

Chapter 20

Decisions Involving Uncertainty

1. Risk Aversion
2. Reducing Risk
3. Behavioral Economics: How People Make Mistakes Around Uncertainty

Chapter 20 (1 of 4)

Learn how to make good decisions when the **outcome is uncertain:**

- Understanding Risk
- Diminishing Marginal Utility
- Risk-Reward Trade-off
- Expected Utility



1. Risk Aversion
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Uncertainty Is All Around You

There's **risk** whenever you **don't know** what the **outcome** will be **with certainty**:

- Will the shoes I bought online fit comfortably?
- Will I get into a car accident today when driving?
- Will I like living in the new city I just moved to?
- Will I still be happily married to this person in 40 years?
- Will I like being a parent?
- Will I make money if I invest in this stock?

*Let's discuss how to make **good decisions** even when the consequences of your choice are **uncertain**.*

Understanding Risk

Risk is a set of **probabilities** and **payoffs**:

- The **probability** of each outcome occurring.
- The **payoff** you'll get from each outcome if they do occur.

Are you willing to invest in this company?

- You could gain \$20,000 if they succeed.
- You could lose \$20,000 if they fail.
- There's a 50% chance of success.

Fair bet: A gamble that, **on average**, will leave you with the **same amount** of money.

- Half the time you're up \$20k, half the time you're down \$20k.
- These gains and losses cancel each other out on average.

Understanding Risk and *Risk Aversion*

Risk averse: Disliking uncertainty

- A **risk-averse** person will **reject fair bets!**
- Why?
- Fair bets take your current level of wealth and add uncertainty into the mix (which you dislike!).

Are you willing to invest in this company?

- You could gain \$20,000 if they succeed.
- You could lose \$20,000 if they fail.
- There's a 50% chance of success.

Cost-benefit analysis: A risk-averse person rejected this fair bet because, *for them*, the **costs outweighed** the **benefits**.

- Look beyond the financial costs and benefits!
- Money is just a means to end — a way to enjoy a

Instead of *money*, let's use a **measure of *well-being*** to assess the costs and benefits.

Key Definitions

To understand how a risk-averse person weighs costs and benefits, we focus on well-being (rather than money).

Utility: A measure of **well-being**.

Marginal utility: The **additional utility** you get **from one more dollar**.

Diminishing marginal utility: Each additional dollar yields a **smaller boost** to your utility than the previous dollar.

- Diminishing marginal utility explains why you're risk averse!

Diving into the Definition

Fair bet example

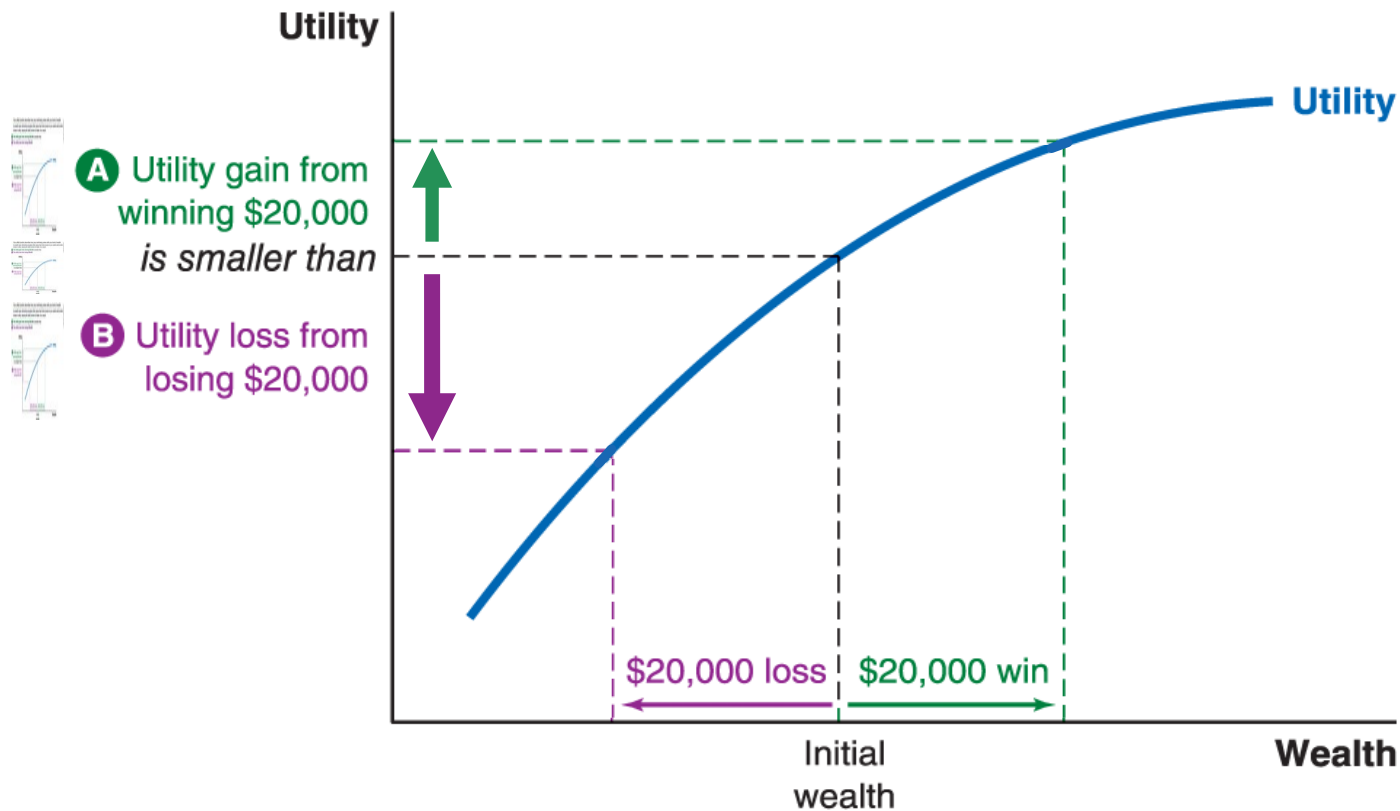
continued: Diminishing marginal utility says your 20,001st dollar is less useful than your 20,000th.

- As you get wealthier, more money doesn't make as much of a difference.

Thus, for risk-averse people, the **pain of losing** \$20k **outweighs** the **joy of gaining** \$20k.

- In terms of **utility**, the **costs** of a fair bet **exceed the**

Visualizing utility and risk aversion



More wealth leads to more utility, but **not** on a **one-for-one** basis.

➤ Diminishing marginal utility!

Additional wealth yields **smaller and smaller boosts** in your utility.

➤ Utility function **flattens** out at higher levels of wealth.

For a risk-averse person...

The utility gain from **winning \$20,000** is **smaller than...**

The Risk-Reward Trade-off (1 of 2)

Even a risk-averse person is better off taking a risky choice if it comes with a **sufficiently high reward**.

Fair bet proposal:

- You could gain **\$20,000**.
- You could lose **\$20,000**.
- There's a **50%** chance of success.

New proposal:

- You could gain **\$30,000**.
- You could lose **\$10,000**.
- There's a **50%** chance of success.

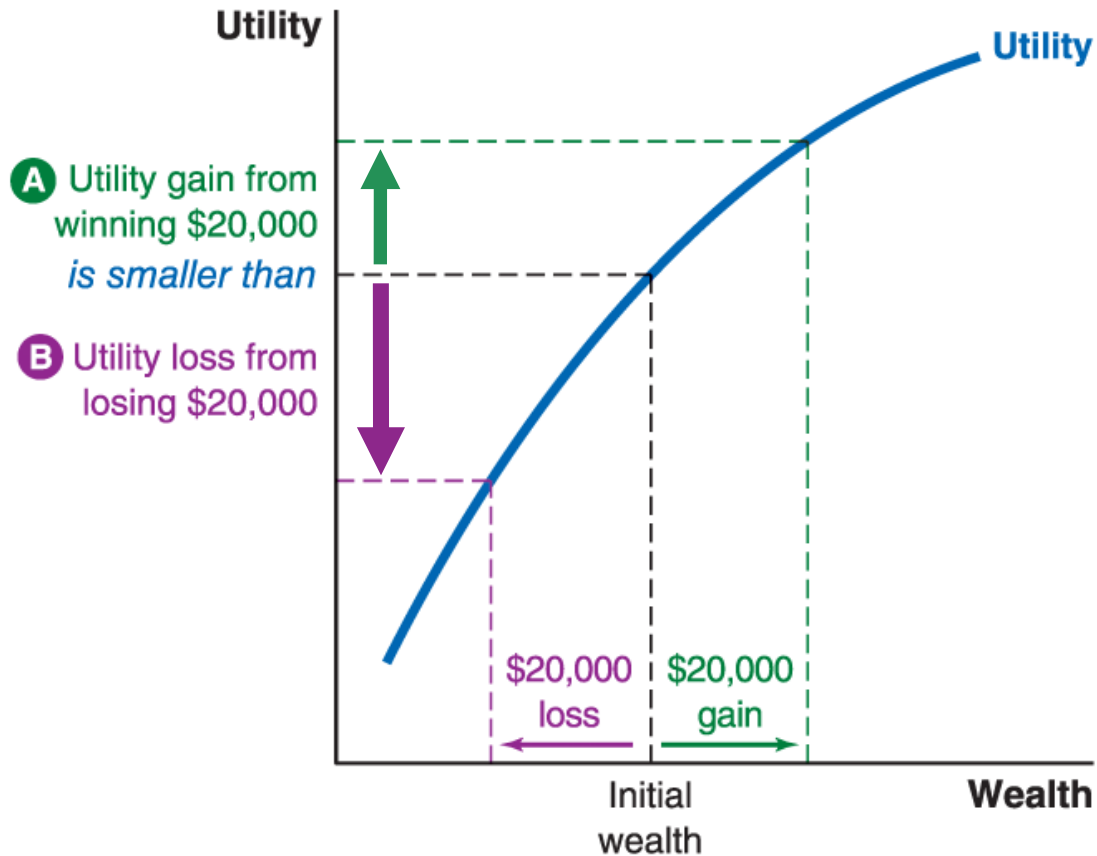
For the risk-averse person, we have seen that the **fair bet fails** the cost-benefit test.

- Under the **new proposal**, bigger payoffs make the bet **worthwhile**.

The Risk-Reward Trade-off (2 of 2)

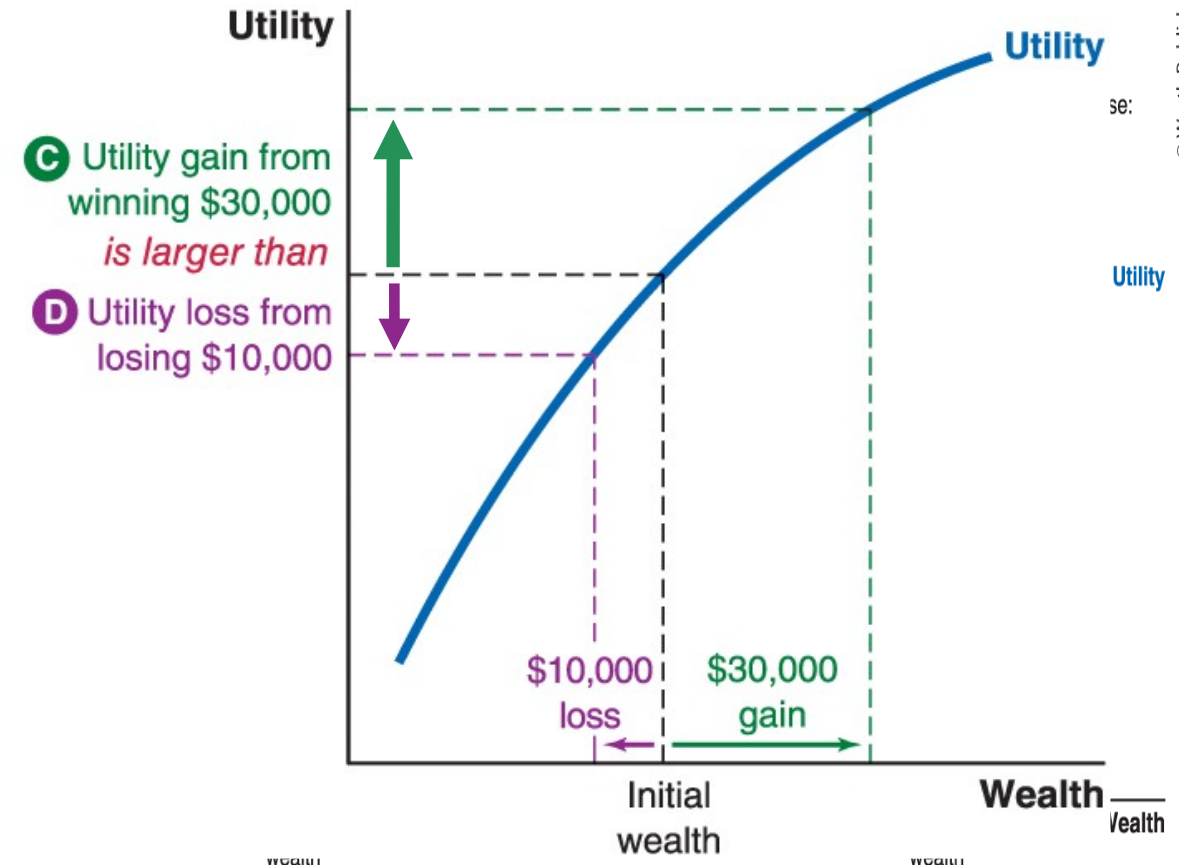
Fair bet proposal

Reject: **utility gain** < **utility loss**



New proposal (same risk, higher reward)

Accept: **utility gain** > **utility loss**
The greater the reward, the more likely you are to take the risk.



Each of Us Has Different Degrees of Risk Aversion

Your degree of risk aversion depends on...

- your temperament.
- your life situation.

Let's look at the **same risk-reward proposal** through the eyes of **two different people**.

The risk-reward proposal:

- You could gain **\$30,000**.
- You could lose **\$10,000**.
- There's a **50%** chance of success.

Imani:

- Slightly risk averse

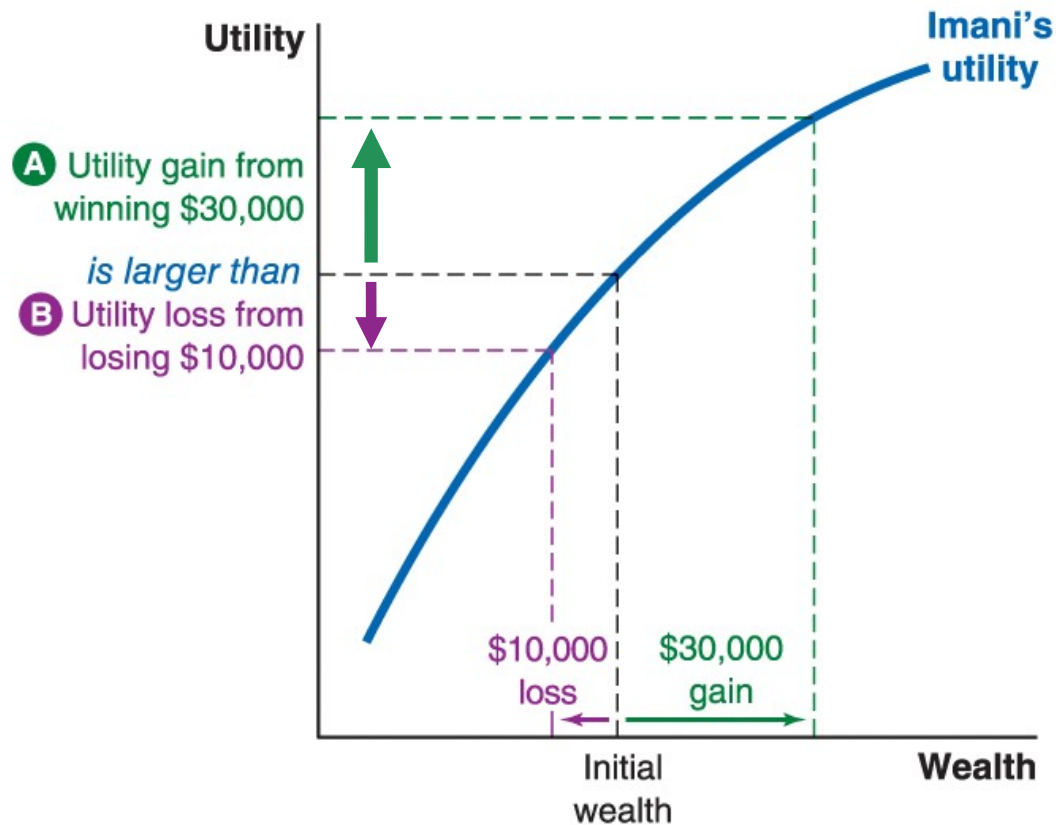
Lucas:

- Very risk averse (initially, very steep utility function)

Differing degrees of risk aversion

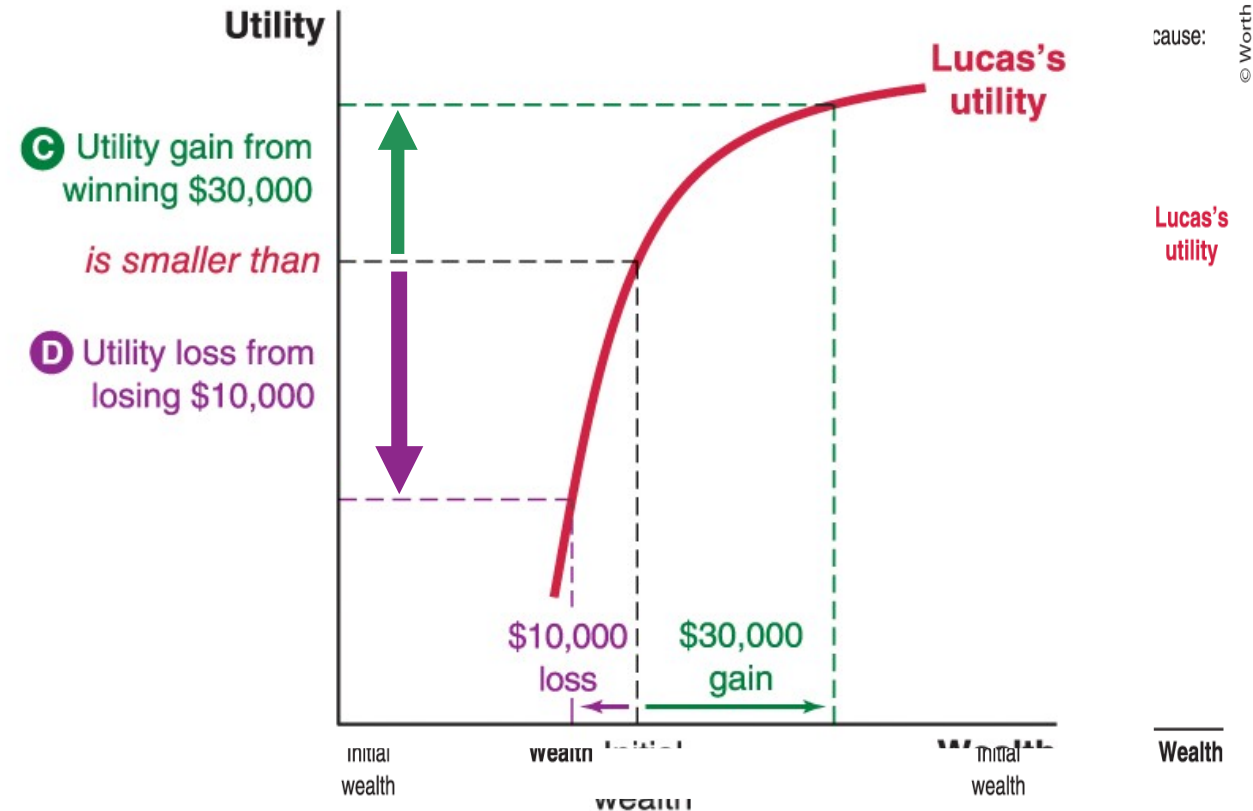
Imani: Slightly risk averse

Accept the bet: **Utility gain** exceeds **utility loss**.

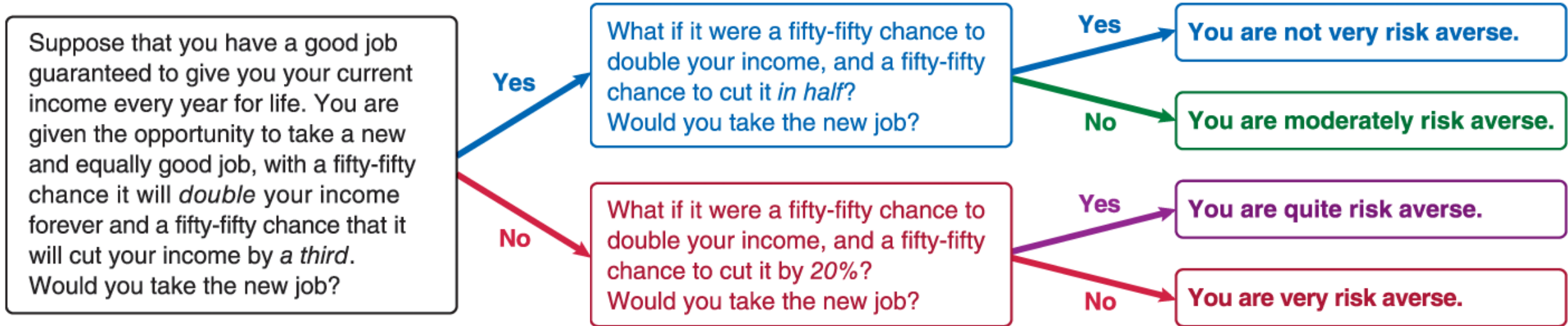


Lucas: Very risk averse

Reject the bet: **Utility gain** is **smaller** than **utility loss**.
If you are more risk averse, you will take on fewer risks.



How risk averse are you?



Risk aversion motivates many choices you make...

- Financial choices
- Health choices
- Whether to change jobs or not
- Start your own business or not
- Move to a new state (or country)
- Whether to buy insurance or not

Expected Utility Is Simply Your Average Utility (1 of 2)

Expected utility: What your utility will be, **on average**, if you make a particular choice.

- The **probability-weighted** average of the different utilities of each possible outcome.

Investment scenario:

You currently have **\$30,000**, which you can choose to invest or not.

- **40%** chance your investment succeeds, and the \$30,000 **grows to \$50,000**.
- **60%** chance your investment fails, and the \$30,000 **drops down to \$15,000**.

Expected utility = 40% × U(\$50,000) + 60% × U(\$15,000)

Note: **U(\$50,00)** means “Your utility when you have **\$50,000**.” ☹ *let’s discuss...*

Expected Utility Is Simply Your Average Utility (2 of 2)

$$\text{Expected utility} = 40\% \times U(\$50,000) + 60\% \times U(\$15,000)$$

Note: $U(\$50,000)$ means “Your utility when you have \$50,000.”

- The answer will depend on *your* utility function.
 - For our purposes: How do you feel on a **0 to 10 scale?**
 - Suppose $U(\$30,000) = 5$; $U(\$50,000) = 7$; $U(\$15,000) = 3$

$$\text{Expected utility of investing} = 40\% \times 7 + 60\% \times 3 = 4.6$$

Your current wealth of **\$30,000** yields a **utility of 5** out of 10.

- Your expected utility from **investing is lower** if you just kept the \$30,000 in your savings.
 - Result: You choose NOT to invest.

Key take-aways: Risk aversion

Every choice involves **risk**.

- You face risk whenever the **outcome is uncertain**.

Risk-averse people will reject a fair bet.

- Diminishing marginal utility
- **Utility gained** is **smaller** than **utility lost**.

Risks are more worth taking if...

- rewards are large; stakes are low; you aren't very risk averse.

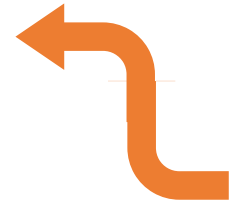
Focus on **expected utility**

- Expected utility = $P_a \times U_a + P_b \times U_b + \dots$

Chapter 20 (2 of 4)

Be ready to apply **five strategies** for reducing the risk in your life:

1. Risk spreading
2. Diversification
3. Insurance
4. Hedging
5. Gathering information



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Risk-reduction strategy 1: Risk spreading

Investment proposal 1:

- 50% chance of success
- Success: you earn **\$200,000**
- Failure: you lose **\$100,000**

Accept or Reject?

- Reject
- The utility consequences of a \$100,000 decrease in wealth are too big.

Take-away:

- Risk-averse over **large stakes**

Investment proposal 2:

- 50% chance of success
- Success: you earn **\$2**
- Failure: you lose **\$1**

Accept or Reject?

- Accept
- The utility consequences of a \$1 decrease in wealth are very small.

Take-away:

- Barely risk-averse over **small stakes**

Risk
spreading

Diversifica
tion

Insurance

Hedging

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Strategy 1: Risk spreading

Two insights:

1. Make **risk-averse** choices when the **stakes are large**.
2. Make nearly **risk-neutral** choices when the **stakes are small**.
 - **Risk neutral:** Indifferent to uncertainty
 - Risk-neutral people only care about whether a choice offers positive **financial** returns on average.
 - Take any risk that's better than a fair bet.

Risk spreading: Breaking big risk into many **smaller risks** so that it can be **spread over many people**.

- Risk spreading explains why big investments require a lot of shareholders.
- Instead of you alone taking a \$100,000 risk, issue 1,000 shares for \$100.
 - Now 1,000 people risk losing \$100 (rather than you alone risking \$100,000).

Risk
spreading

Diversifica
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Insurance

Hedging

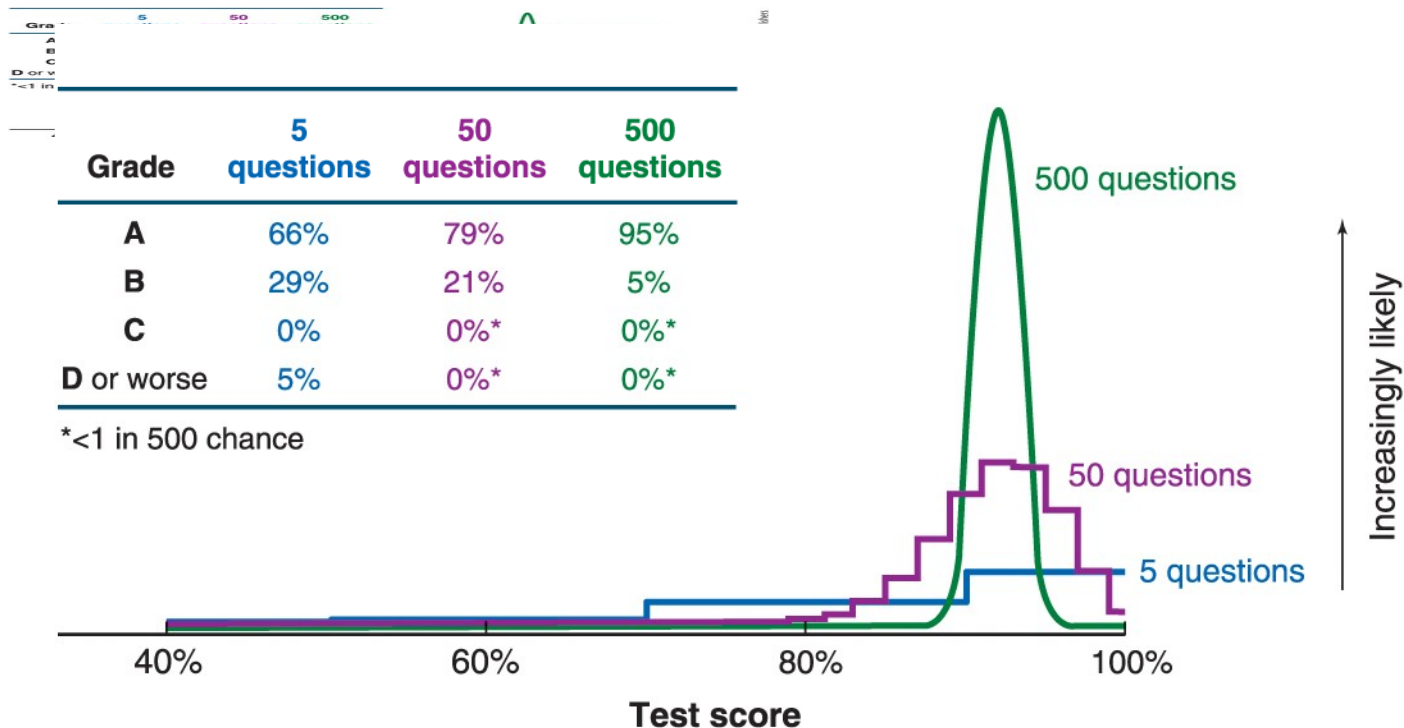
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Strategy 2: Diversification (1 of 3)

Diversification: Reducing risk by **combining** a large number of **small risks** whose outcomes are **not closely related**.

- Don't put all your eggs in one basket.

Example: Choosing the length of your exam



Suppose you've studied enough to know the correct answer to **92%** of all questions.

- *Should* be enough to earn an **A**
- But there's risk!

Risk spreading

Diversification

Insurance

Hedging

Information

Strategy 2: Diversification (2 of 3)

Diversification...

1. Reduces risk most effectively when **risks are not closely related**.
 - Combine investments that are exposed to different risks.
 - **Example:** Don't only buy Barrick Gold, Goldcorp, and Newmont Mining stock.
 - All gold companies whose stock prices fall if gold prices fall.
2. Doesn't **eliminate** risk.
 - **Systematic risk:** Risks that are common across the **whole economy**.
 - Recession, financial crises, wars, pandemics, natural disasters

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Strategy 2: Diversification (3 of 3)

Diversify in all areas of life:

- Invest your money in a variety of stocks (S&P 500 index).
- Stores carry a diversified portfolio of products.
- Companies have a diversified portfolio of clients.
- Employers hire people with different talents.
- Farmers plant a variety of crops.
- You likely applied to a variety of colleges (not just one).
- You likely take a variety of classes, which hone a variety of skills.
- You likely have many friends (not just one).
- You likely have a variety of music playlists.

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Strategy 3: Insurance

Insurance: A **promise of compensation** if a specified bad thing happens.

- The price of insurance is called the **premium**.

Risk-averse people **should buy** actuarially fair insurance.

- **Actuarially fair** insurance policies pay out in compensation as much as it receives in premiums.
- On average, it doesn't change your wealth but it does reduce your risk.

Insurance is likely to be a good idea...

- The closer it is to being **actuarially fair**.
- The **more risk averse** you are.
- The **larger the stakes** involved.

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Strategy 4: Hedging

Hedging: Acquire an **offsetting risk**.

Examples:

- If you're worried that gas prices may rise, you can **buy stock in an oil company** as a **hedge**.
 - If gas prices rise, your fuel bill rises but the stock you own is now more valuable.
- If you're worried automation will take your job, take a few computer science classes.
 - If computers take over, your computer-related skills will become more valuable.

Opposite of hedging ☾ buying stock in the company at which you work.

- If the company goes bust, you lose your jobs AND your stock is worthless.

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Strategy 5: Gather Information

Gathering more **information reduces** the **risks** you face.

- Extra helpful in high-stakes scenarios, or if it greatly reduces uncertainty.

Examples:

There's risk associated with what you **choose to wear** for the day.

- You could be too hot, too cold, or wet if it rains.
- Reduce risk by checking the **weather app** before getting dressed.

Choosing a **spouse** is risky.

- Reduce risk by dating and getting to know that person over time.

Starting a **business** is risky.

- Reduce risk by researching the market first.

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Key take-aways: Reducing risk

You can reduce risk by:

1. **Risk spreading** ☾ Break up big risks into smaller-stakes risks.
2. **Diversification** ☾ Instead of one big risk, take many unrelated risks.
3. **Insurance** ☾ Buy compensating for risk.
4. **Hedging** ☾ Find a risk to offset an existing risk.
5. **Gathering information** ☾ More information can reduce uncertainty.

Chapter 20 (3 of 4)

Prepare to **overcome common pitfalls** when faced with uncertainty:

- Overconfidence
- Problems Assessing Probability
- Problems Evaluating Payoffs



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Behavioral Economics

Economist Richard Thaler said he won the Noble Prize in economics because he “discovered the presence of human life in a place ... my fellow economists thought it did not exist: the economy.”

- Richard Thaler, 2018

Behavioral economics: Economic analysis that **includes psychological factors** in assessing how people make economic decisions.

- Better understand how human beings process information.
- Understand the errors and mistakes people make.

How do you react when you are uncertain? (2 of 2)

95% sure the true number lies between these bounds

Questions	Estimate	Lower bound	Upper bound
1. How many shares are sold each day on the New York Stock Exchange?			
2. What is the world's population?			
3. How many people live in Idaho?			
4. How many Starbucks stores are in the United States?			
5. What is the total annual revenue of Apple?			
6. How many Walmart employees are in the United States?			
7. How many sheep does New Zealand have?			
8. How many different books have been written?			
9. What is the ratio of prices today to prices in 1913?			
10. How many mammals have gone extinct since 1500?			

Were You Overconfident?

How many times did the actual answer lie between your lower and upper bounds?

If you truly constructed your ranges to contain the answer 95% of the time, then...

- the answer should have fallen between your bounds **9 or 10 times**.
- if you got **less** than 9 or 10 correct, then you were **overconfident!**

Overconfidence: The tendency to **overrate** the accuracy of your forecasts.

- Can lead you to underestimate risks and make bad decisions.
- Gandhi: “It is unwise to be too sure of one’s own wisdom.”

Two Systems

System 1: “thinking fast”

Your intuitive thoughts.

- Fast, effortless, and automatic.
- Relies on rough “rules of thumb.”

System 2: “thinking slow”

Your slower, deliberate, logical self.

- Requires cognitive effort.

Good decision makers know when it's time to overrule their



Problems Assessing Probability

Q1: What's the deadliest animal in the world?

Q2: Are there more words that start with the letter **r**, or more that have **r** as their third letter?

Availability bias: The tendency to **overestimate** the frequency of events that are **easily recalled**, and to **underestimate** the frequency of **less memorable** events.

- After the movie *Jaws*, people are convinced that sharks are an ever-present threat!
- Dramatic plane crashes lead people to fear flying (but cars are much less safe!)
- Bill Gates, Mark Zuckerberg, Oprah Winfrey make it seem great to drop out of college.

Anchoring bias

The tendency to **begin with an anchor**, or starting point, and **insufficiently adjust** from there.

- Excessive focus on an initial estimate.

Example: Two groups of auditors were asked about their thoughts on the incidence of fraud:

1. More than **10** out of 1,000 businesses affected?
2. More than **200** out of 1,000 businesses affected?

The second group was given a larger anchor: 200

- Led to a **bigger assessment** of the incidence of fraud.

➤ **Don't get stuck on the anchor!**

Representation bias

The tendency to assess the likelihood that something belongs in a category by judging how similar they are to that category.

Famous psychology experiment: Sarah is “very shy and withdrawn, invariably helpful, but with little interest in people or in the world of reality... has a need for order and structure, and a passion for detail.”

- Librarian or Teacher?
- **Most guess librarian**
 - Mistakenly ignore the large number of teachers and relatively small number of librarians.

Problems Evaluating Payoffs

Focusing illusion: The tendency to mis-predict your utility by focusing on a few factors at the expense of others.

Student Survey Example:

How happy do you think you'll be if you move to **California**? What about the **Midwest**?

- Overwhelmingly, students expected to be happier in California.
- **Reality:** Students in the Midwest evaluate their lives **as favorably as** those in California.

Overly focused on salient difference (weather) and ignored other factors (friends, family, finances, safety).

Loss aversion: being more sensitive to losses than to gains.

- Don't obsess over losses — focus on the underlying payoffs instead.

Key take-aways: Behavioral economics

Evaluate payoffs and probabilities carefully, by avoiding these biases:

- **Overconfidence** ☾ Your forecasts are less accurate than you think.
- **Availability** ☾ Don't be swayed by easily recalled events.
- **Anchoring** ☾ Don't get hung up on an initial estimate or starting point.
- **Representativeness** ☾ Look beyond how similar things are.

Chapter 20 (4 of 4)

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1. You face risk whenever an outcome is **uncertain**.
2. You can reduce risk by: risk spreading, diversification, insurance, hedging, and gathering information.
3. Common mistakes people make come from **problems assessing probabilities and payoffs**.
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