Asset Pricing and Risk Management

FINTECH 522

Jake Vestal

Class 5:

Equities + Portfolio Theory

Quick Review: Financial Metrics

on exam

Equity Value (or Market Capitalization, or MCAP) :

- MCAP = price per share * number of shares outstanding
- **Not all share are freely traded** ; e.g., shares insiders : see "*float*" – only freely traded - buy/sell today

EBITDA:

- Earnings before taxes, interest, depreciation, and amortization
- Comes from the income statement

Net Income:

- Revenue - {what it took for the firm to earn that revenue}
  - COGS, SG&A Expense, Interest Expense, Taxes

Net Debt:

- = short term debt + long term debt – cash + minority interest preferred stock

Enterprise Value:

- EV = Equity Value + Net Debt
- "How much would it cost to buy the firm, given its capital structure?"

Quick Review: Ratios

EBITDA Multiple:

- EV / EBITDA

Net Income Multiple:

- Equity Value / Net Income

Earnings Per Share (EPS):

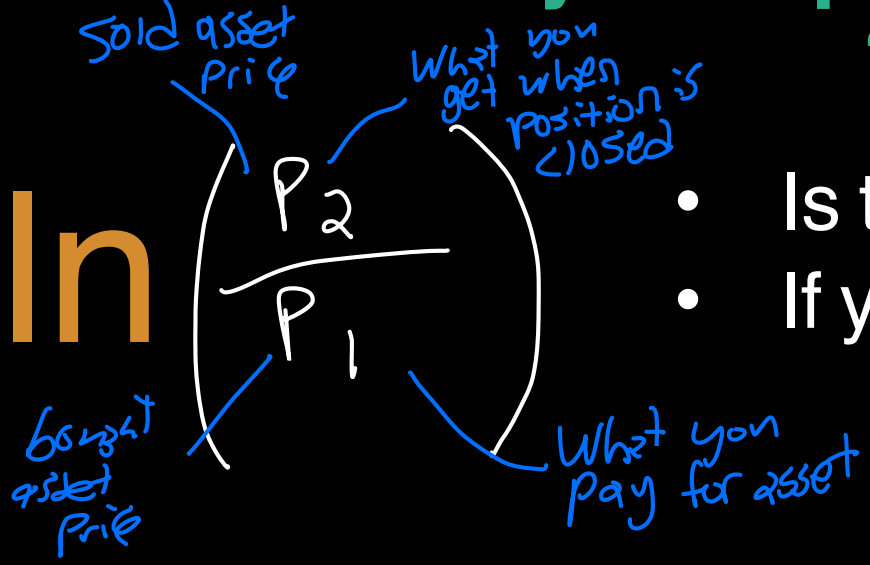
- Net Income / # of shares

See ppt for formula

Sometimes you want to **calculate** a ratio to gain information about a firm
Sometimes you want to **assume** a ratio to evaluate "what-ifs"

Analyzing Series of Returns : Equities

Continuously Compounded Rate of Return



"CCR"

- Is the "rt" in $P_2 = P_1 e^{rt}$
- If you don't believe me:

see ppt for formula ✓

- Also called the "Log Return"
- Has "units" of percent (%)
- Easy to convert
- Symmetric
- Plays well with lognormal distributions

A pretty decent blog post about why we use log returns can be found here:
https://lucaslouca.com/Why-Use-Logarithmic-Returns-In-Time-Series-Modelling/#:~:text=Logarithmic%20returns%20are%20useful%20for,will%20cancel%20each%20other%20out.

OHLC(V) Data

For a specified time period (also called a **bar size**)
(day, month, hour, 5 minute, etc)

Candlestick data

Open: First price at which an asset traded
High: Highest price that someone paid
Low: Lowest price that someone sold
Close: Last price at which an asset traded
Volume: The total number of units (stock, contracts, etc) that were traded

Unadjusted data not free

Adjusted Close (1 of 2)

DIVIDENDS

A company may choose to return excess profits to its shareholders in the form of additional stock, or cash. When/if this happens, some sources (e.g., Yahoo) deduct the value of the dividend from the closing share price.

Adjusted Close (2 of 2)

SPLITS - issues more shares w/o changing value

A company may want to change the number of shares issued (usually increase). For example, if a company issued a *two-for-one* split, the number of shares issued on the market would double… therefore, they'd be worth half as much as before the split.

Some sources incorporate this information into the **Adj Close** of the trading day before the split, by multiplying by the *split ratio* (2 in this example).

If you are trying to re-create what trades would have executed in the past…

…i.e., you're NOT looking for an overall metric of your return including splits and dividends …

NEVER use Adjusted Close, ALWAYS use actual price.

And don’t ever use Yahoo Finance data to make decisions with real money

For demonstration and debugging purposes though, it’s great.

Excel Breakout: Log Returns

Using Adjusted Close Prices

Analyzing a SERIES of returns

We've now got a spreadsheet open, displaying a series of returns in time.

It'd be nice to be able to summarize them so as to compare to other investments.

We will look at two (2) ways to do so

The Arithmetic Mean Rate of Return

(1 of 2)

A series of returns might look like this :

r = [1.3%/week, 3.0%/week, 2.3 %/week, 2.8 %/week, 1.9 %/week]

(**bold** means it's a time series of returns)

In this example, the Arithmetic Mean Rate of Return would be the simple average of the returns:

$$r = (1.3 + 3.0 + 2.3 + 2.8 + 1.9)/5$$

= 2.1% per week 2.5%

But Arithmetic Mean Rate of Return doesn't always tell the most accurate story…

$$\mathbf{r} = [+25\%/\text{qtr}, -20\%/\text{qtr}, +25\%/\text{qtr}, -20\%/\text{qtr}]$$

The Arithmetic Mean Rate of Return is 2.5% per quarter!

Does this make sense??

qtr = "quarter"

Another way to look at it…

look at PPT for formulas

Start Here

No return yet

Earned zero dollars, $0

Another way to look at it…

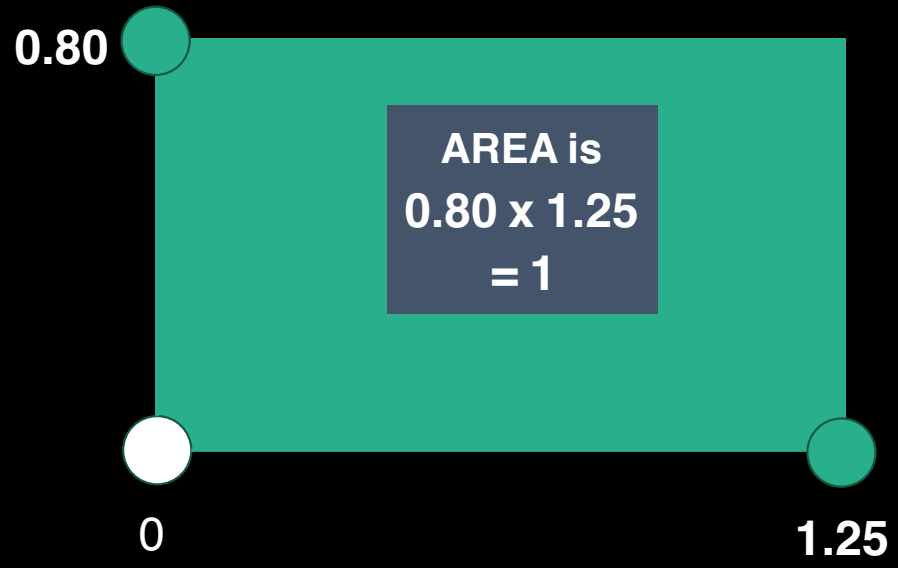
$r_{n=1} = 25\%/\text{qtr}$

End of Q1
Earned +25
Up by factor of 1 + 0.25 = 1.25

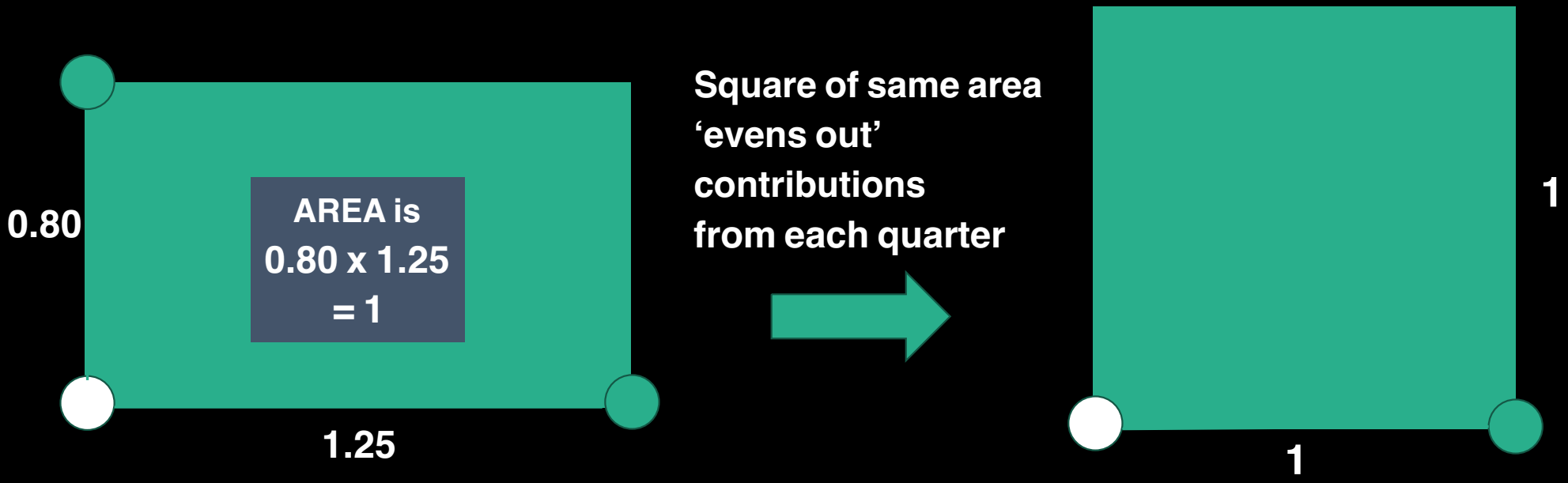
Another way to look at it…

End of Q2
Lost 20%
Down by factor of 1 – 0.20 = 0.80

Another way to look at it…



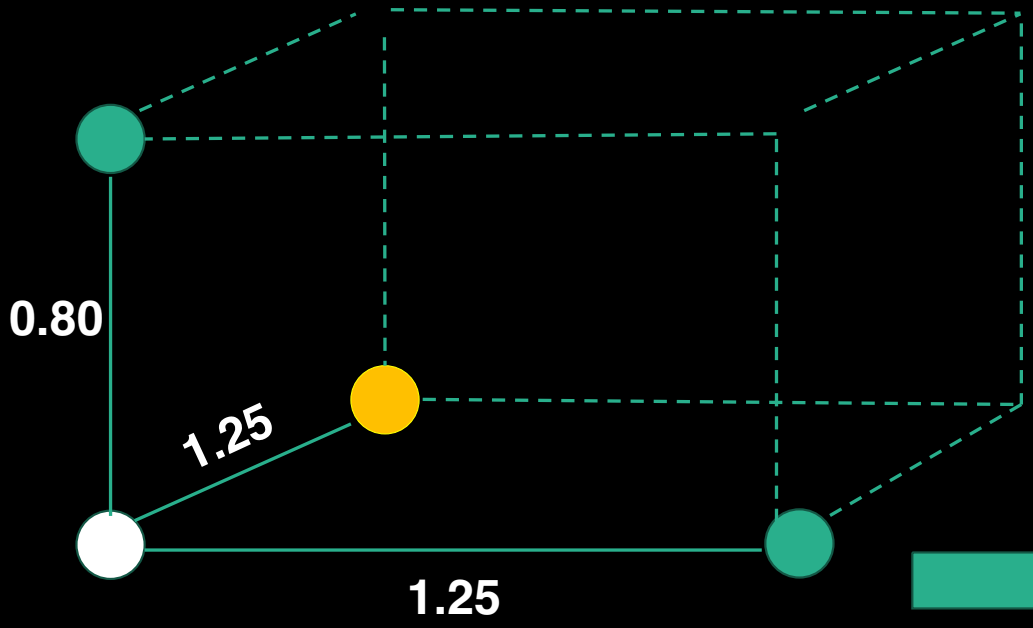
Another way to look at it…



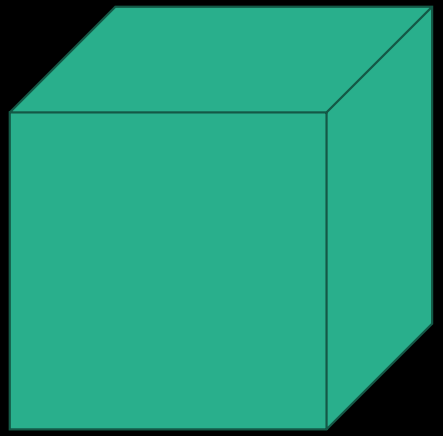
Length of a side of square = 1 (factor)

Subtract 1 to get %: 1 – 1 = 0

Add another dimension…



Even out sides,
Equivalent volume cube…



Length of a side of cube = 1.07 (factor)
Subtract 1 to get %: 1 – 1 = 1.07

…And so on.

By “averaging geometrically” in this way, we arrive at…

The Geometric Mean Rate of Return!

Excel Breakout: analyze a series

For the stock, calculate:

- Average rate of return
- Geometric mean rate of return

A Word on Data

You will, of course, need to obtain data from somewhere. Here are a few sources you might consider

Data Subscription Services:

Two kinds:

Market Data (also called **Live** or **Real-Time**): streaming data updated constantly

Historical Data: Data from the past, only need to download once for a given date range

- **Refinitiv:**
  - Go to the Ford Library (Fuqua) site and find it in “databases”
  - Register for it
  - Has a great Python API and a standalone Workstation app
- **Siblis Research:** https://siblisresearch.com/
  - Provides several historical datasets in Excel format that you may find useful
- **Xignite:** https://www.xignite.com/product/historical-stock-prices/#/ProductOverview
  - Easy-to-use REST API for querying data from Excel, Python, R, etc.

Paper Traders:

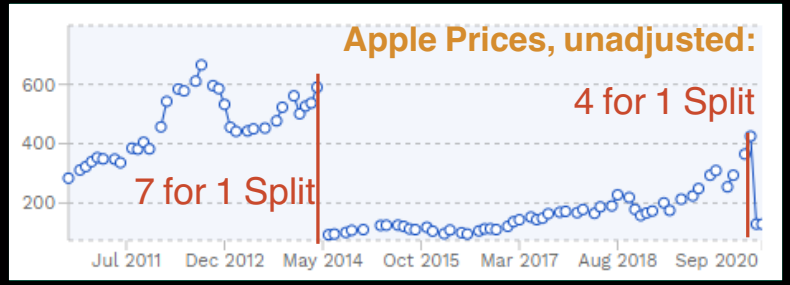
A **Paper Trading** account is a “sandbox account” that uses real market data (often 15 min delayed) and allows you to make trades using simulated money so that you can test out an algorithm before you run it live on real money. Most (if not all) of these services offer some kind of historical data.

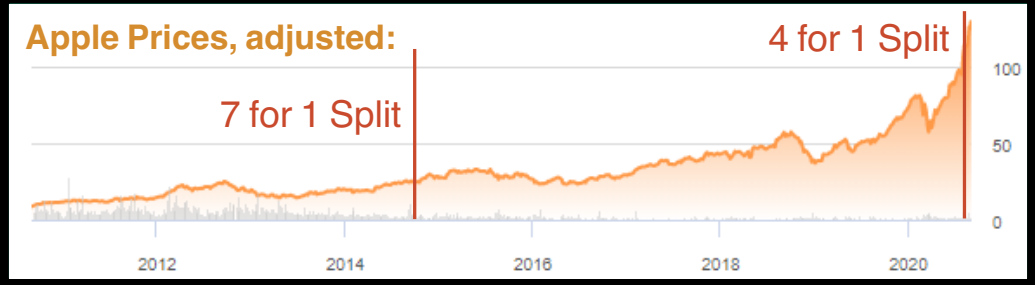
- **Interactive Brokers** (https://www.interactivebrokers.com/en/software/omnibrokers/topics/papertrader.htm)
- **TradeStation** (https://www.tradestation.com/platforms-and-tools/simulated-trading/)
- **NinjaTrader** (https://ninjatrader.com/Simulate)
- **WeBull** (https://www.webull.com/)
- **thinkorswim** (https://www.tdameritrade.com/tools-and-platforms/thinkorswim/desktop.page

A Word on Data 2

Whatever service you choose, be sure you have all the data you need and understand how it's presented

- **Prices:** You might find that you can implement a strategy via limit orders; therefore, you might not really need to pay for a real-time market data subscription (i.e., *not* 15-minute delayed prices)
- **Historical Prices:** Unadjusted is best for backtesting because:
  - You often care about whether or not a trade would have filled in the past – adjusted prices won't tell you this
  - The way data providers adjust prices for splits, dividends, and M&A might not be what you think or what you'd like
- **Dividends:** Make sure you can get data for past dividends. Future dividends, as they're announced, are nice to have
- **Splits:** You'll need data for splits:





- **STOCK TICKERS CAN CHANGE OVER TIME:** You might want historical prices for United Technologies Corp, a multinational industrial conglomerate traded under symbol UTX on the New York Stock Exchange (NYSE).
  - On 03 Apr 2020, UTX merged with Raytheon (RTN) to create a new company called Raytheon Technologies, traded as "RTX"
  - Merger immediately spun off Carrier Global Corp. (CARR) and Otis Worldwide Corp. (OTIS)
  - … but if you query your data provider for "UTX", you *might* get data up to the present day! Why???
    - It's because your data provider is somehow adjusting for the merger
  - Be sure you understand how your data provider handles this, and take it into account.

A Word on Data 3

I have personally found problems with data from:

- **Yahoo Finance:**
  - Very hard to tell how they adjust for dividends & corporate actions so that you can un-adjust
  - Not all the companies you might want are available (especially delisted)

- **Compustat:**
  - Sometimes incomplete, sometimes simply inaccurate.
  - Pretty decent, though, for compiled financial information (quarterly & annual reports, lists of companies and statistics by industry, market share, etc)

Dividends

Anatomy of a Dividend Announcement

You see a dividend announcement on a website, your data feed, or your brokerage's news feed:

Company: Exxon Mobil Corp. (XOM)

Declare Date: When XOM announced the dividend.
Usually very regular and predictable (same time every year)

Dividend Amount ($/share)

Declare Date	Ex-Div Date	Record Date	Pay Date	Frequency	Amount
7/29/2020	8/12/2020	8/13/2020	9/10/2020	Quarterly	0.8700

Payable Date: Date on which the dividend is paid out

Record Date: Must be an XOM shareholder on this date to get dividend

Ex-Div Date: Must *purchase* the stock *before* this date to get the dividend.

Instant Dividends: Many brokerages will credit your account by the dividend amount if you own the stock on the ex-div date: you don't have to wait until the pay date.

Might also see: (No new info, not really that useful)

Forward Yield:

How Dividends Wo

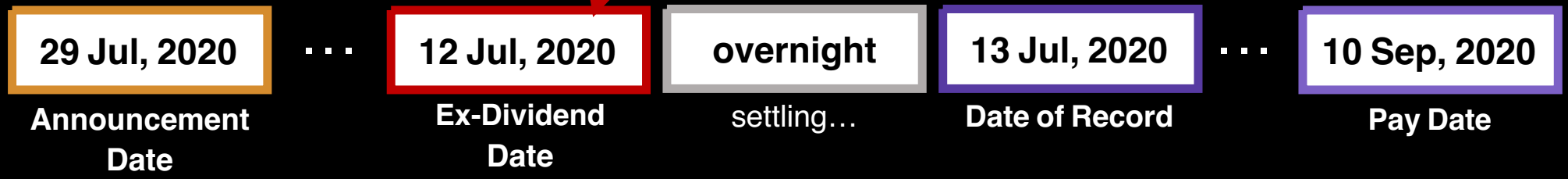
From previous slide

Declare Date	Ex-Div Date	Record Date	Pay Date	Frequency	Amount
7/29/2020	8/12/2020	8/13/2020	9/10/2020	Quarterly	0.8700

Exxon Mobil (NYSE: XOM)

What Actually Happens

Also called Ex-Date, Ex-Div date, etc; it's the date *before which* you have to buy into the stock to get the dividend.



FACT: The **settlement period** is the time it takes between your purchase of an asset and the day on which you appear as registered owner of that asset.

Settlement Period has gotten shorter over history (used to be 5 business days); for many stocks it's now 1 business day.

Bottom line: if you want to get the dividend, you have to buy it *before* the ex-date.

On the ex-date itself, the **seller** gets the dividend.

Many firms now offer 'instant dividends'

Understanding Adjusted Close: DIVIDENDS

Exxon Mobil (NYSE: XOM) **$0.75 dividend paid on 11 Aug, 2015**

Date	Open	High	Low	Close
Sep 01, 2015	73.30	75.47	71.51	74.35
Aug 11, 2015				**0.73** Dividend
Aug 01, 2015	78.70	79.29	66.55	75.24

Using the bare close :

Clearly your return from 01 Aug – 01 Sep was ln($74.35/$75.24) = -1.19% right?

No. if you bought on 01 Aug you earned $0.73/share in dividends.

This price ($74.51) is the "adjusted close"

Industry standard uses "adjusted close":

- **Adjusted close method: ln($74.35 / ($75.24 - $0.73)) = -0.215%**

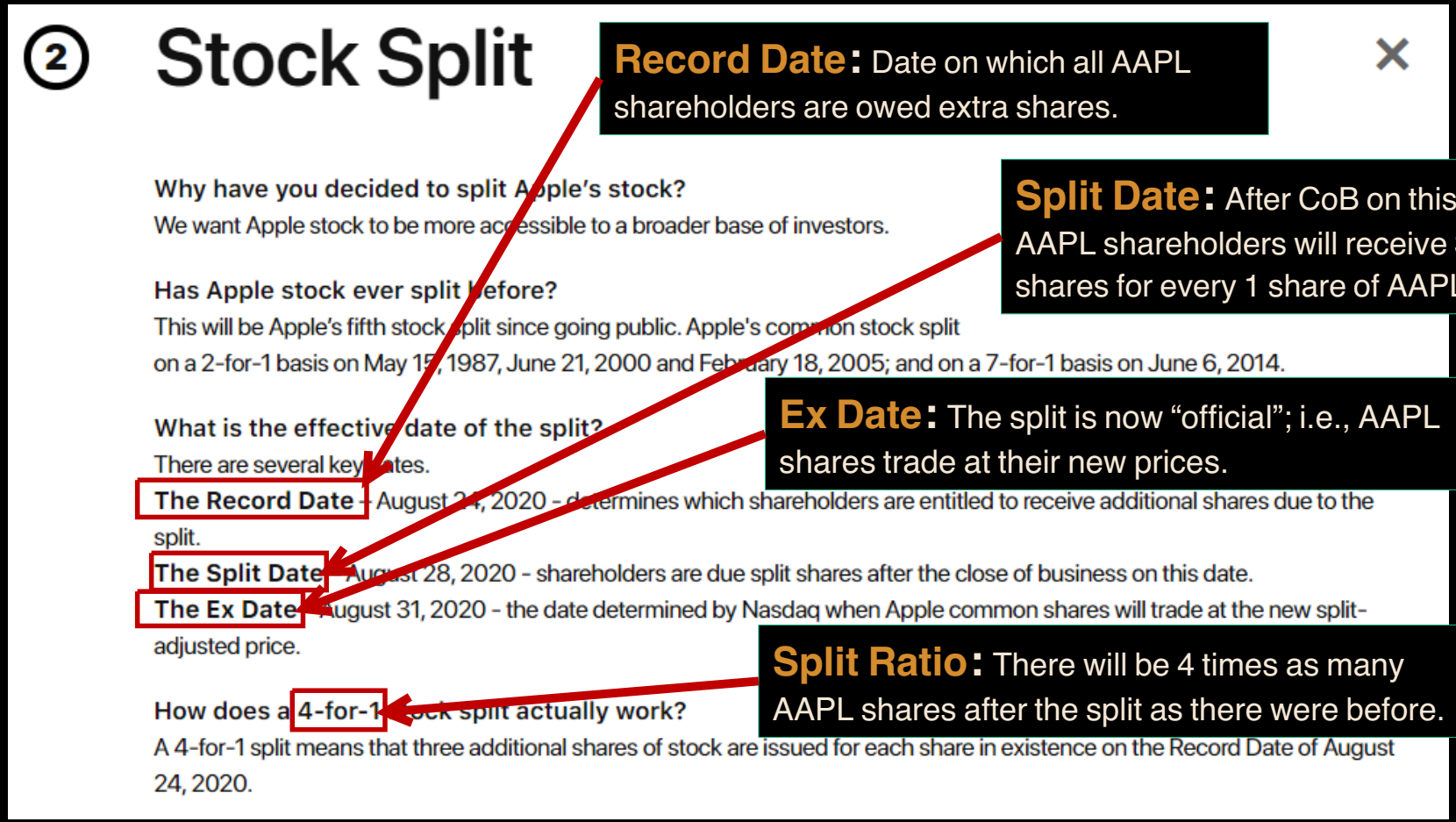
Use for backtesting (very slightly different, more accurate):

- **Actual return: ln(($74.35 + $0.73) / $75.24) = -0.213%**

Splits

Anatomy of a Split Announcement

Apple (NASDAQ: AAPL) recently underwent a 4-for-1 split. Below is the split announcement from their website.



② Stock Split

Why have you decided to split Apple's stock?
We want Apple stock to be more accessible to a broader base of investors.

Has Apple stock ever split before?
This will be Apple's fifth stock split since going public. Apple's common stock split on a 2-for-1 basis on May 15, 1987, June 21, 2000 and February 18, 2005; and on a 7-for-1 basis on June 6, 2014.

What is the effective date of the split?
There are several key dates.
The Record Date - August 24, 2020 - determines which shareholders are entitled to receive additional shares due to the split.
The Split Date - August 28, 2020 - shareholders are due split shares after the close of business on this date.
The Ex Date - August 31, 2020 - the date determined by Nasdaq when Apple common shares will trade at the new split-adjusted price.

How does a 4-for-1 stock split actually work?
A 4-for-1 split means that three additional shares of stock are issued for each share in existence on the Record Date of August 24, 2020.

Record Date: Date on which all AAPL shareholders are owed extra shares.

Split Date: After CoB on this day (a Friday), AAPL shareholders will receive 3 additional shares for every 1 share of AAPL stock owned.

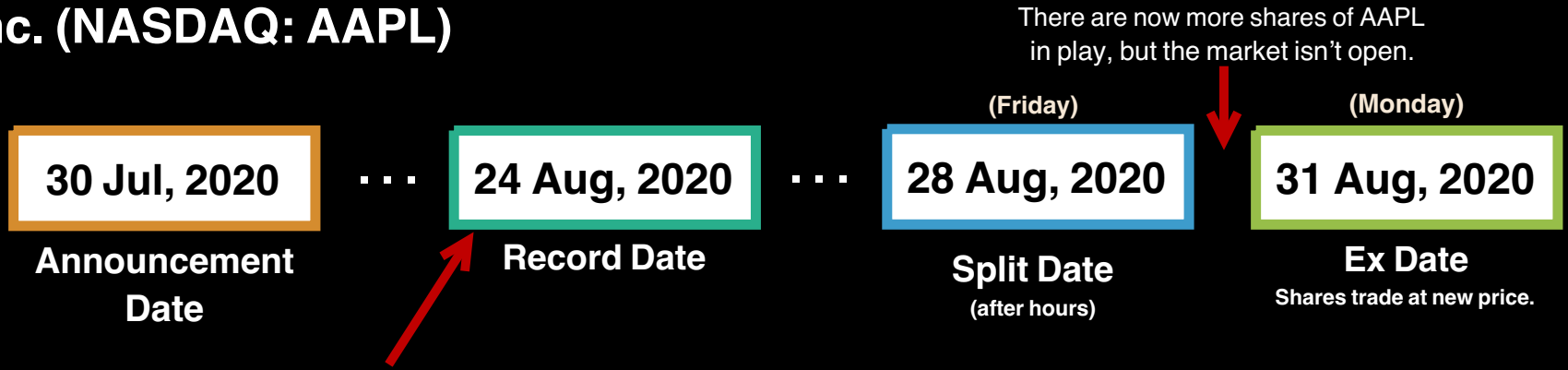
Ex Date: The split is now "official"; i.e., AAPL shares trade at their new prices.

Split Ratio: There will be 4 times as many AAPL shares after the split as there were before.

Understanding Adjusted Close: SPLITS

What actually happens:

Apple Inc. (NASDAQ: AAPL)



Record date doesn't really matter much for traders. Used by AAPL accountants to actually issue shares to current shareholders….

…but not all traders understand this . That means there might be a scramble to buy AAPL shares before this date because traders *think* they need to in order to get the split.

Why is this? Because when a shareholder sells AAPL stock after the record date, they also transfer their right to receive the split to the buyer.

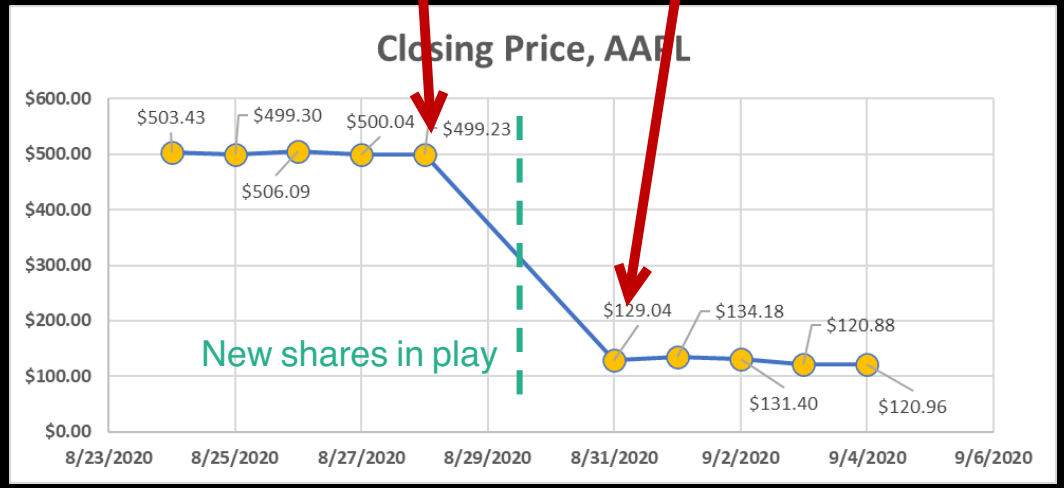
So take note: **Splits don't behave exactly like dividends in this way.**

Understanding Adjusted Close: SPLITS

Apple Inc. (NASDAQ: AAPL)

Split Date 29 Aug 2020

Ex Date 31 Aug 2020



Adjusted Close for splits is done on a basis of the **new prices.**

For example, closing price on 27 Aug 2020 was $500.04.

The **adjusted close** would be:

Split Ratio: 4-to-1

There will be 4 times as many AAPL shares after the split as there were before.

Before Split: approx. $501.62/sh

After Split: approx. $127.29/sh

Because 4x as many shares (supply & demand)

If you owned 100 shares before the split, how many do you own after the split?

Answer: 400 (you are issued 300 more)

Therefore, you must adjust ALL past prices according to splits that took place in between that price's timestamp and today.

Excel Breakout: analyze a series

Unadjusted data!

For the stock, calculate:

- Average rate of return
- Geometric mean rate of return

Portfolio Risk, Return, & Diversification

“Diversification is the only free lunch in investing”

- Harry Markowitz

Harry Markowitz's Contribution:

1. Consider a set of investment opportunities
   (stocks, algo strategies, bonds, doesn't matter)
2. Think about a time period (e.g., *n* days into the future)
3. Write down, for each asset:
   your expected return over the next period
   your expected risk over the next period
4. Write down, for each *pair* of assets:
   your expected correlation of returns over the next period

You do 3. and 4. using *whatever* machine learning, 'best practice', gut estimate, or any other method you choose. Bottom line is, whatever it is, **you must believe in it**.

4. Markowitz showed that given the above, **there exists an optimal allocation of your money that should be placed on each of the investment opportunities you identified**.

And the things that make this great:

1. It's philosophically sound so long as you're sure you believe what you believe
2. Easy(ish) to calculate
3. You can use it to trade with today
    - And many in industry do exactly that.
    - Unlike other strategies (e.g., Kelley Betting) that are fascinating and promising but difficult to implement

Markowitz Portfolio Theory at-a-glance

E.g., buy a stock, run a strategy, enter an investment

Return that YOU EXPECT for that investment over the next period

Risk that YOU EXPECT for that investment over the next period

The covariance that YOU EXPECT between the returns of each investment during the next period

Investment	Expected Return	Expected Risk
A	12.5%	17%
B	9%	15%
C	5%	11%
D	19%	28%
E	3%	2%

Vary Allocation
Set Risk or Return

Note
The **true values** of the three pieces of information you must specify (exp risk, return, and cov) are **unknown and unknowable**, but once you determine what you believe, the optimal portfolio follows as a logical consequence.

Your Portfolio
The allocation of resources that you should take so as to maximize the return you get for your level of risk.

Passive professional equity investing

- Index-Fund Investing return **equals benchmark**
- **John Bogle** senior thesis (1951) "*Mutual Funds can make no claims to superiority over the Market Averages*."
- **Malkiel**, *Returns from Investing in Equity Mutual Funds 1971 to 1991* (1995)
- **Malkiel**, *Random Walk Down Wall Street* (1973, 1995, 2016)
- Equity Index Funds and ETFs **get 9 out of 10 dollars invested in 2017 (NYTimes)**

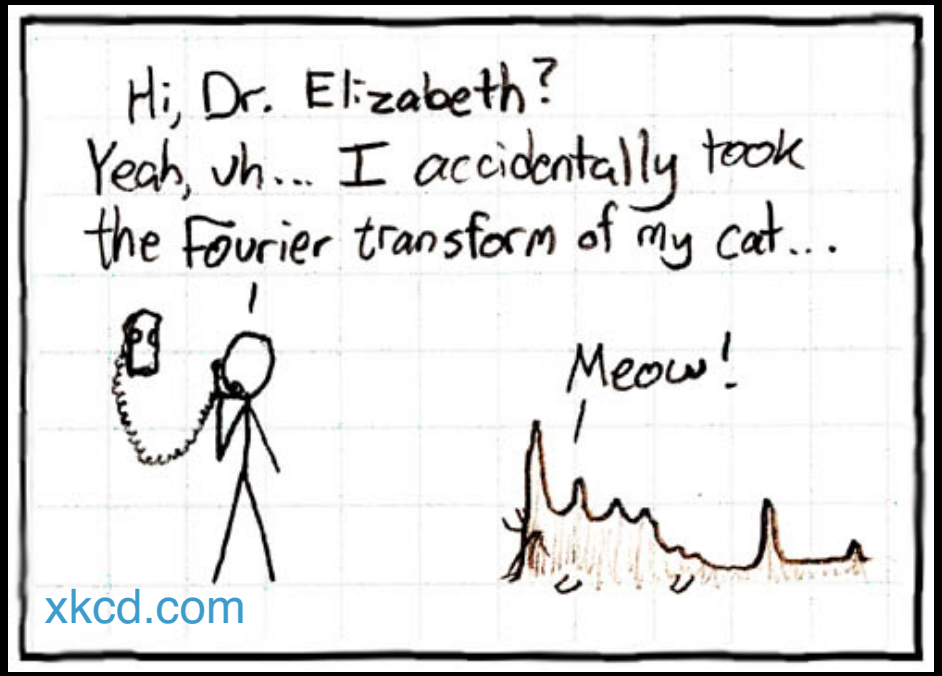
REPORTS SPIVA U.S. Scorecard

Report 1: Percentage of U.S. Equity Funds Outperformed by Benchmarks

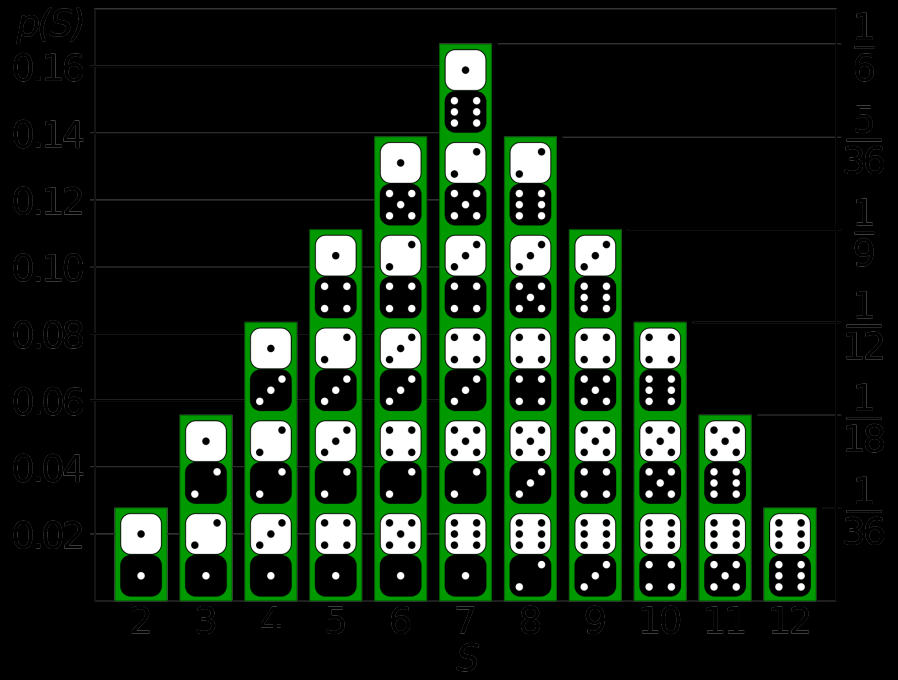
FUND CATEGORY	COMPARISON INDEX	1-YEAR (%)	3-YEAR (%)	5-YEAR (%)	10-YEAR (%)	15-YEAR (%)
All Domestic Funds	S&P Composite 1500	63.43	83.40	86.72	86.65	83.74
All Large-Cap Funds	S&P 500	63.08	80.56	84.23	89.51	92.33
All Mid-Cap Funds	S&P MidCap 400	44.41	86.34	85.06	96.48	94.81
All Small-Cap Funds	S&P SmallCap 600	47.70	88.83	91.17	95.71	95.73

The Notion of “Spaces”

1) Representing a Cat in Fourier Space

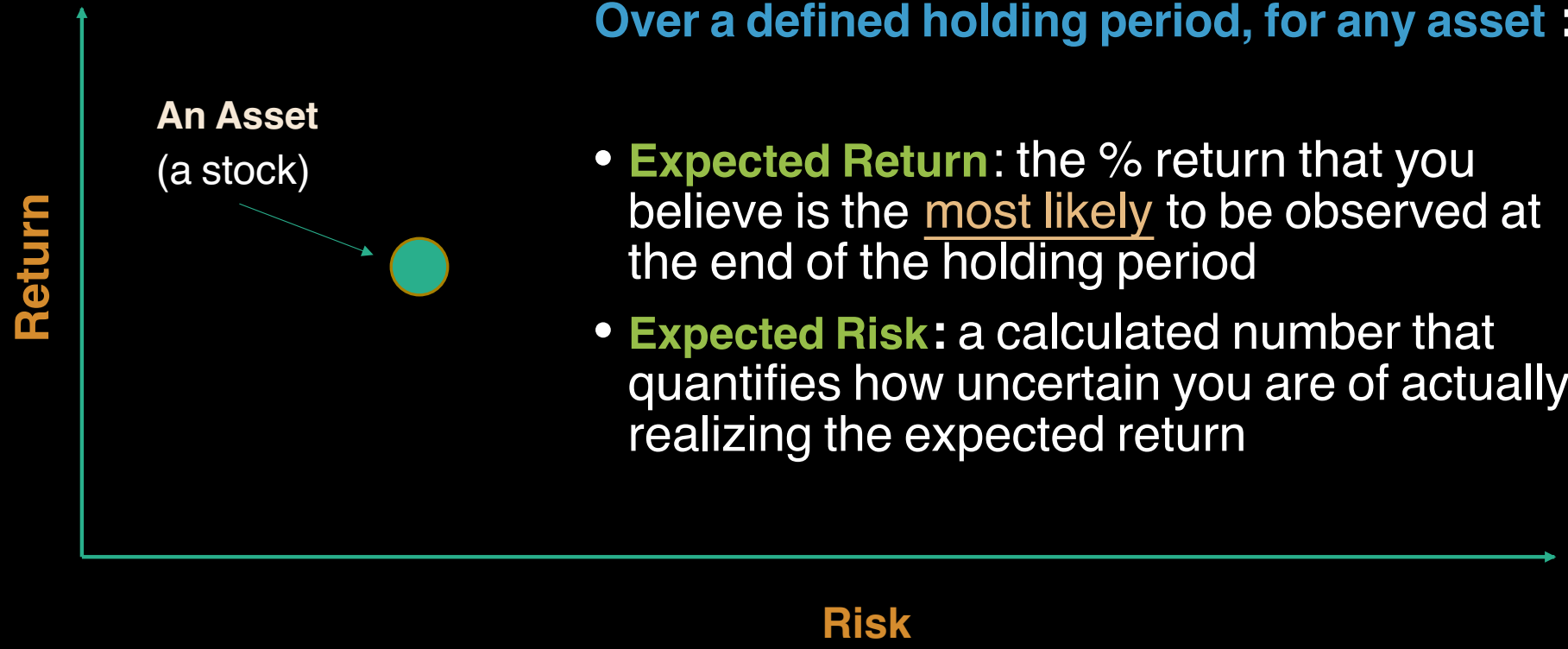


2) Representing outcomes of rolling a pair of dice in Probability Space



Portfolio Space

The Foundation of Financial Risk Analysis



Over a defined holding period, for any asset :

- **Expected Return**: the % return that you believe is the most likely to be observed at the end of the holding period
- **Expected Risk**: a calculated number that quantifies how uncertain you are of actually realizing the expected return

What return can I get if I am willing to accept 0% volatility of return risk?

Answer: the RISK-FREE rate of return.

The interest paid by US Govt. on short-term borrowing

Assumption:
Investors are Risk Averse and Profit Maximizing

- Between two assets with the **same** forecast **volatility**, investors will choose the one with **higher** expected **return** (**Profit Maximizing**).
- Between two assets with the **same** expected **return**, they will choose the one with **lower** forecast **volatility** (**Risk Averse**).
- Map volatility on the x-axis (E-W), expected return on the y-axis (N-S). Investors want to be in the "upper left"

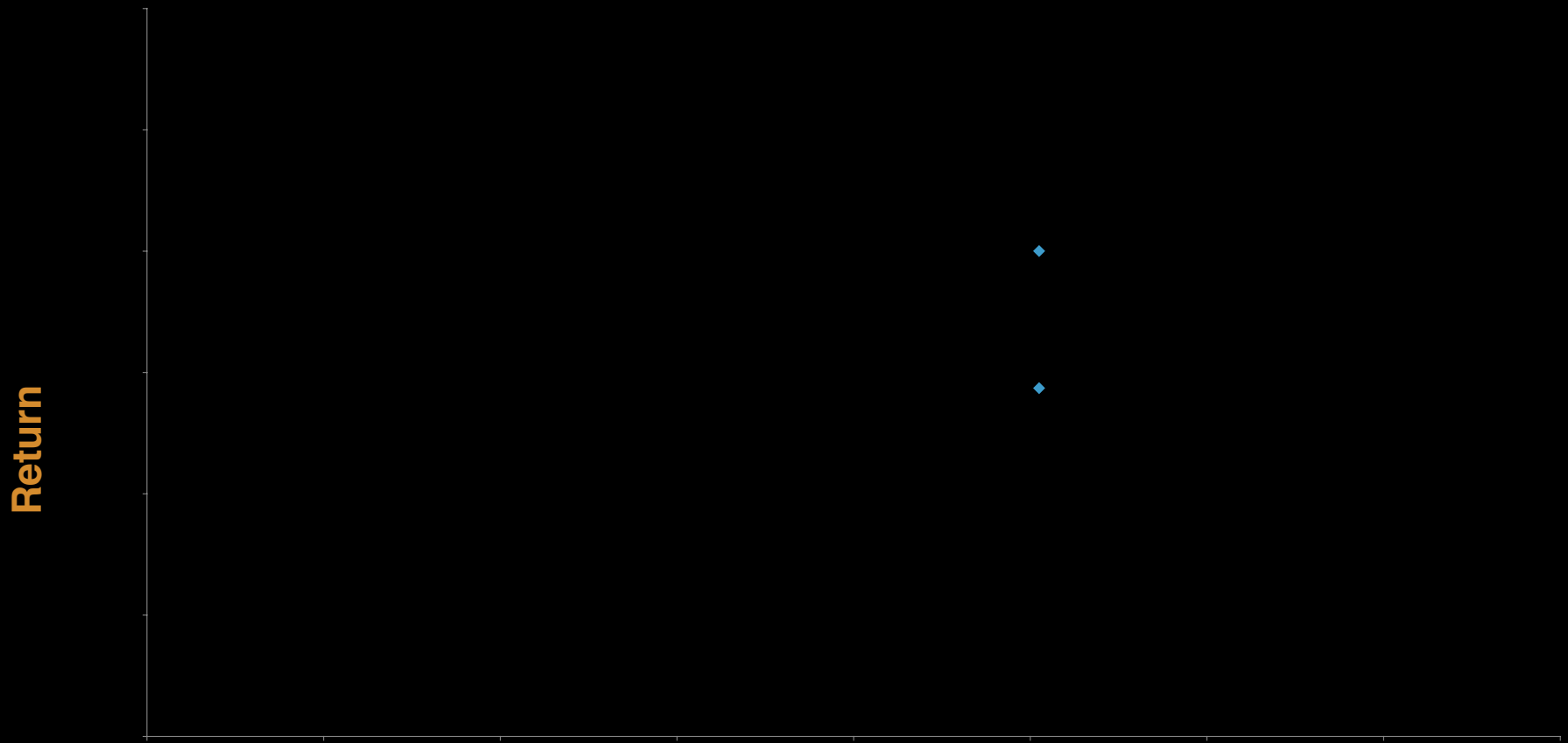
"Risk-Averse" = "Northwest" Corner

Assumption:

Market Prices are Martingales (all else being equal)

Definition:

The best estimate for the next value is the current value.


Return
SE
Standard Deviation of Returns

To Maximize Risk-Adjusted Return

First - Set projected volatility on x-axis, expected return on y-axis

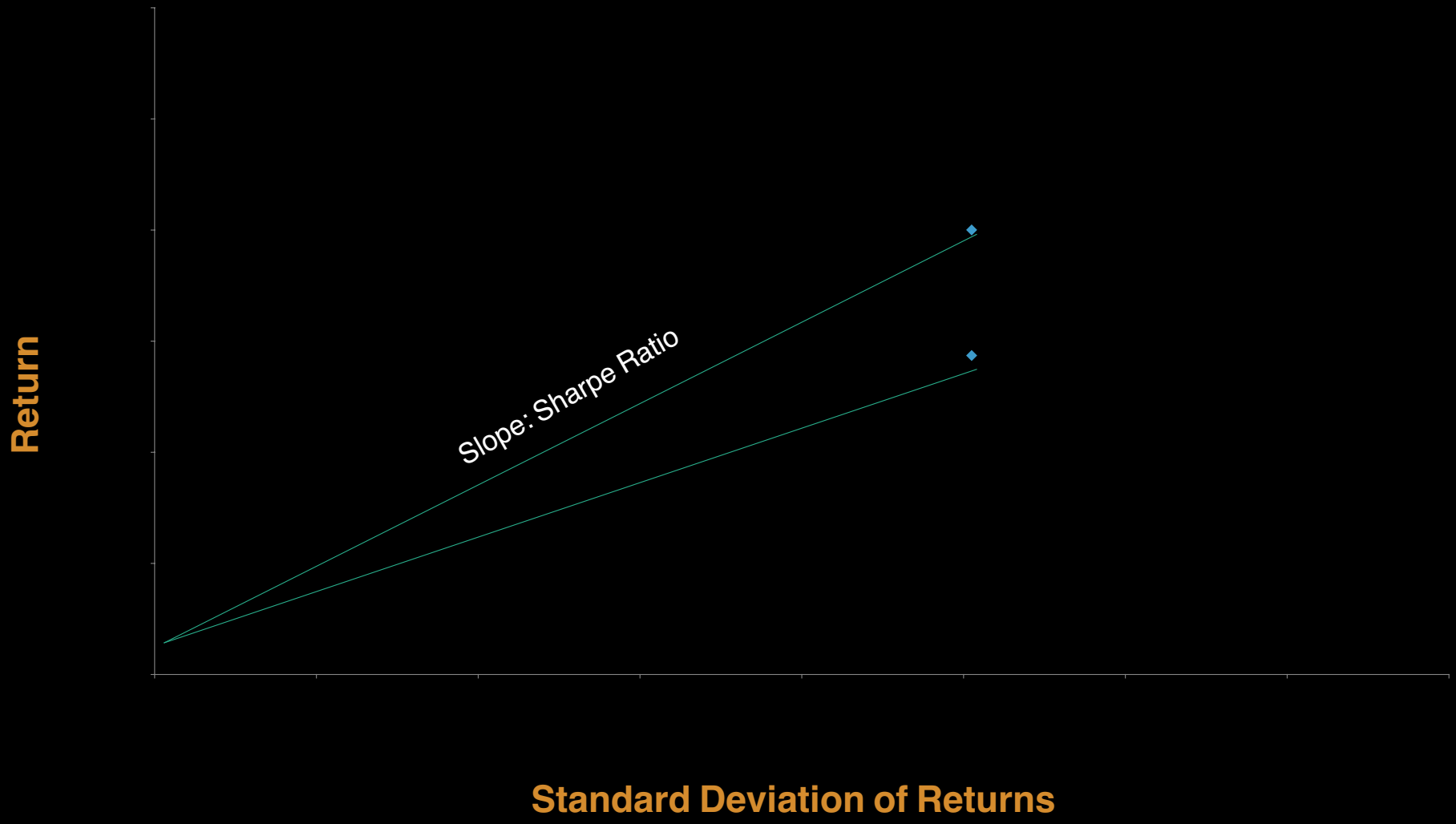
Second - Locate the "risk-free return point" on graph: **x = 0**, **y = risk-free rate**

(currently about 2% in US)

Goal:

Find portfolio point (x,y) with **maximum slope** from risk-free return point

The difference between the expected return and the risk-free return, divided by the expected volatility of return, is the **Sharpe Ratio** (more on this later)!


Return
Slope: Sharpe Ratio
SE
Standard Deviation of Returns

What about Return of a portfolio?

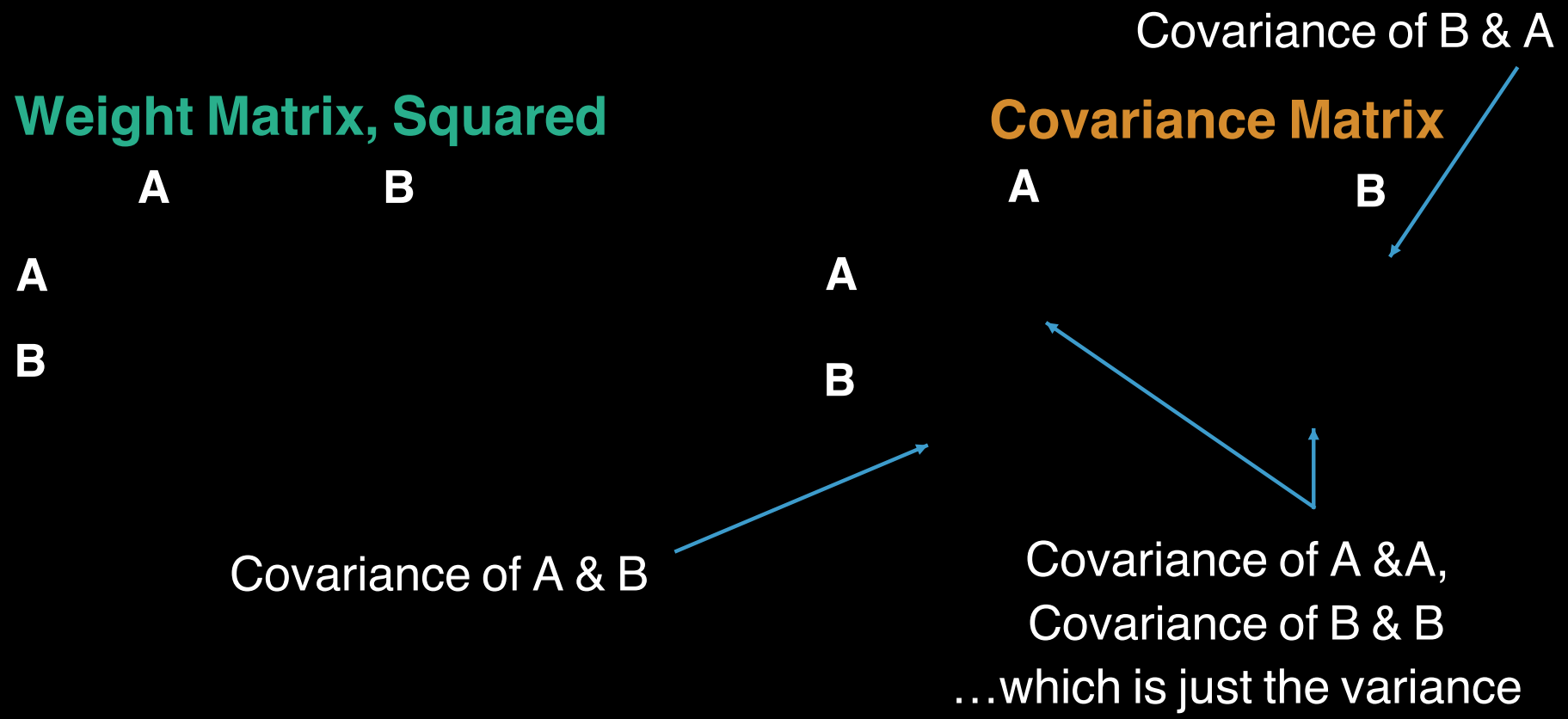
Portfolio Return

Weighted average of the individual expected returns

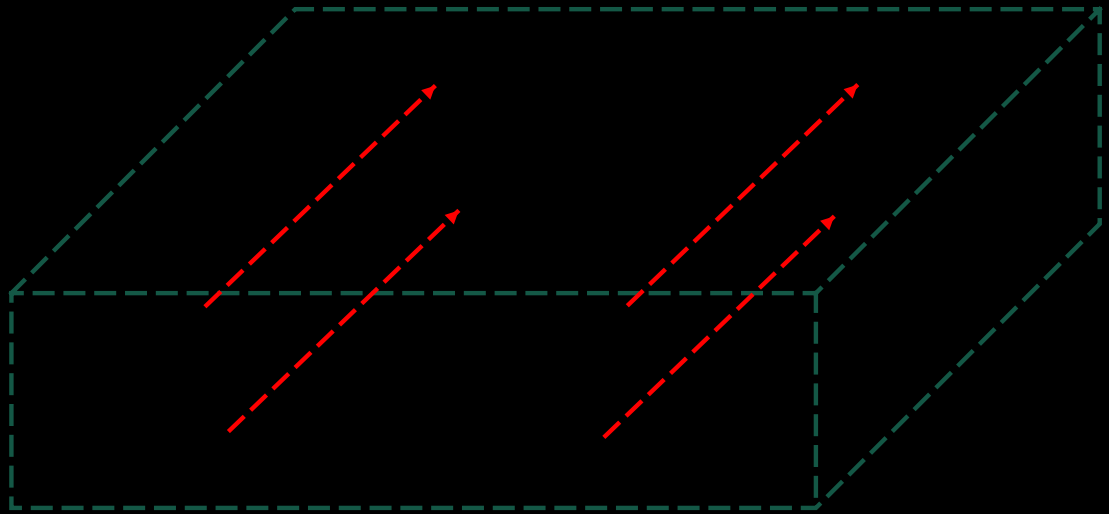
What about Variance of a portfolio?

Portfolio Variance of Returns: 2 Assets

- Variance of **combination** of two assets is dependent upon Volatility (SD) of each, weight of each, and Covariance.
- Note that weights w(a) + w(b) sum to 1
- **Variance** of the combined assets:


Weight Matrix, Squared
A
B
A
B
A
B
Covariance Matrix
A
B
Covariance of B & A
Covariance of A & B
Covariance of A &A,
Covariance of B & B
…which is just the variance

1) Multiply element-wise

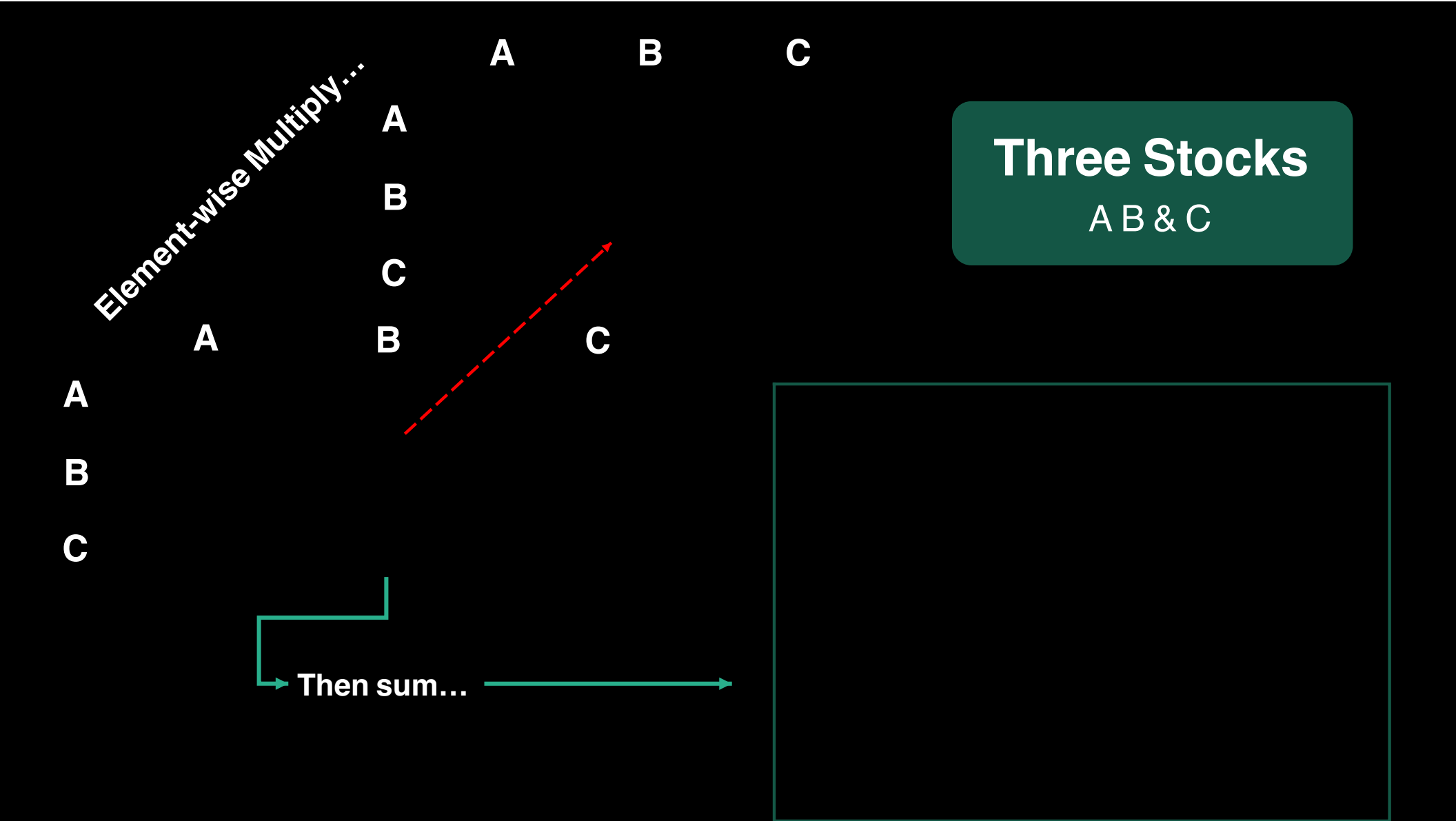


Equal

2) Sum them up

Element-wise multiplication, then sum, has a name:
”**Frobenius Product**”

3) Portfolio Variance:


A
B
C
Element-wise Multiply…
A
B
C
A
B
C
A
B
C
Three Stocks
A B & C
Then sum…

…and so on for *n* stocks.

3 Factors in Stock Price Volatility

- Market Risk: Stock price moves linked to **stock's overall universe**
- Sector Risk: Stock price moves linked to companies in same **industry sector**
- Idiosyncratic: Stock price moves **unrelated** to either; specific to stock

But returns of assets are correlated.

Correlation Coefficient

Definition: The slope of the line-of-best-fit that minimizes the sum-of-squares differences between two random variables.

- The long way: Graph in Excel, plot line, get R^2, take square root
- The easy way: **CORREL()**

Some Pairs of Stock Price Changes are More Correlated Than Others

Perfectly Correlated: $R = 1$

Negatively Correlated $R < 0$

No Correlation: $R = 0$

- Stock prices changes of companies of **same size** in same **market sectors** tend to have high correlations

- All stocks generally have > 0 correlation with their market

Covariance

Measures the extent to which two random variables change together.

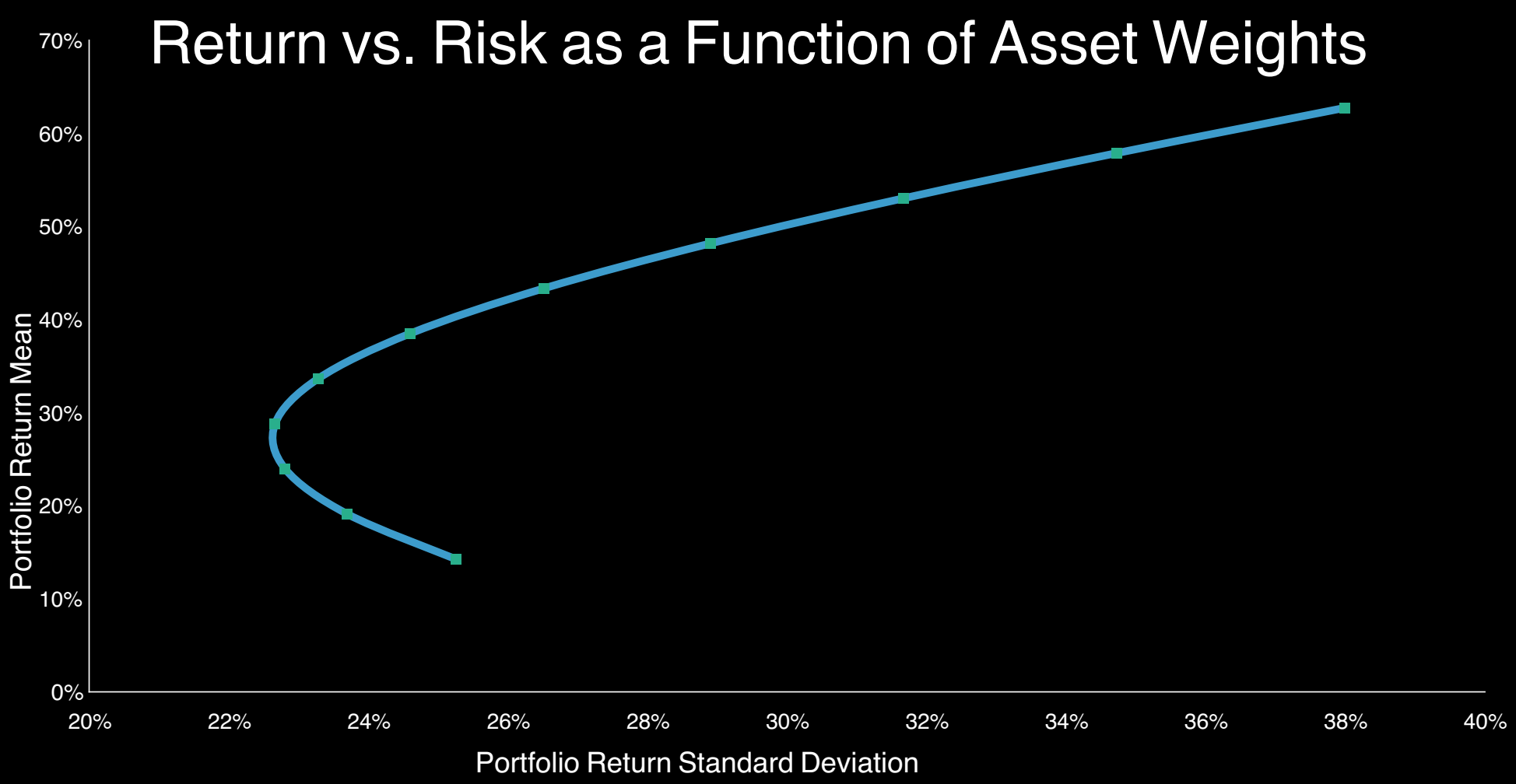
Use the **COVARIANCE.P()** function in Excel

Covariance and R

A “Standardized covariance”

In other words…

The Efficient Frontier


Return vs. Risk as a Function of Asset Weights
70%
60%
50%
40%
30%
20%
10%
0%
Portfolio Return Mean
20%
22%
24%
26%
28%
30%
32%
34%
36%
38%
40%
Portfolio Return Standard Deviation

Interpreting the Graph

One end point is 100% GM stock, 0% Microsoft stock

Other end point is 0% GM stock, 100% MS stock

The 9 other marked points on the curve are:

w(GM) = .9, w(MS) = .1,
w(GM) = .8, w(MS) = .2,
w(GM) = .7, w(MS) = .3,
And so on

The graph contains some **bad choices**

The upward sloping portion of the graph is called the Efficient Frontier

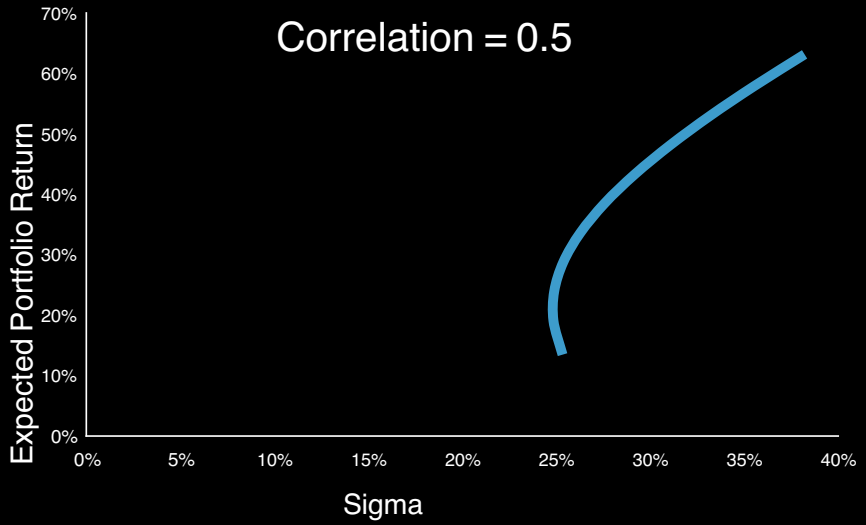
"Northwest is Best!"

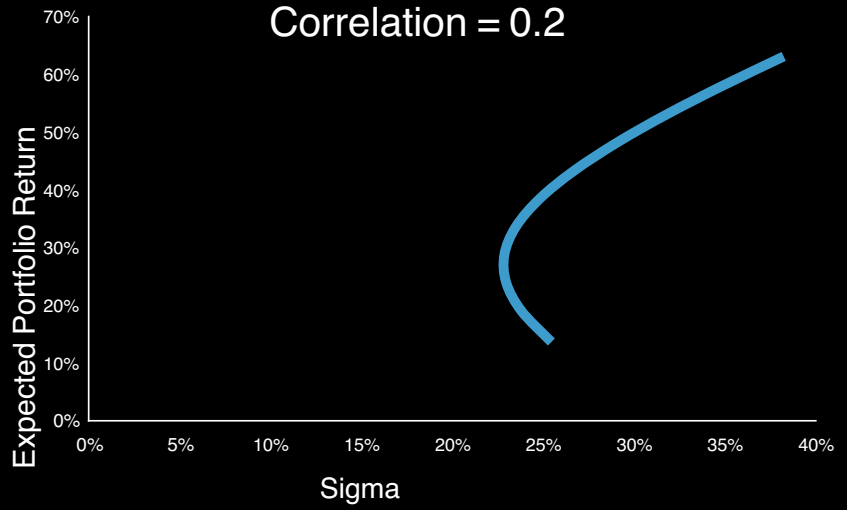
The “Efficient Frontier”

We assume:

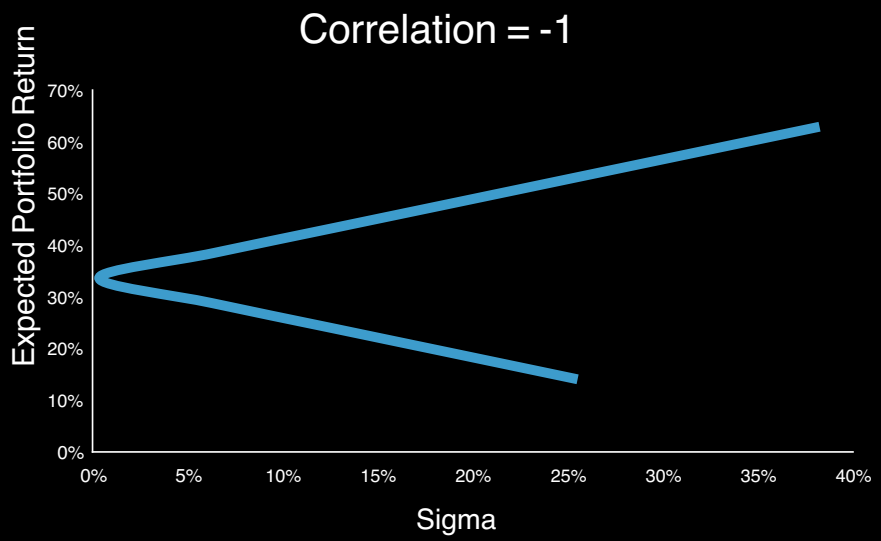
- Investors are “profit-maximizing” and “risk-averse”
- Given 2 portfolios with same SD of returns, investors pick the one with higher expected return
- Given 2 portfolios with same expected return, investors pick the one with lower SD of returns

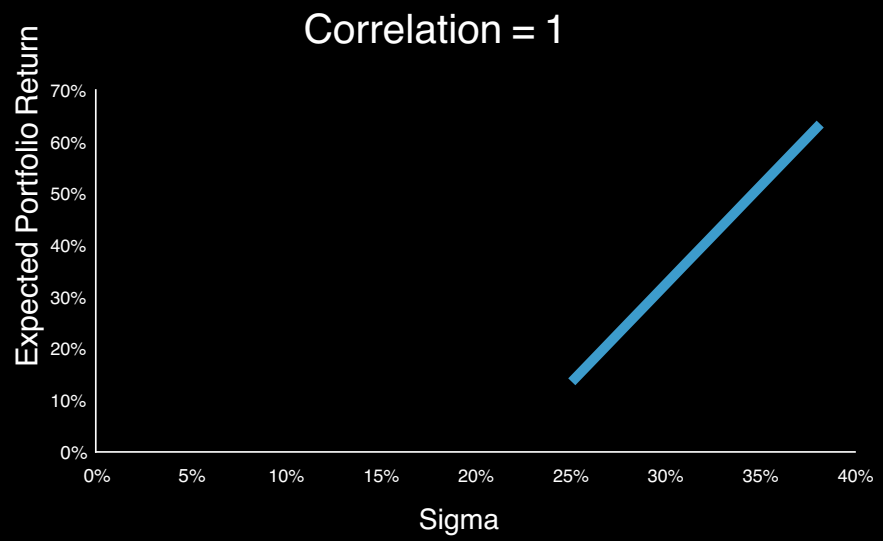
Correlation's Impact on the Efficient Frontier



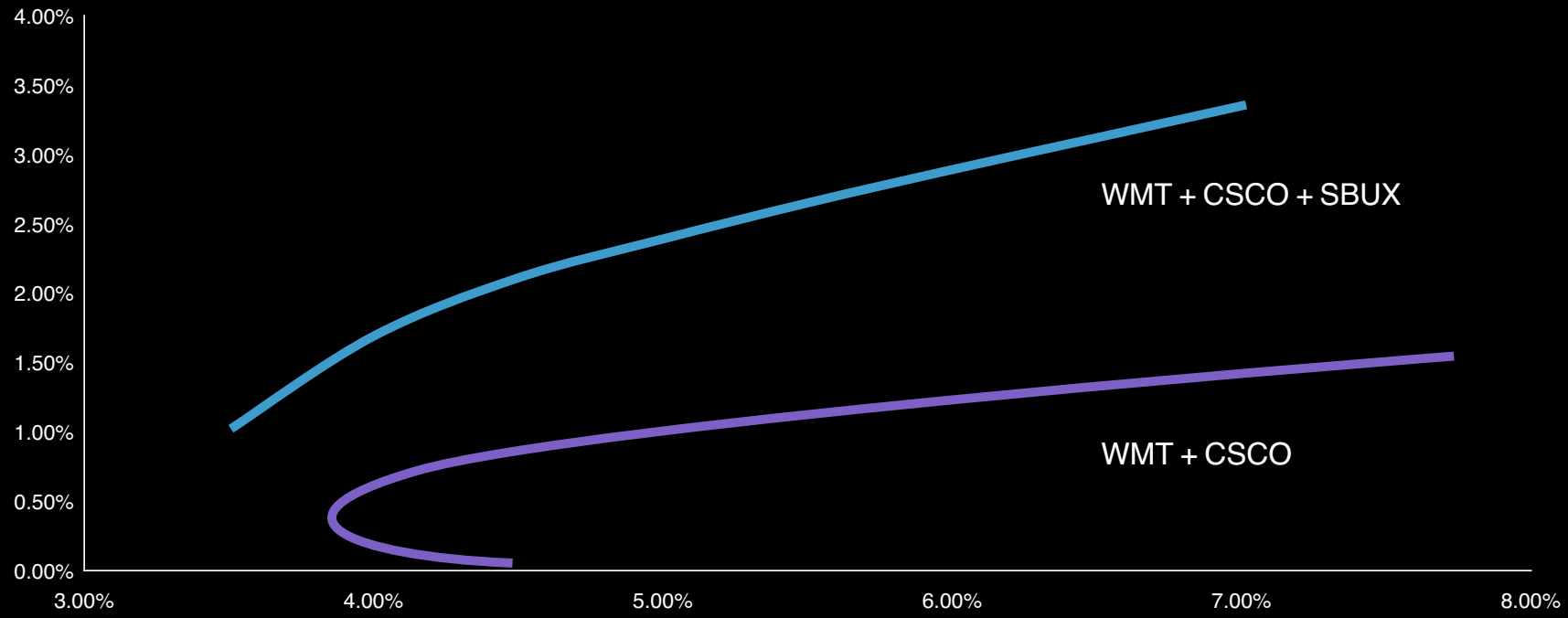


Correlation's Impact on the Efficient Frontier





Adding a 3rd Asset Moves Efficient Frontier



Consequences:

The better you are at forecasting what the expected return, vol, and correlation of returns will be in the next period = the more you can beat the market.*

That means its possible to make good risk-adjusted returns in the long run even if you're limited to a set of poor investment assets/strategies.

*However, beware! It's difficult to improve – even with a great model – on the basic assumption that "whatever these parameters were duing the last period is what they'll be during the next" when you're dealing with new, out-of-sample data.

Portfolio Theory: Key Assumptions

(1) Definition of "risk" used is "volatility of period-over-period returns"

- Historical return/ volatility time series data are assumed to be reasonable basis for forecasting the future
- Distribution of price changes is assumed to follow a Gaussian, or normal probability distribution

(2) All investors are assumed to be " risk-averse"

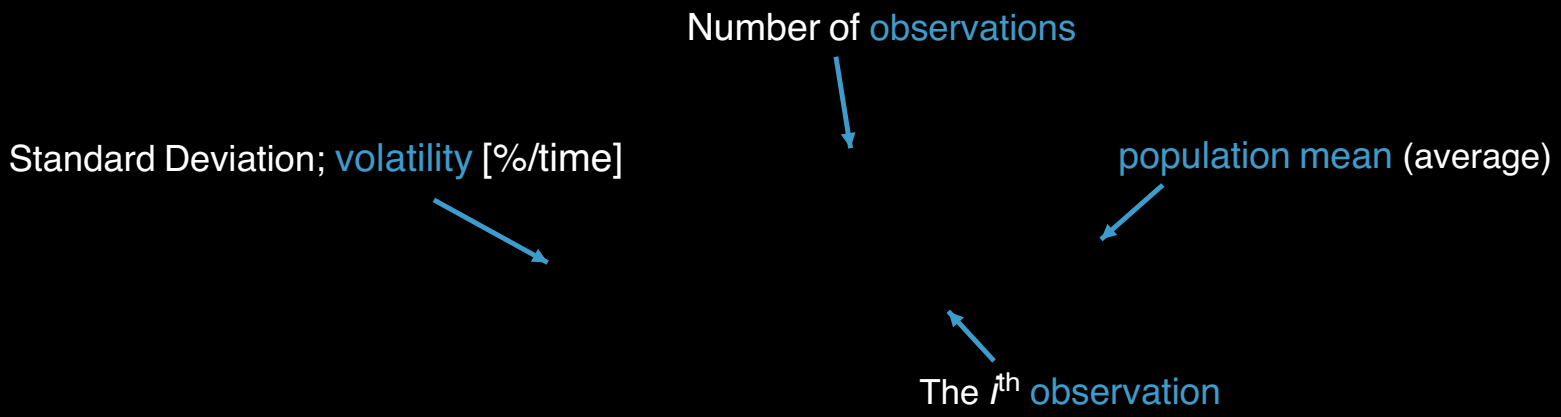
Standard for graphing:

- Projected volatility – x axis
- Projected return – y axis

Volatility of Returns == Standard Deviation of Returns

Standard deviation of a series of numbers; e.g., monthly or annual returns

Standard deviation is a measure of how **dispersed** a group of numbers is around their mean



Quick side note: not all dangers are included in Portfolio Theory definition of "Risk"

Risk is used to mean "random outcome with known properties"
Mean, standard deviation, shape of probability distribution all assumed known

Not included in this definition:

- Liquidity Risk: no buyer exists, at any price, when you want to sell – a "liquidity hole"
- Uncertainty: probability distribution of future outcomes unknown
- Counterparty Risk: Default, partial default (bonds & derivatives)
- Political Risk: Expropriation, Hyperinflation
- Fraud Risk: Ponzi Schemes (Madoff Fund)

Portfolio Weightings

- By definition, sum of all weightings = 1
- No single component's weight > 1 (absolute value)
- Weighting <0
  - Short Selling
  - **Assume no short selling** (longs only), unless explicitly stated otherwise in a problem statement, for this course

QUESTION

Let's say we designed a trading competition in which everyone spun up a trading account and traded stocks all semester. At the end of the semester, who wins?

Student 1

Puts all cash into a risky startup, the return on which fluctuates wildly during the period – sometimes up, sometimes down by large amounts

On any given day, student might be up by as much as 60%, or down by as much as -60%.

On the official end of the competition, student is up by a whopping 75%.

Got Lucky. The competition just happened to end on a good day for Student 1. By the end of next week, Student 1 was down to -15% return.

Student 2

Diversifies risk by allocating cash across a variety of assets in different industries.

Value of the portfolio goes steadily up – a healthy, reliable return with low variance.

At the end of the competition, Student 2 is up by a very respectable 12%.

Should win. Student 2 was consistently earning a return with low volatility. By the end of next week, Student 2 was up by a little more than 12%.

How can we quantify this?

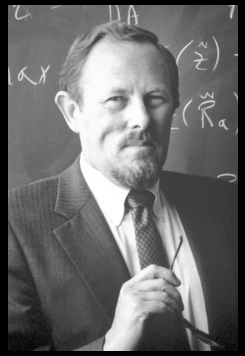
The Sharpe Ratio: Definition

We'd like to develop a metric that has units of **RETURN** / **RISK** so that we can quantify how well an investment is doing for the risk being taken.

1) The Return
Difference between the portfolio's **return** and the **risk-free rate** (i.e.; how much better are we doing than risk-free?)

2) The Risk
Portfolio's **volatility** (expected standard deviation of returns)

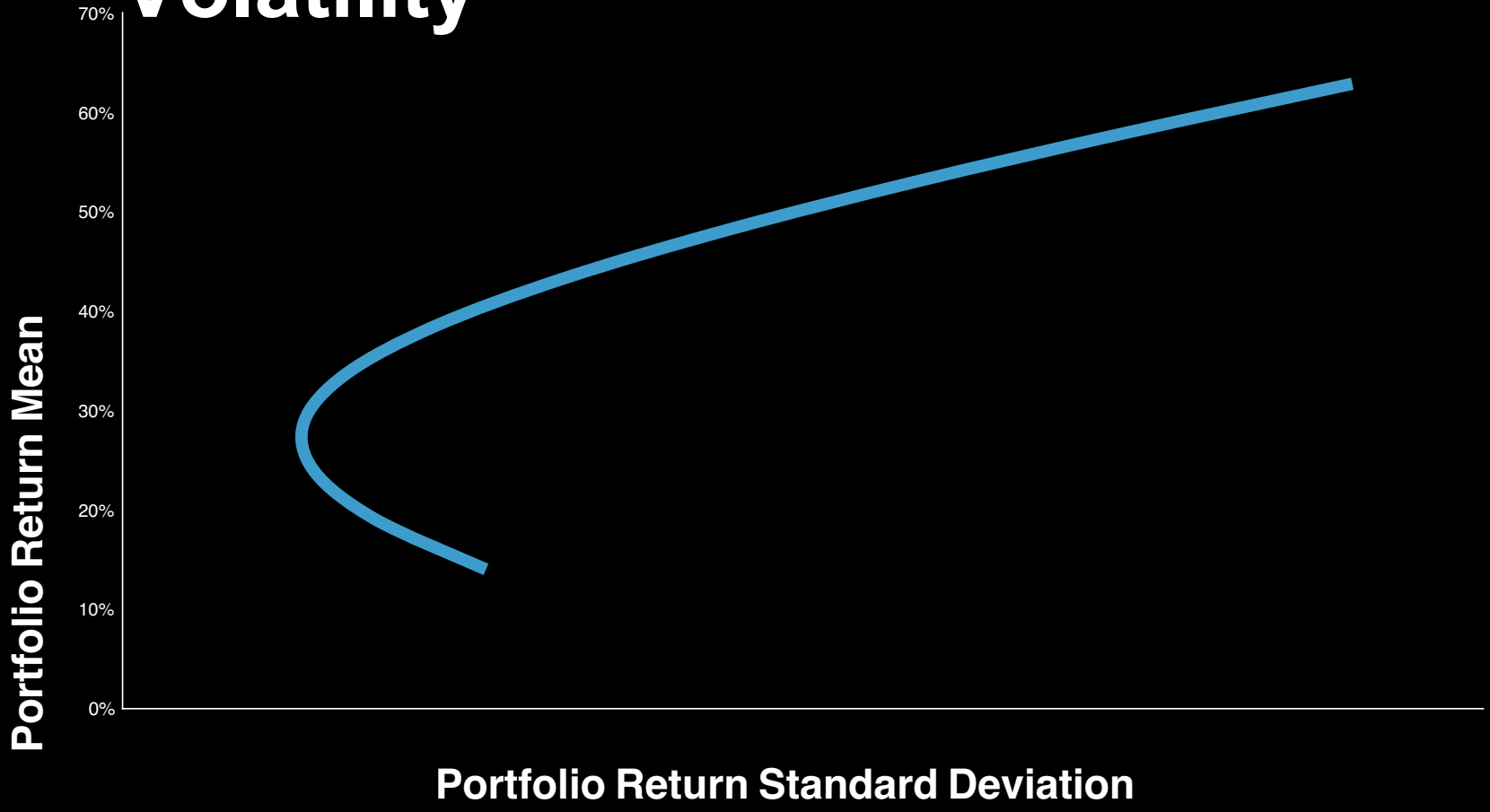
Expected OR Historical
Can measure Sharpe ratio in the past to compare performance, or use expected values to balance a portfolio today



3) Give it a name
William F. Sharpe

Original Paper (1966):
http://web.stanford.edu/~wfsharpe/art/sr/sr.htm

Tradeoffs Between Return and Volatility



Sharpe Ratio

The term "market" as used here is taken to mean "all of the assets you're taking into consideration for your portfolio."
Also called your "universe".

By weighting portfolios containing stocks & risk-free bonds, can achieve best available risk/return on the CML (Capital Market Line).

Portfolios that fall on that line have the highest ratio of Return vs. Risk available in a given market.

- Slope of the CML is defined by the best-return portfolios*
- Slope of the CML = best Sharpe Ratio available in your universe*
- Most common metric used to express **risk-adjusted returns**

* Except for the case in which you're leveraged at a rate higher than the risk-free rate .

Let's explore these concepts in an Excel breakout.

Excel Breakout

Let’s explore the Efficient Frontier.