Asset Pricing and Risk Management

FINTECH 522

portfolio balancing Q ~

Jake Vestal

Class 6:

Equities + Portfolio Theory pt. 2

Asking Questions about HW and Lectures

X not email

X not direct message

X coming up after class

Ask during class

Ask in a Teams channel

Reason:

It's a big class and you're probably not the only student who has that question. Ask it publicly where other students can see it and learn!

EVENING with the BOND KING

Next week is our review session, but we've also got a special guest:

Richard King

One of the top minds in bonds & fixed income.

He'll be here to talk about the bond world some more – very cool experience for us! After he speaks for an hour or so we'll do our review session.

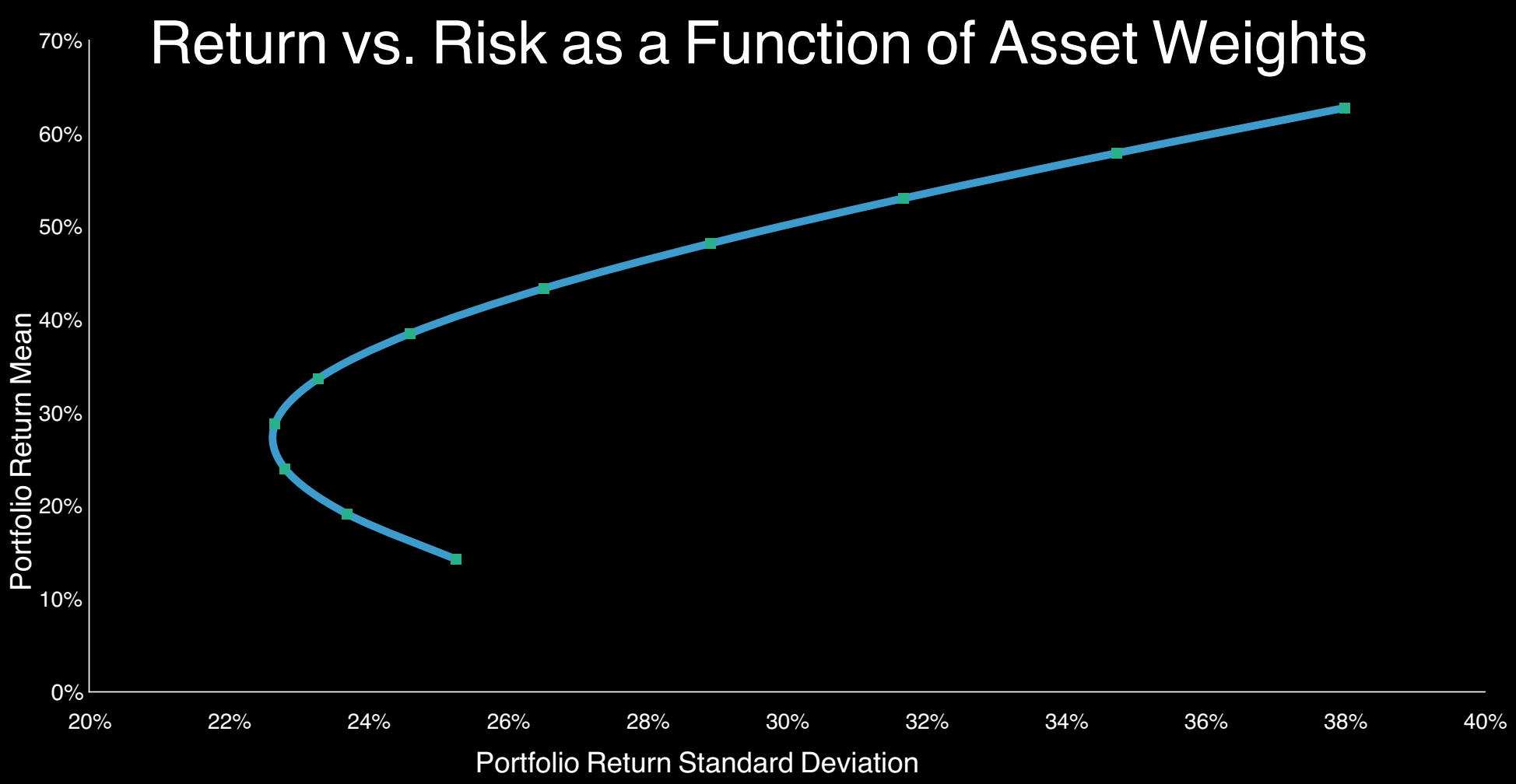
Exp Ret for GE is 6%. What C.F. for sleaft sale

Moving on to Portfolios

Alpha & Beta
Security Market Line
Efficient Fronteir
Capital Market Line

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


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

Let’s take a look at HW4

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!"

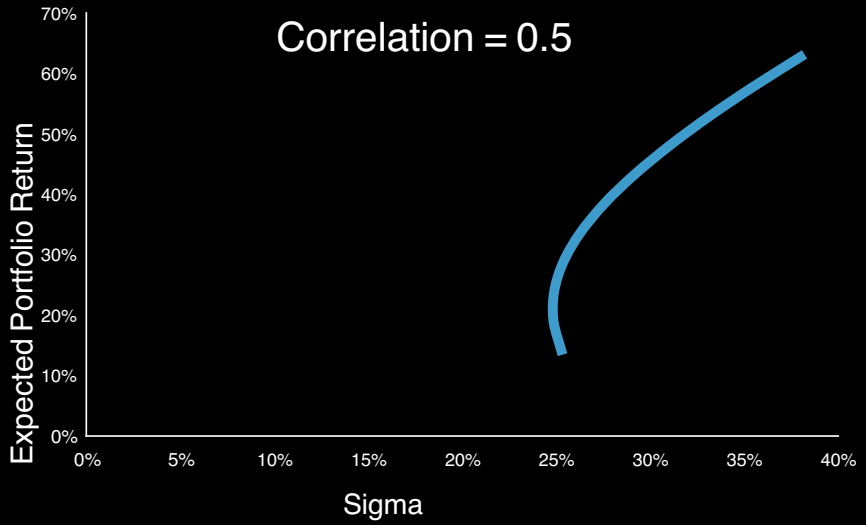
The “Efficient Frontier”

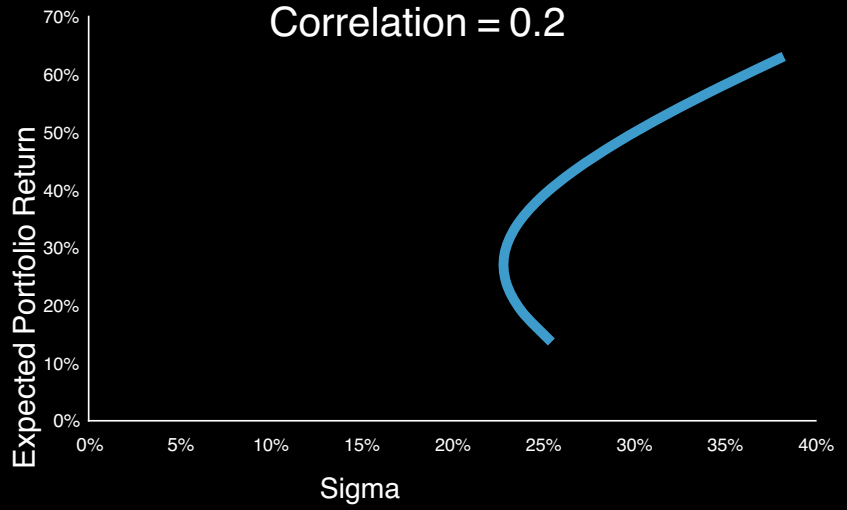
We assume:

- 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

↳ Volatility

Correlation's Impact on the Efficient Frontier





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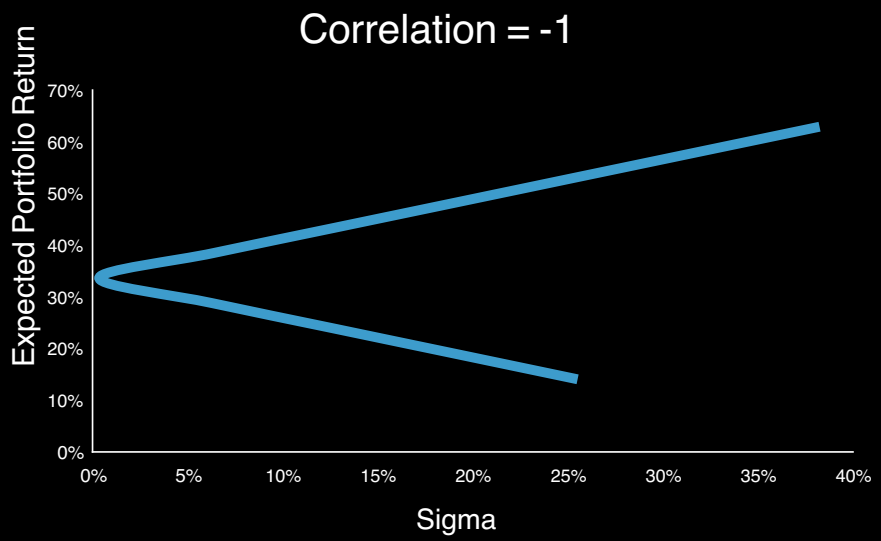
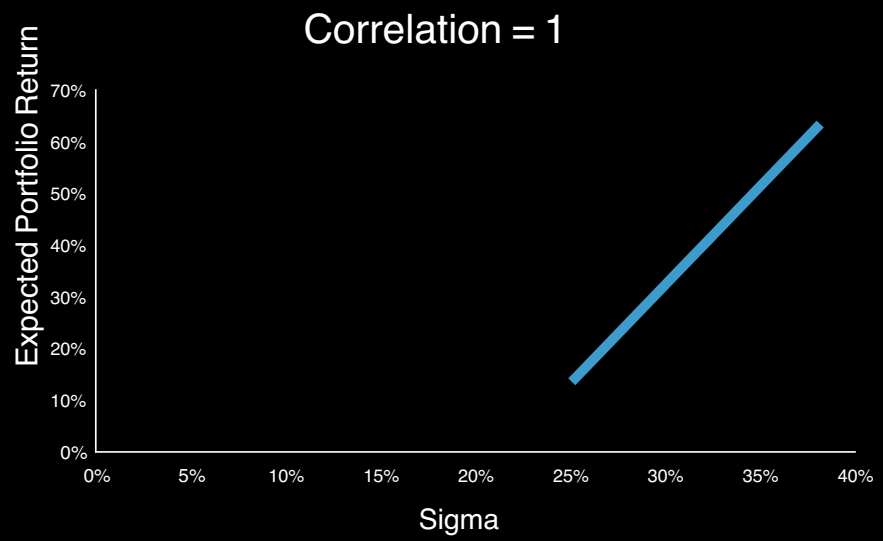
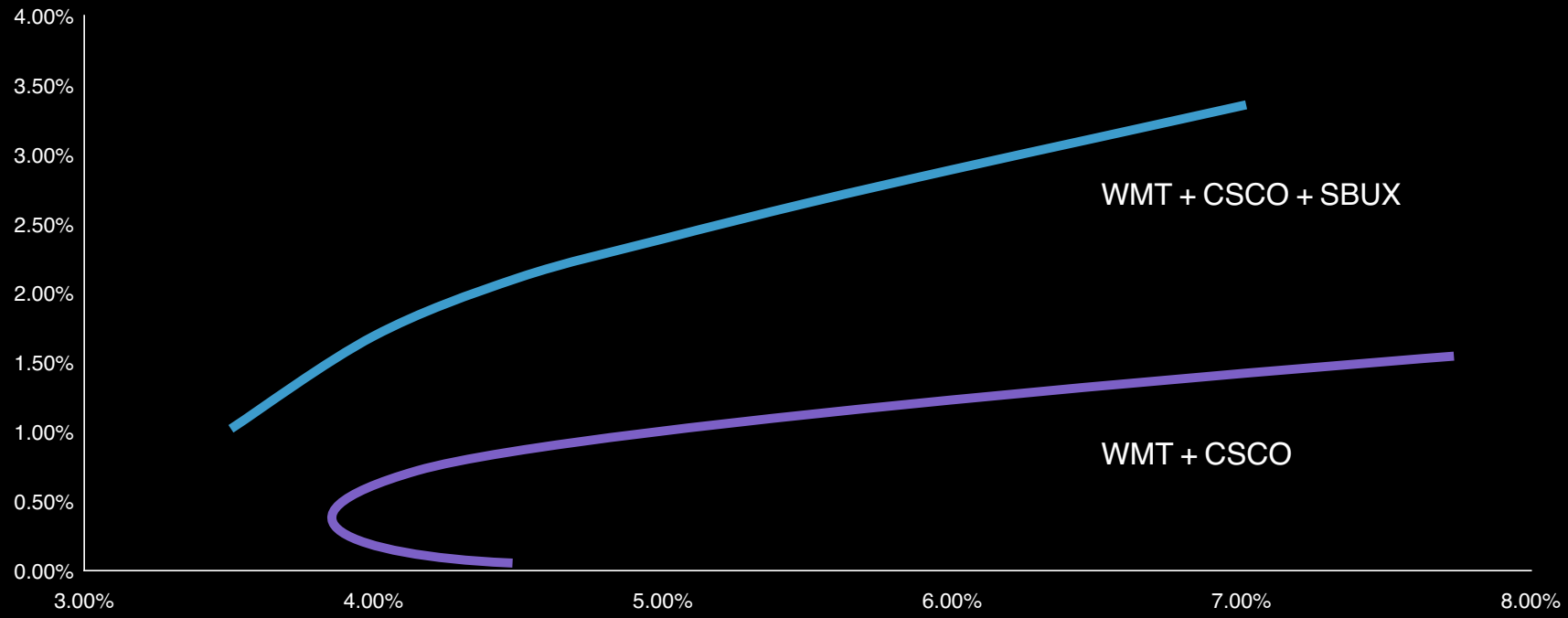




Adding a 3rd Asset Moves Efficient Frontier



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.*

Martingale assumption

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.

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

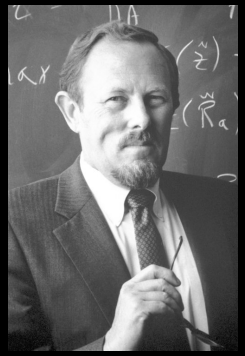
We'd like to develop a metric that has units of **RETURN** / **RISK** so that we can quantify how well an investment is doing for the risk being taken.

return risk-free rate

$$\frac{E(r_p) - r_f}{\sigma_p \text{ risk}}$$

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?)
↳ guaranteed by government

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



3) Give it a name
William F. Sharpe

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

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

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 tie it all together.

Stock A: _____

Exp rtn:

Exp vol:

Stock B: _____

Exp rtn:

Exp vol:

Correlation: () =

Risk-free rate:

Alpha & Beta

After Markowitz published in 1952

- People realized: more stocks, more betas, better risk adjustment
- Adding stocks into the universe allows for more selection opportunity to find the best efficient frontier
- Theoretically, the “best portfolio” whose universe included all available stocks would have weightings assigned to all stocks
- Such a “best portfolio” would not necessarily assign non-zero weights to every stock- some are left out (weight = 0).

Conclusion: No subset of any given universe can produce a more optimal portfolio than the one calculated on the universe as a whole.

Alpha & Beta: Motivation

Sometimes we want to compare an investment's returns against those of a different asset (i.e., a **benchmark**).

We can do this by graphing the returns of the benchmark on the x-axis, and those of the asset on the y-axis.

Alpha & Beta: Definition

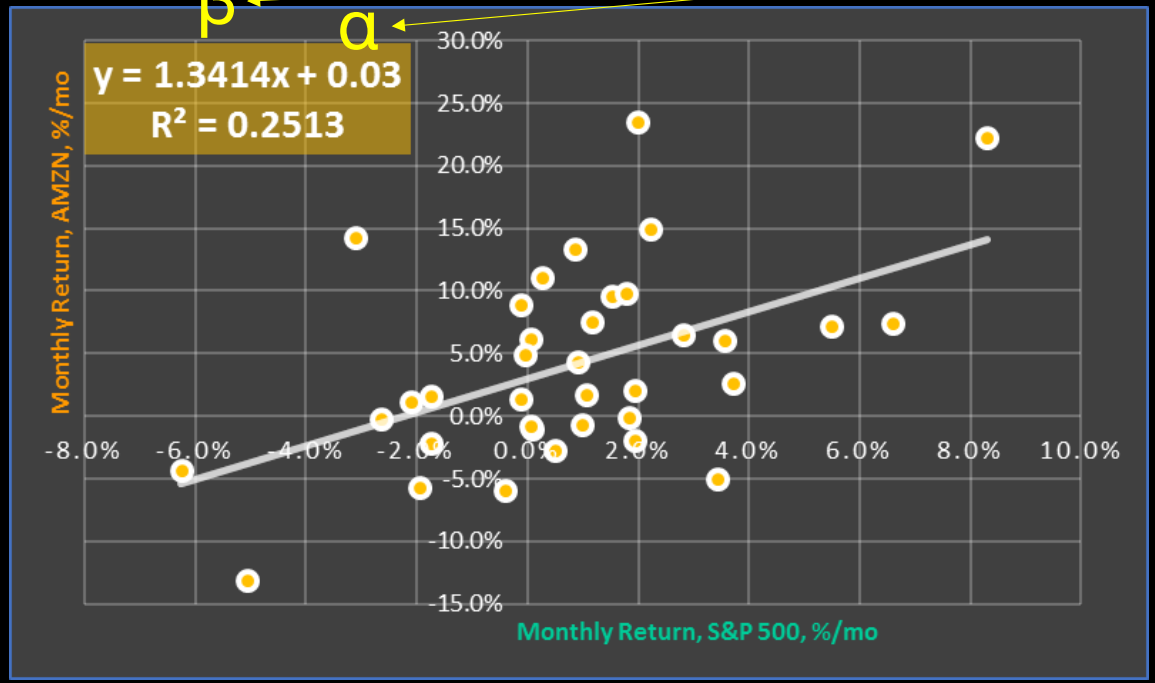
x-axis: Historical returns of a **Benchmark** (S&P 500)

y-axis: Historical returns of an **Asset** (AMZN)

Alpha (**α**): The y-intercept
Beta (**β**): The slope
…of the line-of-best-fit between an **asset** and an appropriate **benchmark**.

Returns

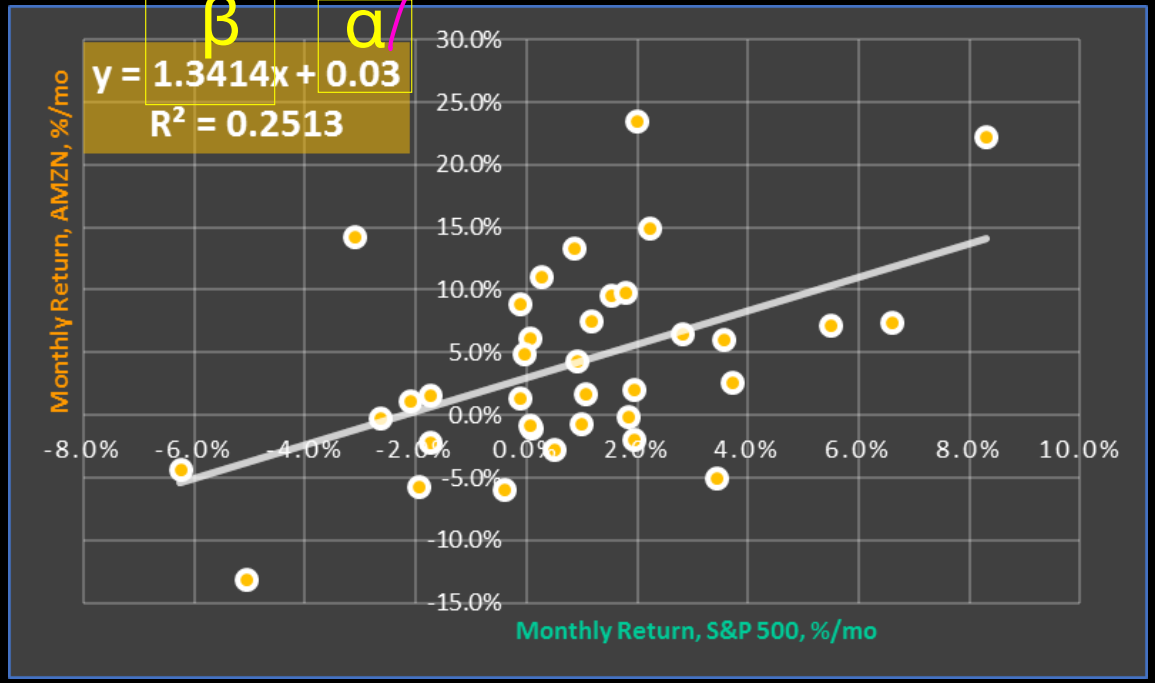
	A	B	C
1	datadate	SP500	AMZN
2	20150131	-3.1%	14.2%
3	20150228	5.5%	7.2%
4	20150331	-1.7%	-2.1%
5	20150430	0.9%	13.4%
6	20150531	1.0%	1.8%
7	20150630	-2.1%	1.1%
8	20150731	2.0%	23.5%
9	20150831	-6.3%	-4.3%
10	20150930	-2.6%	-0.2%
11	20151031	8.3%	22.3%
12	20151130	0.1%	6.2%
13	20151231	-1.8%	1.7%
14	20160131	-5.1%	-13.2%
15	20160229	-0.4%	-5.3%
16	20160331	6.6%	7.4%
17	20160430	0.3%	11.1%
18	20160531	1.5%	3.6%
19	20160630	0.1%	-1.0%
20	20160731	3.6%	6.0%
21	20160831	-0.1%	1.4%
22	20160930	-0.1%	8.9%
23	20161031	-1.9%	-5.7%
24	20161130	3.4%	-5.0%
25	20161231	1.8%	-0.1%
26	20170131	1.8%	9.8%
27	20170228	3.7%	2.6%
28	20170331	0.0%	4.9%
29	20170430	0.9%	4.3%
30	20170531	1.2%	7.5%
31	20170630	0.5%	-2.7%
32	20170731	1.9%	2.0%
33	20170831	0.1%	-0.7%
34	20170930	1.3%	-2.0%
35	20171031	2.2%	15.0%
36	20171130	2.8%	6.5%
37	20171231	1.0%	-0.6%



Benchmark can be:

- An index
- Another stock
- A strategy
- …any financial instrument for which we have historical returns

Alpha & Beta: Interpretation



What are we saying by drawing a regression line through these returns?

There is **mutual information** between **AMZN** and **SP500** prices – knowing whether one increases or decreases improves our ability to predict the other

What happens if SP500 Return set to 0?

If the S&P returns nothing, AMZN still returns 0.036% (α). (and that's good!)

- **α** is therefore sometimes called the "excess return" over the benchmark
- If these returns are all log returns, what is Amazon's excess return, **annualized**?
  = 0.03% * 12 = **0.36%**

β measures the sensitivity of AMZN's returns to those of the S&P 500; i.e., Market Risk

- **β** of **1.34** shows that **AMZN** was quite sensitive to the market during this time period
- **β > 1** termed **aggressive**
- **β < 1** termed **defensive**

Alpha and Beta can refer either to **Historical Measures** or **Forecasts**

In Capital Market (CAPM) theory, **over the long run**:

- Every asset will have a return equal to the product of its Beta and the difference between the market and the risk-free rate of return
- Every asset will therefore have forecast Alpha of 0
  - Alpha is defined as an asset's return minus the product of its beta and the difference between the market and risk-free return
  - historical data show Alphas > 0 and Alphas <0

Because Alpha gives a fund's return when the overall market's return is zero, it provides a decent measure of a money manager's performance over the market.

In other words: why put your money in a mutual fund vs. simply buying shares of an S&P500 index yourself?

- Because you believe that the mutual fund will earn you a better alpha. — more return than S&P500
- But mutual funds charge fees, and when you take *that* into account…

The Efficient Market Hypothesis

Malkiel (1995) results

Analysis from Malkiel, "Returns from Investing in Equity Mutual Funds 1971-1991" Journal of Finance (1995) (posted on Sakai)

- Considered *all* US mutual funds in existence from 1971 to 1995, except those investing in foreign securities or in one particular industry sector (gold stocks, pharma, etc)
- Accounted for management and gross expenses charged by funds to arrive at the actual return an investor would have received
- The mean Alpha of all US equity mutual funds surviving 1972-1991 is **0%**!
- Capital Market (CAPM) Theory says that over long time intervals, measured alpha will approch 0%.

Survivorship Bias

In 1992, Malkiel did not just look at the mutual funds that existed, acquire their past data, and start calculating returns (doing so would have injected "survivorship bias" into the analysis).

Eliminate survivorship bias by including the funds that went out of business during the time period being studied.

Annualized Returns From 1982-1991:

- S&P 500 returns: **17.52%**
- Mean return on mutual funds in existence in 1982 ***that were still in business*** in 1992: **17.09%** (slightly worse than market)
- When mutual funds that went out of business during the time period are included (adjust for survivorship bias), mean return was: **15.69%**

Survivorship Bias

Of 239 funds surviving 1982-1991 , compared against S&P returns:

- Funds with positive, statistically significant alpha: **0**
- Funds with negative, statistically significant alpha: **19**

Efficient Market Hypothesis

Essentially says: For markets made up of assets that:

- are highly liquid (i.e. frequently traded), and
- for which the information relevant to determining price is public and widely available, and
- there is a low barrier to entry (easy for many traders to access the market)

… no observed risk-adjusted excess returns are earned in the long run by money managers that actively buy & sell (i.e., mutual funds).

- Guessing "heads or tails" eight times in a row – a "skill" that one in 256 people possess
- Good luck naturally appears, both to the lucky themselves, and to others, to be skill
- This is what finance writer Nassim Taleb calls, " **Fooled by Randomness** ."

Efficient Market Hypothesis

In an efficient market, no excess risk-adjusted returns possible:

- by analysis of past price movements – WEAK FORM
- By analysis of publicly-available information – SEMI-STRONG FORM
- By use of any information, public or "insider" – STRONG FORM

Capital Market Line (breakout)

In theory, the market is only willing to give you one best “price” (in terms of risk) that you’ll pay to earn a return.

That “price” is given by the slope of the Capital Market Line, which is the Sharpe Ratio of the best portfolio available in a market.

Let’s explore with Excel.

Solver required for exam?

Capital Market Line

all Portfolios have the same Sharpe in example b/c.... there is no better Price for return via risk in those markets

Notice - what is the MPT step 5 sheet(s) on excel

When to hire active money managers:

When they manage money in markets that are *less than* efficient (e.g., **alternative asset classes)**

- Markets with inefficient transactions (each one unique)
- Markets with few highly-informed participants
- Markets where relevant information is expensive
- Algorithmically identify and exploit mispricing
  - Warning: Even when the market is "wrong", and you take a position to exploit a price inefficiency, the market can remain "wrong" until *after* you go broke
- Illiquid Investments (benefit from lack of "Liquidity premium")
  - Buyouts, Venture Capital, etc
  - Needs specialized knowledge and access in order to participate

Manager should be able to explain, concisely and clearly, what the inefficiency is that they're exploiting, why they have an "edge" over everyone else, and, perhaps most importantly, *how they'll know when that "edge" stops working.*

Technical Analysis

Try to identify for “patterns” (or “fractals”, as some say) in stock prices, observe a “pattern” that is partially complete, then take a position assuming that the pattern will repeat

- Called “chart traders”, “pattern traders”, or “chartists”
- Looked down upon by most professionals
- Relies upon past price patterns to predict future prices.
- Does not work (except possibly in high-frequency trading cases)
- Do you really believe that **past price patterns contain information to reliably predict future price patterns** ?

Don’t trust any trading strategy unless you can write down clearly and concisely why it works (or at least have a theory), and how you’ll know when it stops working.

Fundamentals Analysis

- *Does* sometimes work – due to the **weak** & **semi-strong** forms of the Efficient Market Hypothesis (EMH)
- EMH **strong** form says that it can't work
- *The Big Short* by finance writer Michael Lewis is an example in which fundamental analysis payed of big…
  - …but the money managers almost went broke before it did!

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Efficient Market Hypothesis & Security Market Line

We already know:

α_i: the (excess) return of a security *i* when that of the benchmark is 0

β_i: 'conversion factor' between (excess) returns of benchmark and *i*

In Symbols:

Efficient Market Hypothesis & Security Market Line

The **Efficient Market Hypothesis** states that all relevant, publicly available information is already reflected in the market prices

When true:

long-term alpha for active managers = 0

Long-term return of a security should be its beta * the market's excess return + the risk

Efficient Market Hypothesis & Security Market Line

All relevant, publicly available information is already reflected in the market prices

When true:

long-term alpha for active managers = 0

Long-term return of a security should be its beta * the market's excess return + the risk

Active Manager's long-term Sharpe Ratio is expected to be same as the market portfolio

Excel Breakout: SML