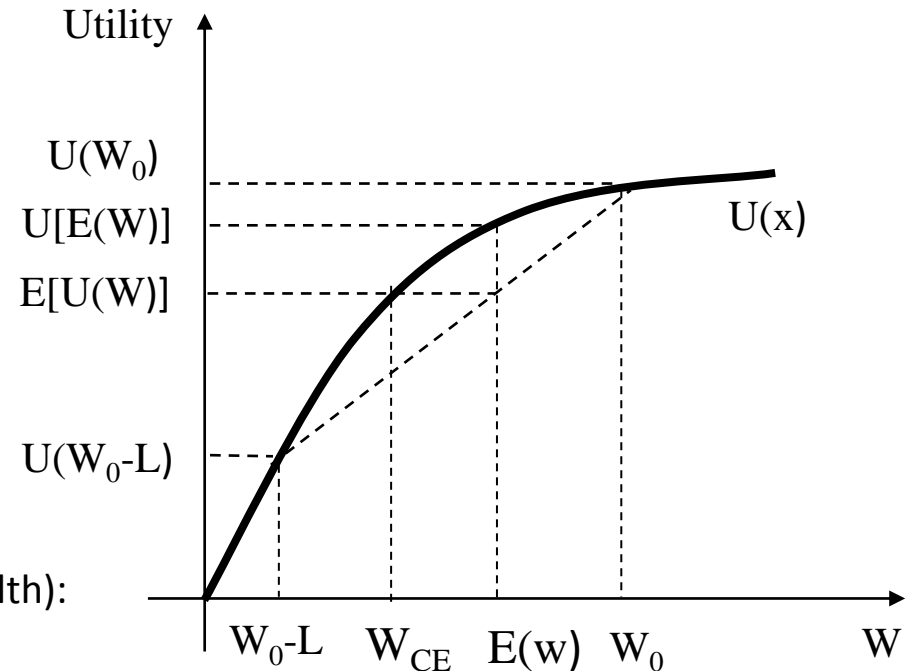
- $E[U(W)] = (1-p) \cdot U(W_0) + p \cdot U(W_0 - L)$

- 期望财富的效用值 (Utility of Expected Wealth):

- $U[E(W)] = U[(1-p) \cdot W_0 + p \cdot (W_0 - L)]$

- 确定性等值 (Certainty Equivalent):

- $U(W_{CE}) = U[E(W)]$



- 风险厌恶(Risk Aversion):

$$U[E(W)] > E[U(W)], \text{ 也等同于 } W_{CE} < E(W)$$

3. Insurance



- Suppose that an insurance company can offer David an insurance: if David is willing to pay a premium of \$1 million, then the company will pay David all his loss in case of the fire accident
- The wealth profile of David after purchasing the insurance

	Wealth	Probability
$w =$	$w_0 - I$	$1-p=0.9$
	$w_0 - L - I + L$	$p=0.1$

- Source of insurance company's profit
 - Purchasing insurance is purchasing certainty
 - Uncertainty causes risk averse consumer in their utility/pleasure
 - In order to avoid this loss, consumers are willing to pay a price in order to go back to certainty
- The maximum possible of the insurance premium is the difference between the certain wealth and the certainty equivalence of the uncertain outcome:

$$I_{\max} = w - CE = 1M - 0.9M = 0.1M$$

Insurance Company

- When selling insurance to consumers, profit of the insurance company is uncertain as well

	Wealth	Probability
$\pi = \begin{cases}$	I	$1-p=0.9$
	$I - L$	$p=0.1$
\end{cases}		

- Expected profit of the company:

$$E(\pi) = I \times (1-p) + (I-L) \times p = I - pL$$

$$= I - 0.1 \times 0.8 = I - 0.08$$
- Assume that insurance company is risk neutral. It only cares about its expected profit.
- In order to stay profitable, the insurance premium should make $E(\pi) \geq 0$. i.e., $I - 0.08 \geq 0$ Hence $I_{\min} = 0.08M$, which is the expected value of loss of the consumer (or the expected value of the compensation provided by the insurance company)

4. Asymmetric Information

- ***Asymmetric Information*** occurs when buyers and sellers have different information on important facts
- ***Hidden characteristics***: Things one party to a transaction knows about itself but which are unknown by the other party.
- ***Hidden action***: Action taken by one party in a relationship that cannot be observed by the other party.

4.1 Adverse Selection

- Refers to a situation where a selection process results in a pool of individuals with economically undesirable characteristics.
- “Adverse Selection” always happen when asymmetric information exists before agents signing the contract.
- The most famous model is Akerlof’s “The Market for Lemons”.
- A simple example highlights the basic issues involved in adverse selection.



Lemon Problem in the Used Car Market

- Four sellers selling used cars in the market. Depending on difference in time and extensiveness of usage, their cars are worth \$8000, \$6000, \$4000, and \$2000, respectively.
- Asymmetric Information Problem: The buyers in the market do not know the quality of a given used car.
- However, they know the distribution of the quality of used cars.



One of these is worth of \$8000. But which one?

- Even if the seller “tells” a buyer that his car worth \$8000, the buyer won't believe it. Because the buyer worries that the seller always wants to over sell his car to earn more surplus.
- For this reason, when facing any car, a buyer is only willing to pay an expectation value of the quality of all used cars in the market:
$$P = 0.25 \cdot 8 + 0.25 \cdot 6 + 0.25 \cdot 4 + 0.25 \cdot 2 = 0.5 \text{ (thousands)}$$

- After realizing that any buyer is only willing to pay at most \$5000 for a used car, sellers with high quality cars (\$6000 and \$8000) exit the market. This is the first round of “adverse selection”
- At the same time, buyer’s information about the distribution of car qualities is updated as well. However, the asymmetric problem sustains.



This car might worth \$4000 or \$2000 with equal probabilities.

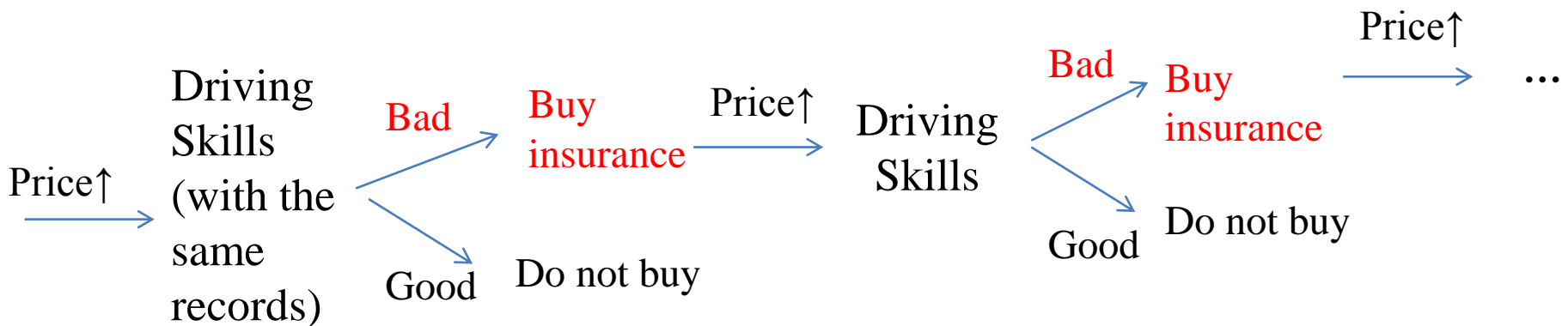
- When facing any car, the buyer only wants to pay the expected quality of the cars left in the market:
 $P = 0.5 \times 4 + 0.5 \times 2 = 3$ (thousands)
- Now, sellers with \$4000 cars begin to withdraw from the market. This is the second round of “adverse selection”.
- The market is only left with \$2000 cars. And the buyer will pay \$2000 to buy any of them.

Adverse Selection in Insurance Industry



Problem of Raising Insurance Price

- Asymmetric Information: Insurance company does not know car accident records are due to bad driving skills, OR bad luck
- Raising insurance premium will lead to adverse selection
 - Only the really lousy drivers will have incentive to purchase the insurance at higher price

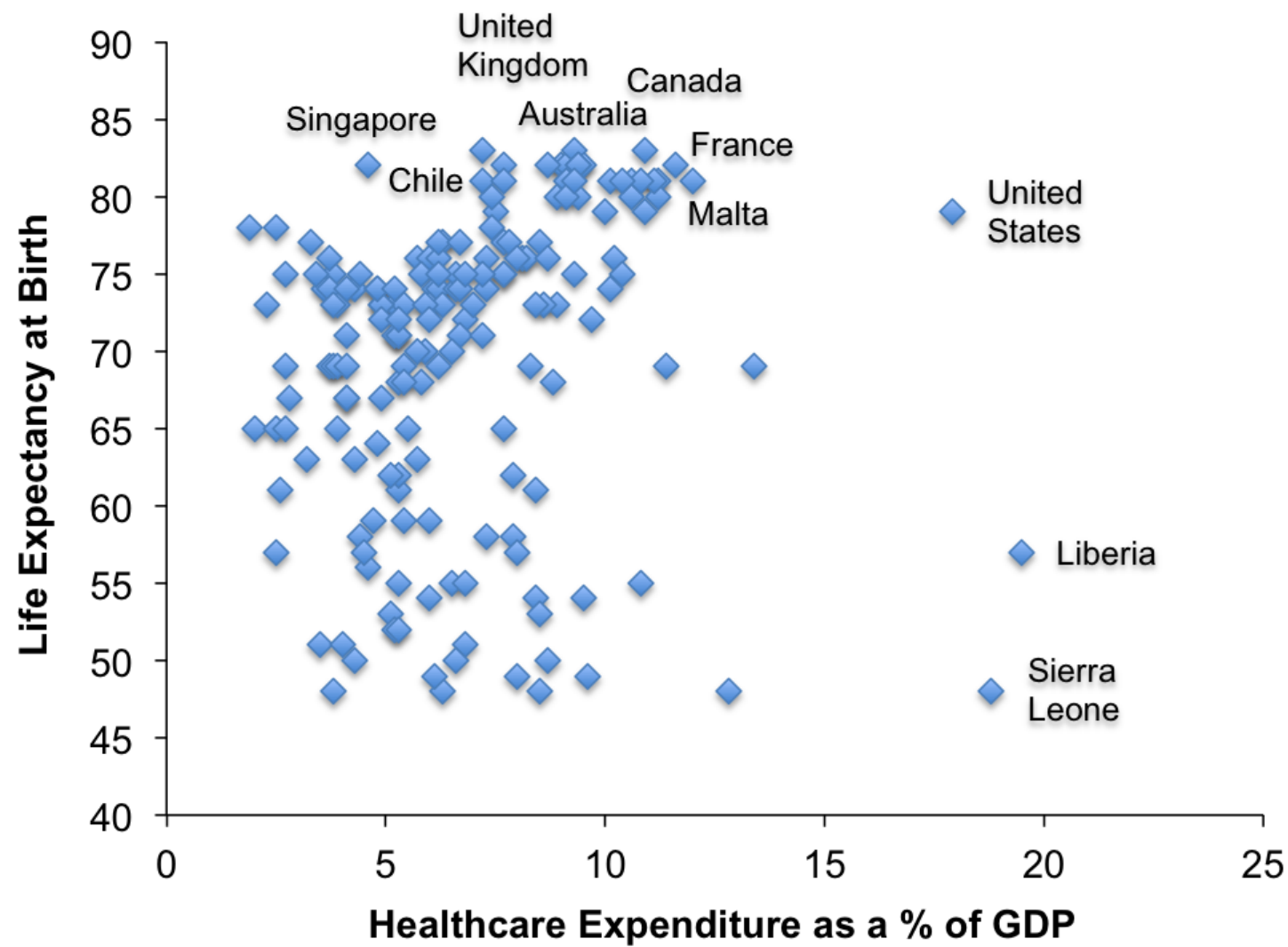


Solution: Signaling

- ***Signaling***: An attempt by an informed party to send an observable indicator of his or her hidden characteristics to an uninformed party
 - signal/records/certificates
- The signal need to be **credible**:
 - more costly (or impossible) for the low type to send
 - Otherwise the low type can mimic the same signal as the high type
- Example:
 - Diploma in the labor market
 - Long-term consumer credit records
 - Long-term driving history

4.2 Moral Hazard

- Situation where one party to a contract takes a hidden action that benefits him or her at the expense of another party
- The nature of insurance markets makes insurance companies particularly vulnerable to the moral hazard problem
- Insurance policy may change people's incentives, which in turns changes the probability of the events covered by insurance



Moral Hazard and Medical Expenditure

- Moral hazard is one factor that has contributed to rising medical costs during the past decade.
- When individuals have health insurance or belong to a health maintenance organization (HMO), they do not pay for the full marginal cost of medical services. This leads to accelerating medical expenses because
 - Individuals are more likely to visit a doctor than necessary
 - Abuse of the medicine, e.g., antibiotics



Solutions

- Deductible
 - If the deductible is \$200, the first \$200 in losses is paid by the insured
- Risk sharing
 - Full insurance is the main cause of moral hazard
 - Partial insurance means that the insured need to a certain share of the loss