



Module 1: Health Insurance

Part 1: Risk and Uncertainty

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Describing risk

We need three things to define risk in this class:

1. Probability
2. Expected value
3. Preferences (i.e., a utility function)

1. Probability

Definition: The likelihood that a given outcome will occur.

Important to note the timing here...probability applies to an uncertain event that may have several possible outcomes. For example, I may have a heart attack or I may not. [Risk Calculator](#).

2. Expected value

Definition: The probability weighted average of the payoffs (or costs) associated with all possible outcomes.

For two potential outcomes, x_1 and x_2 , with probabilities p_1 and p_2 :

$$E[x] = p_1 x_1 + p_2 x_2$$

Example

What is my expected cost?

- Two possible outcomes: heart attack or no heart attack
- 10% chance of having a heart attack
- Cost of \$100,000 if I have a heart attack (but I will survive and recover)

Answer

I will incur a cost of \$100,000 with 10% probability. So my expected cost is just $E[\text{cost}] = 0.1 * 100,000 = 10,000$.

3. Preferences

Definition: Preferences take the form of a utility function, $u(x)$, which tells us how much we benefit get from some consumption bundle, x .

Expected utility combines expected value and utility...

$$E[u(x)] = p_1 u(x_1) + p_2 u(x_2)$$

Risk preferences

With probabilities, expected values, and utilities/preferences, we can now measure preferences toward risk.

- **Risk averse:** We prefer to avoid the risky situation. You would rather have the same (or slightly less) with certainty than a lottery over two risky outcomes.
- **Risk neutral:** Indifferent between the risky situation or that of certainty.
- **Risk loving:** Prefer the risky situation.

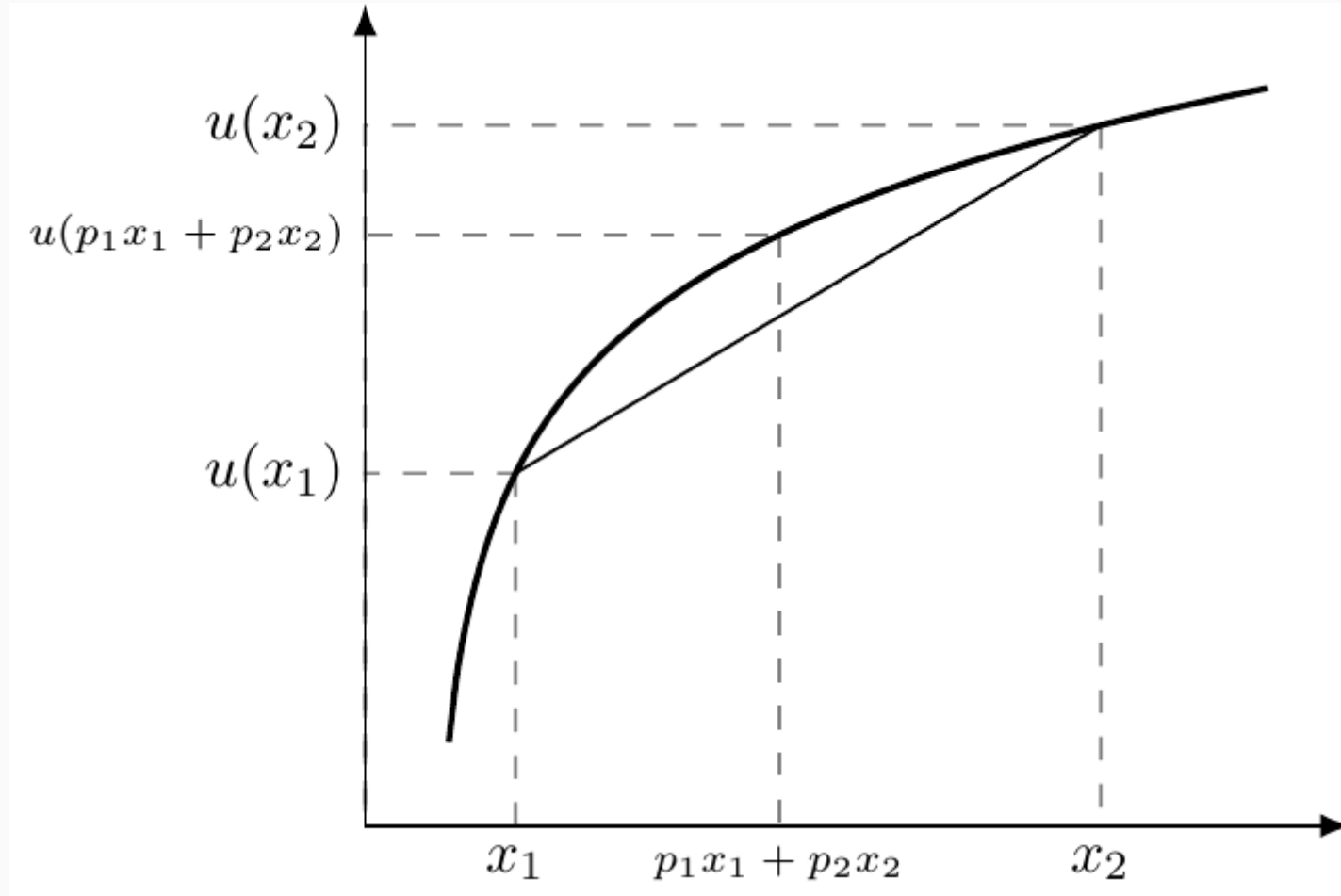
Risk aversion

Most common assumption is that individuals are risk averse. Mathematically, this follows from diminishing marginal utility.

$$u'(x_1) > u'(x_2) \text{ for } x_1 < x_2$$

What does this mean in words?

Risk aversion



In-class Problem: Expected values

An individual starts with a wealth of \$100,000. With probability 0.3, they will get sick and incur a cost of \$40,000.

1. What is this person's expected cost of illness?
2. Assume this individual has a utility function of the form, $u(w) = w^{0.20}$. What is this person's expected utility?
3. Calculate this person's utility if they were to incur the cost of illness with certainty. Is this utility higher or lower than what you found in part (2)?

Why purchase health insurance?

Say your utility function is $u(w) = \sqrt{w}$ and that you're starting with $w = \$100$. I propose a lottery in which I flip a coin...heads you win \$20 and tails you lose \$20.

1. What is the expected monetary value of this lottery?
2. What is your utility at this expected value?
3. What is the expected utility from this lottery?

Answer

Expected wealth is simply $\frac{1}{2} \times 80 + \frac{1}{2} \times 120 = 100$, which yields a utility of $u(w) = 10$. But your expected utility is

$$\frac{1}{2} \times u(w_{heads}) + \frac{1}{2} \times u(w_{tails}) = \frac{1}{2} \times \sqrt{80} + \frac{1}{2} \times \sqrt{120} = 9.95.$$