MODULE 22

Probabilities I

Dive into the fascinating world of financial probabilities and unlock tools that can help predict the next Bull Market or recession!

Learn how we calculate probabilities and explore the concept of expected value, which helps weigh risks and rewards, helping us make smart, informed decisions in a world full of financial uncertainties.

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Key Takeaways From This Module

Guiding Questions

- What are probabilities and how do they help us make informed decisions about the future?
- How can we create probabilities to help us model any scenario?
- What is the probability of a recession and are there indicators that can help us change this probability?
- How do compound probabilities work and how are they calculated?
- What are conditional probabilities and how are they more complicated?

Enduring Understandings

- Probabilities are used to make informed predictions about future events, enabling better decision making under uncertainty.
- We can construct probabilistic models to simulate real-world scenarios.
- Probabilities can be applied in finance all the time - from predicting the likelihood of a recession to understanding the trillion dollar insurance industry.
- Provide students with the knowledge to calculate and understand compound probabilities.

What Are Probabilities?

Probability is a measure of the likelihood that a specific event will occur, expressed as a number between 0 (impossibility) and 1 (certainty).

When you hear that there's a 70% chance of raining, that's a probability!

Probability is crucial for risk assessment, helping individuals and organizations make informed decisions about potential gains and losses.

As an investor, we must constantly evaluate the probabilities of different events and how they will impact a company's stock price. Understanding these probabilities is critical as you build your investment portfolio.

Let's Imagine A Quarter

When you flip a coin, there's 2 things that can happen: Heads or Tails.

This means that flipping a coin has **50/50 odds.**

In theory, that means each side has a 50% chance of appearing, each and every time you flip the coin.

It's important to remember that even if you flipped heads 3 times in a row, the next time you flip the coin, it still has a 50% chance of flipping heads!

That's because **past performance does not impact future results!**

Expected Value

We can calculate the expected value of a scenario by multiplying the probability of an event by the value of its outcome.

Let's call the probability of some event where we make $10 happening as P(X).

If we multiply the probability we make $10, and assume the actual probability is 0.5 (P(X) = 0.5) then we see:

$$P(X) \times \$10 = 0.5 \times \$10 = \$5$$

Now, more generally, if we call E(X) the Expected Value and replace $10 with the Success Value then:

$$E(X) = P(X) \times \text{Success Value}$$

Expected Value Of The Lottery

Do you think buying a lottery ticket is a good financial decision?

Most lottery tickets have a negative expected value, meaning the average amount you win is less than what you pay for the ticket. This is how lotteries make a profit.

The lure of a large jackpot obscures the reality that most players will either win nothing.

The excitement and hope of winning don't outweigh the mathematical reality that the lottery is a losing bet in the long run.

$1,000,000,000
LOTTERY PRIZE

$5.00
PRICE PER TICKET

0.00000001%
PROBABILITY OF WINNING

What is the expected value of a lottery ticket?

Why is this a bad financial decision?

Now What If We Moved To A Die?

Say we have a single, 6-side diced, which means that it has six faces, each with a different number of dots from 1 to 6.

Now imagine that we were to roll the die multiple times, recording the outcome of each roll to gather data.

What do you think is the probability of rolling any specific number?

We can figure out the probability by using the same formula we used earlier!

In a fair die, each number has an equal probability of being rolled, but this doesn't mean the actual results will look like that (in the short term).

$^1/_6$

Likelihood of rolling any value on a 6-sided die

IN-CLASS ACTIVITY

What If **We Took The Sum Of Dice?**

Imagine we rolled two dice 5,000 times and recorded the outcomes of the sum, what do you think would happen?

What Do You Think?

Below are the results of rolling the dice 5,000 times.

ValueD	2	3	4	5	6	7	8	9	10	11	12
Count	151	286	394	552	666	899	683	538	416	269	144
Percent	3.02%	5.72%	7.88%	11.04%	13.32%	17.98%	13.66%	10.76%	8.32%	5.38%	2.88%

THINK ABOUT IT!

Why do the actual percentages not match the theoretical examples we determined?

When would you expect the percentages to be exact?

What can this teach us about probability?

There is a game called Flip, where we flip a coin. If it is heads, you lose $1. If it is tails, you win $5.

Would you want to play the game?

What is the expected value of 10 games?

The game developers now release the game Roll, where we roll a dice. If it is a 6, you win $5. If it is any other value, you lose $1.

Would you want to play the game?

What is the expected value of 10 games?

How Insurance Companies Work

Insurance companies use probability to assess the risk of certain events and determine the likelihood of these events in order to determine insurance costs.

- Based on this risk assessment, companies set **premiums - the amount customers pay for coverage to protect them against the financial cost of a future event.**
- Insurance relies on pooling risk across a large number of policyholders. That's based on the same logic that you may flip heads 3 times in a row, but you won't do it 1 million times!
- Insurance companies diversify their risk by insuring a wide range of clients and events, ensuring that the impact of particularly costly claims is balanced by the majority of policyholders who don't make large claims.
- **By having thousands of policies, insurance companies can more accurately rely on the theoretical probability.**

Probability Of A Recession

There have been 11 recessions in the US in 77 years. The chart below shows the unemployment rate since 1947. If we divide the total number of years that we have had a recession (12 years) by 77 years, what is the probability?

Things Change When You Introduce Data

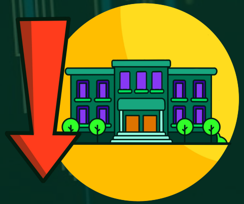
Economists closely monitor indicators like stock market trends and manufacturing activity, which sometimes influence the probability of a recession.

Whenever new data arrives, we must use this data to update our predictions and probabilities so that we are making the most informed predictions possible.

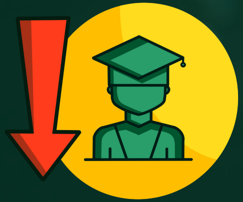
Even after more economic data, predictions are not easy because there is always the unknown. We never have a 100% probability of a recession until we are actually in a recession, which isn't very helpful!

FACTORS THAT COULD INCREASE THE PROBABILITY OF A RECESSION

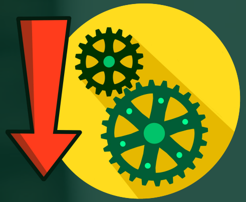
DECREASE IN FACTORY OUTPUT



DECREASE IN HOME PRICES



DECREASE IN OVERALL EMPLOYMENT



DECREASE IN ECONOMIC OUTPUT

Key Takeaways From This Module

CORE & FUNDAMENTALS

- How to calculate and interpret probabilities in various contexts.
- Calculate the expected value in different probabilistic scenarios.
- Understand that theoretical probabilities and real-world outcomes are not always perfect because there is still uncertainty.

APPLIED KNOWLEDGE

- Apply probability and expected value in personal financial decisions, such as evaluating investment risks or understanding loan terms.
- Perform risk assessment and predict outcomes of future investments.
- Interpret and analyze economic data and market trends through the lens of probability.

RELEVANCE FOR YOU

- Probability and expected value are not just theoretical concepts but vital tools in making informed decisions, from insurance to investments.
- Understanding the likelihood of different events will help you appropriately invest your time and resources in opportunities that have the greatest expected value. It's okay to take risks, but we should always understand the probabilities of success!