

7

CHAPTER 7

Choice under Risk and Uncertainty

Why the same person buys insurance and lottery tickets, and why losing \$100 stings more than finding \$100 feels good.

What this chapter covers



7.2–7.3 Describing risk

- Expected value & spread
- Expected utility
- Attitudes toward risk



7.4–7.5 Measuring & managing

- Risk premium & CE
- Why insurance exists
- Diversification



7.6–7.8 Puzzles & evidence

- Why people gamble
- Paying to avoid small risks
- Prospect theory

THE BIG IDEA

Once outcomes cannot be predicted in advance, choices gain a new dimension. This chapter builds the tools to understand choice when the future is risky.

7.1

Introduction

- A sure \$50, or a coin flip for \$100 or nothing?
- Why buy lottery tickets that pay back less than they cost?
- Why losing hurts more than winning pleases

Three puzzles about risky choice



The coin flip

Would you rather have \$50 for certain, or flip a coin for \$100 or nothing?



Insure AND gamble

Many people buy lottery tickets that pay back far less than their price, and also buy insurance.



Losses sting more

Why does losing \$100 hurt more than finding \$100 feels good?

WHAT TIES THEM TOGETHER

Risk means outcomes a person cannot predict in advance. Allowing for risk gives choice a new dimension, and this chapter builds the tools to understand it.

7.2

Describing Risk: Expected Value and Spread

- A lottery: any situation with uncertain outcomes
- Expected value, the average payoff
- Spread, how risky the gamble is

Two numbers summarize a risky prospect

■ Lottery

Any situation with uncertain outcomes, each occurring with some probability, a coin flip, an investment, a crop that depends on the weather.

■ Expected value (EV)

The average payoff, weighting each outcome by its probability. A coin flip paying \$100 on heads and \$0 on tails has $EV = \frac{1}{2}(\$100) + \frac{1}{2}(\$0) = \$50$.

Expected value is not the whole story

SAME AVERAGE, DIFFERENT RISK

A sure \$50 and the coin flip both have an expected value of \$50, but the coin flip is risky and the sure thing is not. The EV tells us what a gamble pays on average, not how risky it is.

- For risk we look at the spread of outcomes.
- Two gambles with the same expected value can carry very different risk.
- A person's choice between them reveals how she feels about risk itself.

Two gambles, same average, different spread



Gamble A

Pays \$45 or \$55 on a coin flip. Outcomes cluster tightly around \$50, whatever happens, you end up close to the average.



Gamble B

Pays \$0 or \$100 on a coin flip. Outcomes spread far apart, you might walk away with nothing, or with twice the average.

THE TAKEAWAY

Both have an expected value of \$50. Economists summarize the spread with the variance (or its square root, the standard deviation): the larger the variance, the riskier the prospect. Most people, offered A or B for free, prefer the tighter gamble A, a first clue that they dislike risk.

7.3

Expected Utility and Attitudes Toward Risk

- Weighing utility, not dollars
- Diminishing marginal utility of wealth
- Risk averse, neutral, and loving

7.3 EXPECTED UTILITY

People weigh utility, not dollars

■ Expected utility

To choose among risky prospects, a person weighs not the dollar payoffs but the utility those dollars bring, averaging utility across outcomes.

THE KEY FACT

For most people each additional dollar brings a little less extra satisfaction than the last, the diminishing marginal utility of wealth from Chapter 5. This single fact drives everything that follows.

7.3 EXPECTED UTILITY

A person with diminishing marginal utility

Wealth	Utility
\$0	0
\$25	5
\$50	7
\$100	10

Table 7.1 A person with diminishing marginal utility of wealth.

READ THE TABLE

Each extra \$25 adds less utility than the last: \$0→\$25 adds 5, but \$50→\$100 (four times as much money) adds only 3. The utility curve flattens as wealth rises, the signature of diminishing marginal utility.

7.3 EXPECTED UTILITY

Why this person prefers the sure thing

Option	Expected value	Expected utility
Sure \$50	\$50	7
Coin flip \$0 / \$100	\$50	5

Sure \$50 yields utility 7; the coin flip yields $\frac{1}{2}(0) + \frac{1}{2}(10) = 5$.

RISK AVERSION

Both have the same expected value of \$50, but the sure thing gives more expected utility, so this person prefers it. The gain in utility from winning the extra \$50 is smaller than the loss from ending up with nothing.

Three attitudes toward risk



Risk averse

Prefers a sure amount to a risky prospect of equal expected value. Utility is concave (diminishing MU).



Risk neutral

Cares only about expected value; indifferent between the sure \$50 and the coin flip. Utility is a straight line.



Risk loving

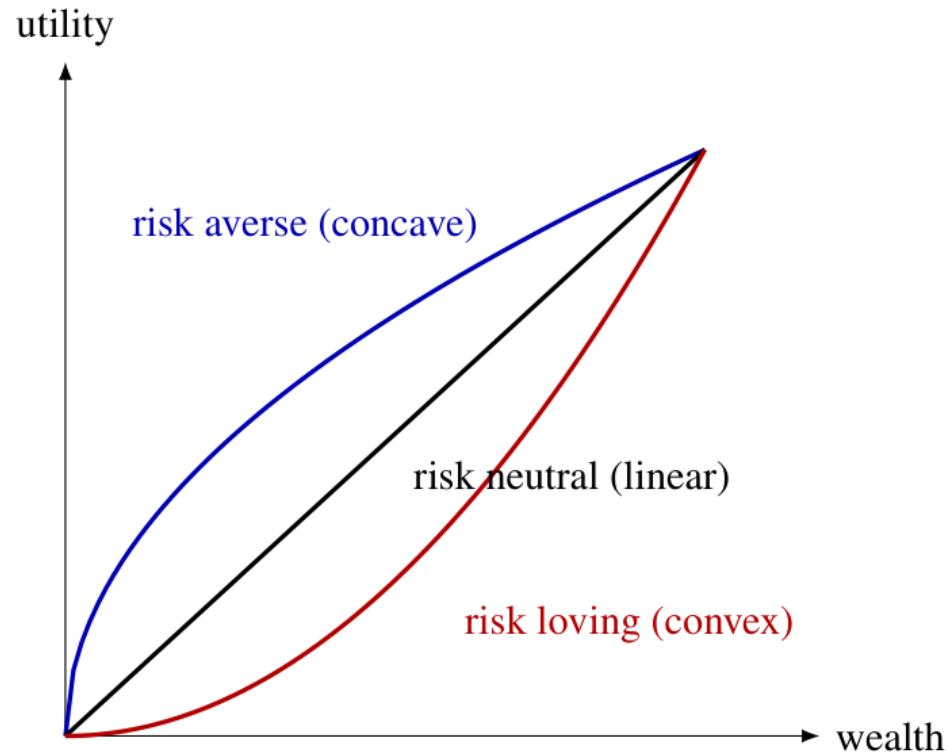
Actually prefers the gamble. Marginal utility of wealth is increasing; utility is convex.

It Is All in the Curvature

The attitude shows up as the curvature of the utility-of-wealth function: concave, straight, or convex.

7.3 ATTITUDES TOWARD RISK

Risk attitudes as the shape of the curve



Concave. Risk averse, each extra dollar adds less utility.

Linear. Risk neutral, utility rises in a straight line.

Convex. Risk loving, each extra dollar adds more utility.

Figure 7.1 Risk attitudes as the shape of the utility-of-wealth curve: concave, linear, convex.

7.4

Measuring Risk Aversion

Risk premium and certainty equivalent.

- Certainty equivalent, the sure amount that ties the gamble
- Risk premium, what she would give up to avoid risk

The certainty equivalent

■ Certainty equivalent

The sure amount of money that makes a person exactly as well off as facing the gamble.

WORKED FROM TABLE 7.1

For the person in Table 7.1, the coin flip yields expected utility 5. Reading the table, a sure wealth of \$25 also yields utility 5. So her certainty equivalent for the coin flip is \$25, she would trade the gamble for a guaranteed \$25.

The risk premium

■ Risk premium

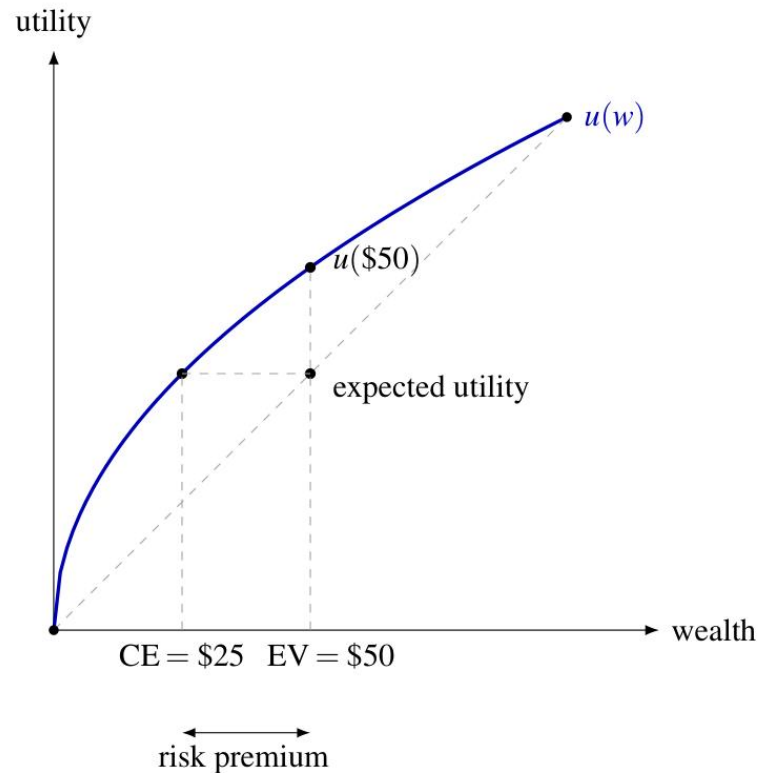
The difference between the gamble's expected value and its certainty equivalent. Here $\$50 - \$25 = \$25$.

WHAT IT MEANS

It is the amount she would willingly give up to avoid the risk: she values a coin flip worth \$50 on average at only \$25, and would pay as much as \$25 to swap it for the sure thing. The more risk averse the person, the larger her risk premium.

7.4 MEASURING RISK AVERSION

Both measures on the concave curve



- The certainty equivalent (\$25) is the sure wealth giving the same utility as the gamble.
- The risk premium (\$25) is the gap between expected value (\$50) and the certainty equivalent.

Figure 7.2 The certainty equivalent and risk premium for a risk-averse person facing a 50–50 gamble.

Self-check: a quick calculation

SELF-CHECK

A coin flip pays \$100 on heads and \$0 on tails. What is its expected value? If a risk-averse person would trade it for a sure \$30, what is her risk premium?

Expected value = $\frac{1}{2}(\$100) + \frac{1}{2}(\$0) = \$50$. Her certainty equivalent is \$30, so the risk premium is $\$50 - \$30 = \$20$, what she would give up to avoid the risk.

7.5

Why Insurance Exists

- Risk aversion explains insurance
- A premium just above the expected loss
- Why both sides gain

7.5 WHY INSURANCE EXISTS

Risk aversion explains insurance

- A risk-averse person facing a possible large loss, a house fire, a car accident, a costly illness, is willing to pay more than the expected loss to be rid of the risk: exactly her risk premium.
- An insurance company, large enough to pool many independent risks, faces little overall uncertainty: by averaging many policies, its payouts are predictable.
- It can charge a premium slightly above the expected loss, cover its costs, and still leave the customer better off.

BOTH SIDES GAIN

Both sides gain. The customer converts an uncertain large loss into a small certain one. The same logic underlies health insurance, crop insurance, and appliance warranties.

Don't put all your eggs in one basket

■ Diversification

Spreading savings across many companies so the unrelated ups and downs largely cancel out. The expected return is the same, but the spread, the risk, is far smaller.

■ Risk pooling

The same logic for insurers: in any year a predictable fraction of houses burn or cars crash, so the insurer's total payout is steady even though each customer faces a frightening individual risk.

Two faces of the same idea

THE UNIFYING PRINCIPLE

Combining many independent risks shrinks the risk of the whole. Risk pooling and diversification are two faces of one idea, and together they underpin insurance markets, mutual funds, and the advice every financial adviser gives.

7.6

Case Study: Why Do People Buy Lottery Tickets?

If people are risk averse, why buy risk itself?

7.6 CASE STUDY

Lotteries are, on average, terrible bets

60¢

returned in prizes per \$1 wagered in U.S. state lotteries

32¢

expected value of a \$2 Powerball ticket

THE PUZZLE

A player loses, on average, well over a dollar per ticket, far less return than a casino. So why do so many people buy tickets that are risk itself?

Three forces reconcile this with theory

1

Tiny stakes

For the price of a coffee the loss is trivial, while the prize is life-changing, people may be locally risk loving over a small chance of a huge gain.

2

Overweighting

Players overweight very small probabilities, treating one-in-292-million as larger than it is (Section 7.8).

3

Entertainment

The ticket buys the pleasure of anticipation, not just a financial bet.

A NOTE ON WHO PLAYS

Lottery spending takes a larger share of income from lower-income households, which is why economists call lotteries a regressive way to raise revenue.

How can one person do both?

THE PUZZLE

The same person who pays for insurance, a sign of risk aversion, may also buy a lottery ticket, a sign of risk loving. How can one person be both?

Friedman & Savage. A person's attitude toward risk may differ across ranges of wealth.

Over most wealth, risk averse. She willingly insures against losses that would set her back.

For a tiny sum, risk loving. She gambles a trivial amount on a remote chance of a life-changing jackpot.

Not contradictory, but complementary

THE RESOLUTION

She insures the wealth she has and gambles a trivial amount on the remote chance of wealth she could never otherwise reach. Add the entertainment value and the overweighting of small probabilities, and behavior that looks irrational becomes understandable, if still, on average, a money-loser.

Explore it online: look up the current Powerball jackpot and odds, and compute the expected value of a \$2 ticket.

7.7

Empirical Evidence: Paying to Avoid Small Risks

Sydnor (2010) on homeowners' insurance deductibles.

7.7 EMPIRICAL EVIDENCE

A lower deductible is a small insurance policy

- If gambling shows people accepting risk, insurance choices show many of the same people paying dearly to avoid it, sometimes far too dearly.
- Sydnor (2010) examined the deductibles homeowners chose on their insurance policies.
- A lower deductible is itself a small insurance policy: pay a higher premium now, and the insurer covers more of any future claim.

7.7 EMPIRICAL EVIDENCE

Paying \$100 to avoid \$25 of risk

83%

chose a deductible below the available
maximum

\$100

extra paid per year to cut the deductible
\$1,000 → \$500

~\$25

the extra coverage was worth, in expected
terms

THE FINDING

Claims were rare, only about 5% of customers filed one in a year, so the extra coverage was worth only about \$25 in expected terms. Paying \$100 to avoid \$25 of expected risk implies a degree of risk aversion over modest sums that no standard model can justify.

A broad pattern that points to behavior

THE BIGGER PICTURE

Faced with small but salient risks, people are willing to overpay dramatically for peace of mind, a pattern that points toward the behavioral ideas we turn to next.

7.8

Behavioral Economics: Prospect Theory and Loss Aversion

Kahneman & Tversky (1979): gains and losses from a reference point.

From final wealth to gains and losses

■ Prospect theory (Kahneman & Tversky, 1979)

The expected-utility model assumes people evaluate outcomes by their final level of wealth. Prospect theory instead has people evaluate gains and losses relative to a reference point, usually where they are now.

TWO DEPARTURES

Two departures from the standard model stand out: loss aversion and probability weighting.

Loss aversion and probability weighting



Loss aversion

Losses hurt more than equal gains please. A loss looms about 2.25× as large as an equivalent gain (Tversky & Kahneman, 1992).



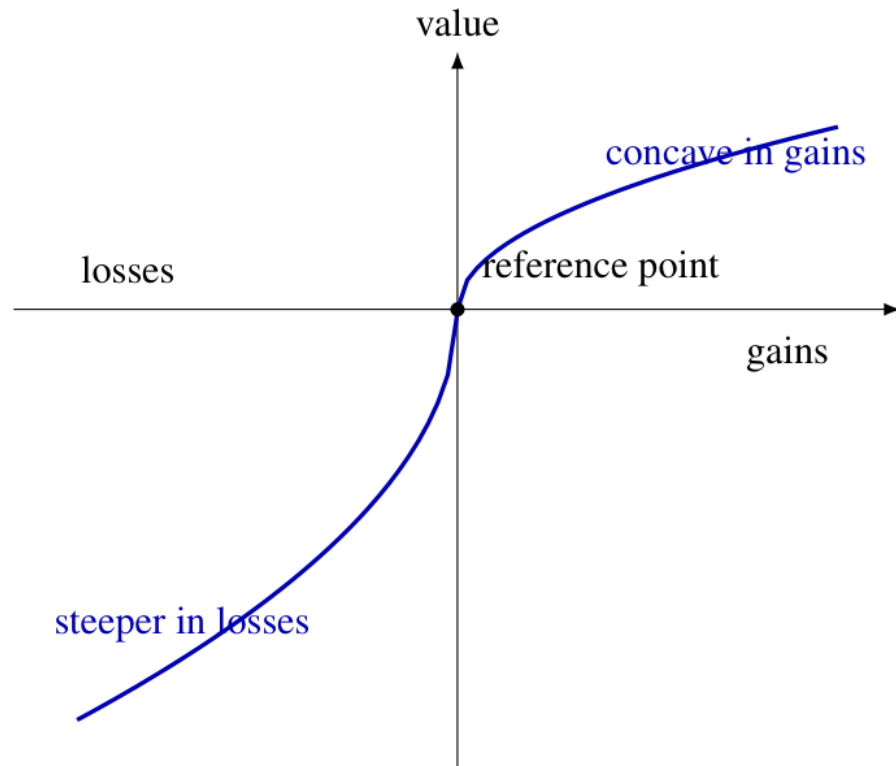
Probability weighting

People overweight rare events and underweight near-certain ones.

WHAT THEY EXPLAIN

Loss aversion explains why people refuse a 50–50 bet to win \$110 or lose \$100, and why the snow-shovel buyers of Chapter 2 reacted so strongly to an unfair price increase. Probability weighting explains both lottery jackpots and the overpurchase of insurance against unlikely losses (Section 7.7).

The prospect-theory value function



Concave over gains. Diminishing sensitivity to bigger wins.

Convex over losses. Diminishing sensitivity to bigger losses.

Steeper on the loss side. The same dollar loss outweighs the gain.

Nobel 2002. Prospect theory earned Daniel Kahneman the prize.

Figure 7.3 The value function: measured from a reference point, losses loom larger than equal gains.

Key takeaways

1

Describing risk

Summarize a gamble by its expected value (average payoff) and its spread (variance).

2

Expected utility

People weigh utility, not dollars; diminishing marginal utility makes most people risk averse.

3

Three attitudes

Risk averse (concave utility), risk neutral (linear), risk loving (convex).

4

Measuring it

Certainty equivalent and risk premium gauge how strongly someone dislikes risk.

5

Managing it

Insurance, diversification, and risk pooling all shrink risk by combining independent risks.

6

Behavior

Lotteries, over-insuring (Sydnor 2010), and prospect theory's loss aversion and probability weighting.