Financial Markets Notes

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Chapter 1

Introduction

Financial institutions are a pillar of civilized society directing resources across space and time to their best use, supporting and incentivizing people in their productive ventures, and managing the economic risks they take on. The workings of these institutions are important to comprehend if we are to predict their actions today and their evolution in the coming information age.
This course is not about getting rich. It's about getting things done.

VaR: VAR in finance means two things: variance and "value at risk" but when the A isn't capitalised, it means value at risk.
It's a term that was invented after the stock market crash of 1987.
Value at risk is usually quoted in units of $ for a given probability and time horizon. E.g. 1% one-year VaR of $10 million means that there's a 1% chance that a portfolio will lose $10 million in a year.

Stress Tests: Originally, the term "stress test" referred to a medical procedure to test for cardiovascular fitness.
In finance, stress test is a method of assessing risks to firms or portfolios. It is usually ordered by the government to see how a firm will stand up to a financial crisis.
E.g. The Dodd Frank Act 2010 requires the Federal Reserve to do annual stress tests for non-bank financial institutions it supervises for at least 3 different economic scenarios.

S&P500: Standard & Poor's 500. It is used as a benchmark on returns.

Chapter 2

CAPM

: Capital Asset Pricing Model. The equation is given by

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f)$$

where,

- $E(R_i)$ is the i^{th} capital asset's expected return
- R_f is the risk-free rate of interest
- β_i is the sensitivity of the i^{th} asset to the market. It is a measure of how it relates to the overall stock market.
- $E(R_m)$ is the expected return of the overall market

Beta

Beta β_i is the regression slope coefficient when the return on the i^{th} asset is regressed on the return of the market.
If $|\beta| > 1$, it means that the asset overreacts to the change in the overall market.
If $\beta > 1$, it means there's a positive association between the asset's return and the market's return. If $\beta < 1$, it means that the asset loses money when the overall market does well, i.e., negative association.
If $\beta = 1$, the asset increases and decreases exactly the same amount as the overall market.

In case of apple, the beta is about 1.5. On the other hand, gold is known to have a negative beta: because people tend to buy gold when the stock market and economy isn't doing well, because of the psychological safety of gold - it will always stay gold. That is, in times of recession, people would rather buy gold than invest in the stock market (because you can run away with gold).

Alpha

Another popular term in the CAPM is **alpha**. Alpha measures the amount that an investment has returned in comparison to the market index or other broad benchmark that it is compared against. If we include alpha, the equation becomes:

$$R_i = R_f + \beta_i(R_m - R_f) + \alpha$$

where each of the terms refer to their expected value as computed based on historical data.
Alpha shows how well (or badly) a stock has performed in comparison to a benchmark index. Obviously a high alpha is good, while a negative alpha is bad.
Alpha is represented as a single number (like or -3), and the number indicates the percentage above or below a benchmark index that a stock or fund price achieved. If the alpha is 0, its return matched its benchmark.

Note that while both alpha and beta are historical measures of past performances, beta indicates how *volatile* a stock's price has been in comparison to the market as a whole, whereas alpha indicates how much a stock has outperformed/under-performed in terms of its expected returns, when compared to the overall market.

2.1 Market Risk vs. Idiosyncratic Risk

Market risk is the risk of the whole stock market. E.g. For an Apple investment, the market risk is the risk that Apple will do something in reaction to the aggregate stock market. But idiosyncratic risk is Apple-only risk. E.g. The death of Steve Jobs only affects the stock price of Apple, not the overall stock market. So, it is an idiosyncratic risk.
By construction, the residuals or error terms in a regression are uncorrelated with the fitted or predicted value. So, the variance of the return of a stock is equal to its beta squared times the variance of the market return (systematic risk) plus the variance of the residual in the regression (idiosyncratic risk).
Note: the coefficient β_i is a measure of the systemic (or market) risk.

Investors, in general, care more about systematic risks than idiosyncratic risks of a stock, because the idiosyncratic risk will average out to zero in the long run but the market/systematic risk will not (by definition of market risk).

Regression Line

Recall that a regression line is plotted by minimising the sum of squared residuals where each residual is given by, $e_i = \hat{Y}_i - Y_i$ where $\hat{Y}_i$ is the model's prediction for the i^{th} data point while Y_i is the actual (ground truth) value of the i^{th} data point.

In our case, $\hat{Y}$ is the predicted return on apple stock and X is the return on the overall market. So, β tells us how much apple stock co-moves with the market, and thus is a measure of the stock systematic risk.
Idiosyncratic risk is the risk that the point will lie above or below the regression line.

Financial returns do **not** follow a normal distribution. In fact, they follow a Cauchy distribution. The Cauchy distribution looks similar to the normal distribution but it has fatter tails on both sides. That is, instead of trailing off to zero for values that deviate significantly from the mean, the distribution has non-negligible probabilities for those values too.
This means that you can be fooled into thinking that you're living in a fairly stable world but then there are these high-impact low probability events that occur from time to time that change almost everything. This is explained very well in the book "The Black Swan" by Nassim Taleb.

Central Limit Theorem (CLT): When independent random variables, each of which follow the same distribution with a finite variance, are averaged (normalized), the resulting random variable follows a normal distribution, regardless of the underlying distribution of the individual random variables. In other words, if $X_1, X_2, \cdots, X_n$ are i.i.d. (independent and identically distributed) random variables, each of which have a mean μ and variance σ^2, then $\bar{X} = (\sum_{i=1}^{n} X_i) \sim N(\mu, \sigma^2)$.
It is important to note that CLT can fail if:

- The underlying random variables are fat-tailed, i.e., the variance of the distribution is infinite.
- The underlying random variables lose their independence.

Also, stocks are generally not independent from other similar companies. In other words, there is some association between 2 different stocks. We can represent this as covariance.

Covariance: Covariance is just a measure of the joint behaviour of 2 random variables. If the covariance of X and Y is positive, it means that whenever $X > \mu_X$, then it is likely that $Y > \mu_Y$. In fact, the formula for covariance is simply, $Cov(X,Y) = E[(X-\mu_X)(Y-\mu_Y)] = E[XY] - \mu_X\mu_Y$. If the covariance is zero, it means that the 2 stocks are uncorrelated (it does not mean that they are independent!). The CAPM also measures covariance through the coefficient β_i. In fact, $\beta_i = \dfrac{Cov(R_i, R_m)}{\sigma_m^2}$ where the subscript m refers to the overall market and the subscript i refers to the i^{th} stock.

It is difficult to interpret the covariance directly because the magnitude does not tell us much about the strength of the correlatedness between the 2 stocks (since the magnitude can be large due to the values of X and Y being large too). So, we use a normalised version of covariance, called **correlation coefficient** that measures the degree of linear association between 2 random variables. It is denoted by ρ or r. The formula is given by, $\rho = \dfrac{Cov(X,Y)}{\sigma_X \sigma_Y}$.
In particular ρ tells us about the strength of **linear** association between 2 random variables. It always takes on a value between -1 and 1. The higher the absolute value of ρ, the higher the strength of the linear association. The sign of ρ tells us the direction (positive or negative) of the association.

The basic lesson here is this: **risk is determined by covariance**. You shouldn't be putting all your money into a group of stocks which have a high covariance (especially a high positive covariance, because that would mean that either all of them will do well, or all of them will do poorly - which is too much risk to take).
In other words, we should try and find stocks that are independent to minimize risk.

Variance Formulae

- $Var(aX + b) = a^2 \times Var(X)$
- $Var(aX + bY) = a^2Var(X) + b^2Var(Y) + 2ab \times Cov(X,Y)$. In particular, if X and Y are independent then, $Var(X+Y) = Var(X) + Var(Y)$

The second formula should make it clear why positive covariance between two stocks is bad for your portfolio - it cases your portfolio's standard deviation to increase. Negative covariance is good.

Chapter 3

Insurance

Risk Pooling is the source of all value in insurance. You are essentially paying a premium to protect yourself against well-defined risks and damages. **You can only insure against the unknown**. This means that if you know your house is going to burn down tomorrow and you get a house insurance the night before, the insurance company will collapse (almost certainly if everyone starts to do this).

It works because of the law of large numbers. That is, there are a small number of predictable bad outcomes and the insurance company pools all of them together and insures against them.

If there are n policies, each has independent probability p of a claim, then the number of claims follows the binomial distribution $Bin(n, p)$. The standard deviation of the fraction of policies that result in a claim is given by $\sqrt{\frac{p(1-p)}{n}}$.
By the law of large numbers, as n gets large, standard deviation approaches zero (and you can become more confident about exactly how many policies will be claimed).

3.1 Fundamental Issues with Insurance

- **Moral Hazard**: people, knowing that they are insured from risks, take more risks. In the extreme case, people deliberately cause "accidents" to claim insurance money.
- **Selection hazard**: If only sick people signed up for health insurance, the insurance companies would run out of business. So, they conduct exams and have disclosures to ensure that both parties have the same information while signing the policy (i.e., there is no information asymmetry). Alternatively, some government policies do not allow insurance companies to take preexisting conditions into account, which means that they don't get to choose whom they can insure.

Some governments provide insurance guarantees for insurance companies. This means that if the insurance company itself goes bankrupt, the government will cover the losses and pay the insurance money. That is, the government is insuring against the failure of insurance companies. But the money paid by the government is often capped and much lower than what should have been paid by the insurance companies themselves.

Obamacare made it mandatory for everybody to get insurance for themselves, and for companies to provide insurance for their employees. A fine was imposed (as a tax penalty) if an individual did not have insurance.

Chapter 4

Alternative to Insurance: Portfolio Management

This is the idea of managing risk, not through purchasing insurance policy, but through diversification of ownership - owning a variety of assets.

Risk is inherent to investing. Ultimately, people who are providing you with investment opportunities are doing something in the real world, which is risky. If it weren't risky, it wouldn't be giving you an extra return.

Don't put all your eggs in one basket.

How do we calculate the optimal portfolio, the best diversified portfolio? If people are all like me, all calculating with the same data, all wanting to hold portfolios on the frontier, then they all want to hold the same portfolio (and cash). So, that has to be the **market portfolio**.

But different people have different degree of risk-averseness.

Another key lesson is this: you should only be concerned about how your entire *portfolio* performs, not each individual stock. So, the mean and variance of the portfolio matter. Also, the law of large numbers means that spreading over many independent assets reduces risk, but has no effect on the expected return.

But people often boast about their investing skills with regard to individual assets; but they shouldn't, because **you win some, you lose some**. It's the average that matters.

So, when thinking of whether or not to invest in an asset, what you really should be thinking of is how does it contribute to the overall portfolio expected return and the overall portfolio variance. Don't look at each asset individually.

If you help people manage their risks, they will take more risks. Sometimes, that is exactly what we want - we want to encourage people to take chances.

CAPM asserts that all investors hold their optimal portfolio.

The **mutual fund theorem** is an investing strategy whereby mutual funds are used exclusively in a portfolio for diversification and mean-variance optimization. The consequence of the mutual fund theorem is that all investors hold the same portfolio of risky assets: the tangency portfolio. Therefore, the CAPM says that the tangency portfolio equals the market portfolio.

The CAPM implies that the expected return on the i^{th} asset is determined from its beta. To recall, β_i is the regression slope coefficient when the return on the i^{th} asset is regressed on the return on the market.

The problem with diversification for individuals is that individuals don't have enough money to diversify (otherwise you end up buying fractional stocks of companies). So, the idea is that people need investment funds to manage their portfolio diversification.

Complete Diversification says that you should hold all possible stocks - regardless of their risks (because they will all average out to give you what is best for you).

In general, **if you take low risks, you'll get low expected returns**.

Stocks with negative betas are important in a different way. Maybe their average returns aren't so good, but they help offset market shocks. So, you should consider owning assets like gold to reduce the risk of your overall portfolio - especially if you're also investing in stocks with high positive betas.

The CAPM equation holds only when *everybody* in the world holds the optimal (tangency) portfolio. But this assumption is not satisfied in the real world, and so, the CAPM equation is not strictly obeyed.

Another problem with applying CAPM in the real world is that we don't know the expected return on any asset or of the market, nor do we know the variance of a given stock. We only know the *past* expected returns and variances. But, who is to say that the future will follow the past trends? If we use the wrong expected values, obviously our "optimal" portfolio (outputted by CAPM) will be wrong.

4.1 Short Sale

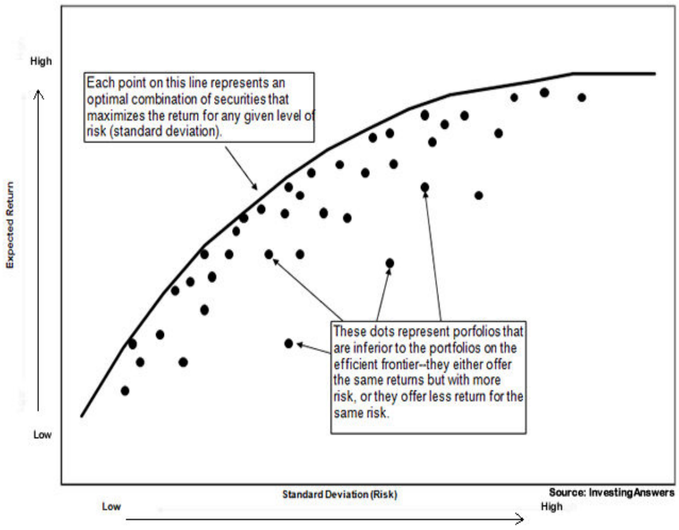
Holding negative amount of an asset is called a **short sale**. Well, how does this work?

It means you borrow the shares and you sell them. So, now you owe the shares to someone else. You would want to do this when you think the price is going to go down. Instead of just not buying it, you buy a negative quantity of it - therefore, betting that the stock price will drop.

CAPM allows the holding of positive or negative amounts of a stock. But if you think about what happens if everybody holds the same optimal portfolio (as assumed by CAPM), everybody would be shorting the same stock, i.e., everybody would be holding negative amounts of the same stock - which does not add up because someone needs to be providing the stock for you to short (but everybody is shorting, so nobody is going to buy the stock). Hence, in equilibrium (on average), shorting does not happen.

4.2 Efficient Portfolio Frontier

Using CAPM, we can plot a graph showing the variation of expected returns of a portfolio vs. the variation of standard deviation of the portfolio, while varying the amount of money you put in each individual asset (i.e., while varying your portfolio).



4.3 Gordon Growth Model

Myron Gordon gave a formula for the present value of a growing quantity.

Suppose we have an asset (say, land) that is producing revenue every year, and the revenue is growing in value. If the growth rate is g, then the yearly revenues would follow a geometric series that looks something like this: $x, x(1+g), x(1+g)^2, x(1+g)^3, \cdots$.

Then, the question is: how much should you pay for this land (in the present)?

Gordon gave a formula to answer this question, and it is:

$$\text{Present Value} = \frac{x}{r-g}$$

where r is the rate of discount or the required rate of return.

This only works when $g < r$ (so the infinite sum $\frac{x}{1+r} + \frac{x(1+g)}{(1+r)^2} + \frac{x(1+g)^2}{(1+r)^3} + \cdots$ converges to $\frac{x}{r-g}$).

It is possible for g (growth rate) to be negative too (this just means that the revenue is depleting by a constant factor every certain period of time). This is important to recognize: even if an asset's revenues are dwindling down to zero, they still have a non-zero present price. That is, **it is not the case that you should only invest in growing businesses. You can make a fortune investing in businesses that are declining too** (as long as you can buy them for less than the present value). By symmetry, you can lose all your money even if you invest in high-growth industries (if you buy their stocks at a price greater than their present value).

The theory behind the Gordon Growth Model (also called the Dividend Discount Model) is that the present-day price of any asset is the sum of all its future dividend payments when discounted back to their present value.

There's an implicit idea here, which is known as **time value of money**. This basically means that money's value is dependent on time (because of inflation). For example, \$10 dollars today will likely be worth more than \$10 dollars after 5 years.

The generic equation for this is:

$$\text{Present Value} = \frac{\text{Future Value}}{(1 + \text{interest rate}\%)}$$

A firm's cost of equity capital represents the compensation the market and investors demand in exchange for owning the asset and bearing the risk of ownership. This rate of return is represented by (r) and can be estimated using the Capital Asset Pricing Model (CAPM) or the Dividend Growth Model. However, this rate of return can be realized only when an investor sells his shares. The required rate of return can vary due to investor discretion. Companies that pay dividends do so at a certain annual rate, which is represented by (g). The rate of return minus the dividend growth rate $(r-g)$ represents the effective discounting factor for a company's dividend. The dividend is paid out and realized by the shareholders.

Chapter 5

Financial Innovations

5.1 Limited Liability

People like gambling when there is a high probability of a small loss and a small probability of an enormous gain. Think of a lottery: people are willing to pay $2 dollars for a minuscule chance (virtually zero) of winning millions of dollars. It's because people savor the small probability - you aren't just paying for the chance to win a million dollars; you're paying for the right to fantasize about winning for weeks.

Limited liability does the same thing for corporate stocks. You put a small amount of money in companies that have a small chance of succeeding (but if they do succeed, you'll end up becoming a millionaire).

So, part of financial innovation is about reframing risks to make them more appealing.

The idea of limited liability is quite simple: investors should have protection against liability for what the managers of the business do, i.e., investors should have limited liability. This was made explicit by a law passed in New York in 1811. It said that investors can never be pursued for the mistakes of the company they invested in. So, investors can buy shares of a business, but they are only liable for what they put in initially. (So, if a company you invested in committed a crime (after 1811), you cannot be asked to pay on their behalf just because you're an investor. Before 1811, you could potentially be sent to debtors' prison if you didn't comply. Interestingly, Massachusetts passed the opposite law around the same time, claiming that investors were responsible for the actions of the business, and they could be considered "party to the crime" itself. Then, businesses just moved from Massachusetts to New York)

Limited liability was an invention; it was an experiment in human nature. We discovered that investor psychology favors limited liability (if you're going to be held responsible for everything a company you invested in does, you might as well not take the risk and not invest at all). Without limited liability, investors overestimate the minuscule probability of loss (just like you overestimate the minuscule probability of winning a lottery ticket).

With limited liability, an investment in a corporation wsa a throwaway item, like a lottery ticket - this is called the lottery effect (according to prospect theory). Essentially, it makes buying shares just as fun as buying lottery tickets (because there's no need to worry - in the worst case, you lose the money you put in, but nothing else happens).

Another effect of limited liability was that it allowed for investors to hold a highly diversified portfolio - not a concept that framers of corporate law were comfortable with back then. If you didn't have limited liability, no one would be willing to have a diversified portfolio (as it would increase the chances of at least one of those companies failing and people coming after you for money).

5.2 Inflated Indexed Debt

History shows many examples of nominal debt being wiped out in real terms by high inflation.

The idea is: why don't we have a price index and have a debt contract that pays back index to inflation (so that it is fixed in real terms)?

For some reason, debt-index took centuries to emerge, and toady there is still no private indexed debt. There is, nevertheless, inflation-indexed debt in USA, and it has spread around the world. With conventional bonds, investors get a fixed interest rate and receive regular interest payments, also known as coupon payments. The latter are in nominal dollars, meaning an amount that is not adjusted for inflation. The bond's principal is returned once it reaches maturity.

The inflation risk for conventional bonds is significant, since rising inflation can erode the bond's value over time.

Inflation-indexed bonds pay a fixed interest rate, offer regular coupon payments and return the principal at maturity. Here's where they're different: The principal is regularly adjusted for inflation, and the fixed-interest rate is applied to the adjusted principal.

5.3 Unidad De Fomento

In 1967, Chile was going through a hyperinflation. To tackle this problem, Chile created a new unit of account. In Spanish, ”Unidad de Fomento” means ”unit of development”. The “Unidad de Fomento” (UF) is an inflation-indexed unit of account, calculated and published by the Central Bank of Chile (BCCh). It is authorized for pricing credit operations in national currency by banks and credit and savings cooperatives.

Money has several functions: it’s a store of value, a unit of account, and a means of transactions. You can separate out those functions: you can have a separate unit of account that is not money.

So, what Chile did was tie the value of UF to the Consumer Price Index, and everyday they would publish the exchange rate between the Escudo and UF. This helped Chile get its inflation under control (at least to some extent).

5.4 Real Estate Risk Management Devices

Values of homes go up and down a lot and people are not protected against these fluctuations. We have home insurance, casualty insurance (that protects you against accidents in your home), so why not protect against the change in value of your home itself?

For some reason, there’s no such risk management device available out there yet. The best way to protect against the value of your home falling would be to short the building’s stock (or whatever company that owns the building) since it negatively correlates with your risk. That is, even if the price of your home drops, you’ll end up making money because you were shorting the stock.

There are other kinds of risks that are not well managed right now too. For example, human capital. What if you spend $500, 000 on your education, only to find yourself being pushed out of your job by a robot after 5 years? How do we protect ourselves against that? (Well, one way would be to short the robot company’s stock.)

Chapter 6

Forecasting and The Efficient Market Hypothesis

Representativeness heuristic - people don't behave like forecasters. They think that something they saw in the past is representative of what will happen in the future.

The **random walk theory** (coined by Statistician Karl Pearson) says that a process is random if it changes in such a way that each change is independent of previous changes and totally unforecastable.

If the market follows a random walk, we expect (on average) that it doesn't deviate from the current state - because on some days it goes up, on others it goes down; but on average, it stays the same. We have no reason to believe it will go up or down - since it is completely random anyway. So, the best guess of the future market is to predict that it remains exactly the same (under the random walk theory).

Psychologically, we are not attuned to understand the random walk of stocks - because that means we have no knowledge (or control) of the future prices, and that is scary.

The random walk equation is: $x_t = x_{t-1} + \epsilon_t$.

An alternative to the random walk model is the first order **autoregressor (AR-I) model**: $x_t = x_0 + \rho(x_{t-1} - x_0) + \epsilon_t$, and the mean reverts to x_0 (initial or current position). Note that ρ is a value between -1 and 1. Imagine the random walk of a drunk man at a lamp post with an elastic band tied to his legs. If he starts walking away from the lamp post in any direction, he gets tugged a little bit back to it, and the further away he goes, the more he is tugged back.

It's hard to tell whether stock prices follow a random walk or an AR-I model.

6.1 Intuition of Efficiency

The idea of market efficiency is that there are so many smart people trying to beat the market and that means that you really can't predict it (because people can get information at the speed of electricity now, which means any new information available to you, is likely also available to everyone else, and they would have already made the necessary trades that would bring the price to its "real" value, in light of this new information). So, maybe the market isn't exactly efficient *just after* new information is released, but it adapts extremely quickly (in a few seconds or minutes). In short, if you read something in the newspaper last week, it's already incorporated into the market prices.

Markets play a crucial role - they are not like gambling at a casino. They provide useful information about the value of a business - how else would you know how much a commodity is worth?

In fact, markets are better knowledge than any individual because it involves so many people putting their money on the line. And then it produces values which are the best estimates of the fundamental values, which then drives businesses and people to make important decisions (like whether to build a new factory or to hire new people or not).

To summarize, as per the efficient market hypothesis, security prices accurately reflect available information, and respond rapidly to new information as soon as it becomes available. Don't misunderstand the efficient-market idea. It doesn't say that there are no taxes or costs; it doesn't say that there aren't some clever people and some stupid ones. It merely implies that competition in capital markets is very tough - there are no money machines, and security prices reflect the true underlying value of assets.

However, the efficient market hypothesis has taken a hit after the financial crisis of 2007-08 (because crises shouldn't happen in an efficient market in which prices accurately reflect value of assets).

There are 3 different forms of efficiencies:

1. Weak form efficiency: prices incorporate information about past prices (so past prices cannot be used to predict future prices).
2. Semi-strong form - incorporate all publicly available information (so public information cannot be used to predict future prices)
3. Strong form: all information, including inside information (so future prices are unpredictable)r.

6.2 Price as PDV of Expected Dividends

PDV: Present Day Value

The idea is that the price of the stock should be the present discounted value of expected dividends.
In general, price $= \frac{\text{earnings or dividends}}{\text{discount factor}}$

If earnings = dividends, and dividends grow at long-run rate g, then by growing consol model, $P = \frac{E}{r-g}$ and so, $\frac{P}{E} = \frac{1}{r-g}$. So, efficient market theory purports to explain why P/E varies across stocks. That is, it would explain differences in price relative to earnings in terms of either the discount rate or the growth rate of earnings. Only then we can say that markets are all priced right - i.e., some stocks have high P/E while others have low P/E and that's okay as long as the r and g explain it.

Some stocks sell at a P/E ratio of 100, which means people are willing to pay 100 times the earnings of the stock. Efficient market hypothesis, in its infinite wisdom, would say that it is either because of very low risk (r) or a very high growth rate (g)

Low $\frac{P}{E}$ stocks does not mean that the stock is a "bargain", it only means that earnings are rationally forecasted to decrease in future.

In other words, the price-to-earnings ratio $\frac{P}{E}$ tells you how much investors are willing to pay per unit of a company's earnings.

Reasons to think markets ought to be efficient:

1. Marginal investor determines prices (the marginal investor is the investor who is most likely to be trading at the margin and therefore has the most influence on the pricing of its equity).
2. Smart money dominates trading
3. Survival of fittest

6.3 Doubting Market Efficiency

Not everyone is equally intelligent.

Efficient market theory is a half-truth. There are a lot of smart people investing. But a lot of that smartness is devoted to marketing and manipulation of your psychology, Ultimately, as humans, we have emotions and we don't always make 100% rational decisions.

The stock market is a leading indicator of the economy, i.e., it has a tendency to fall before a recession.

Chapter 7

Behavioural Finance

Adam Smith, the Father of Economics, said that people have an intrinsic desire to be praised. On the other hand, people don't derive pleasure if you praise them for something they didn't do. As people mature, the desire for praise morphs into a desire for praiseworthiness (i.e., even if everyone doesn't praise you, you are content knowing that they work you've done is praiseworthy in the eyes of some community of people).

7.1 Prospect Theory

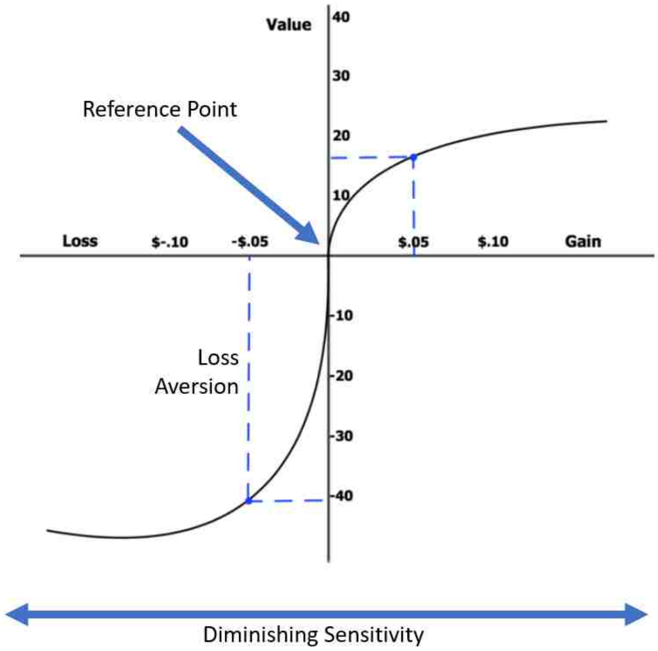
The term "prospect theory" was coined by psychologists Daniel Kahneman and Amos Tversky. This theory criticised the core theory of economics and replaced it with a constructive alternative. The core theory being expected utility theory and the new theory being prospect theory.

Earlier, according to the expected utility theory, economists believed that everyone has a utility function that depends on the things that they consume and it represents their happiness. In general, people act in a manner to maximise their expected utility.

Kahneman and Tversky changed 2 things in expected utility theory.

1. They replaced utility function with a "value" function
2. They replaced the probabilities with subjective probabilities determined by a weighting function in terms of actual probabilities.

One important thing that they proposed was that people make decisions *relative* to their current state. In other words, it's not the absolute amount of utility on any given day that matters. It's the change that causes happiness or sadness. Moreover, they found empirically that losses weigh nearly twice as much as gains - i.e., people are loss-averse in nature.



One implication of this is that people will not take small bets. The fundamental issue is that people view bets as being isolated - not as being a part of a long game. For example, if you're offered a bet in which you'll get paid $1000 if a tossed coin shows heads, and you'll have to pay $500 if a tossed coins shows tails, you would be hesitant. But what if we tossed the coin 100 times and repeated this bet over and over? In that case everybody would take the bet.

The problem is that people panic at little bets, even if they have positive expected value. But it is *irrational* to refuse 1 bet and then be willing to take 100 of those same bets. So, anytime you get a small bet with a positive expected return, you should take it.

We are loss-averse, but at the same time, we have more risk preference to escape losses than to make gains. Let me explain this with an example:
Case 1:

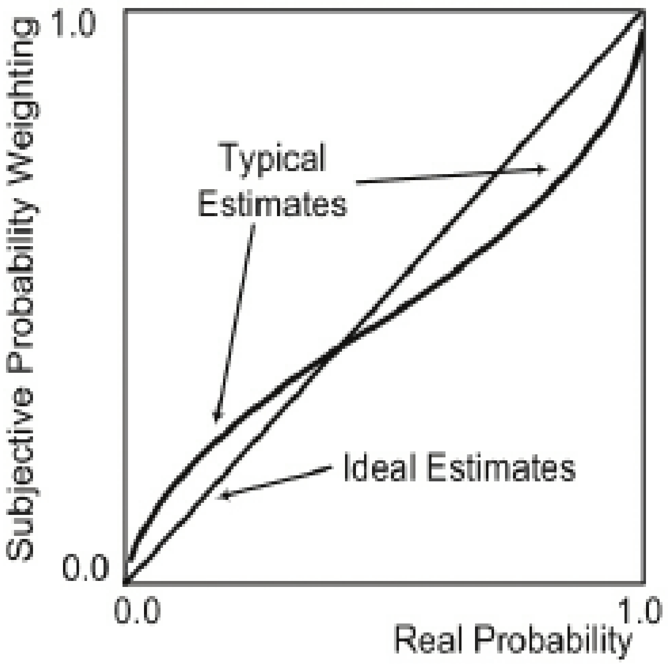
1. 100% chance that you get $100
2. 90% chance that you get $200 and 10% chance that you get nothing

Case 2:

1. 100% chance that you pay $100
2. 90% chance that you pay $200 and 10% chance that you pay nothing

Most people choose option 1 for case 1 but option 2 in case 2. Even though the expected value in both cases is the same for both options, people would rather take a risk to avoid losses (because, the pain of loss is rather not very sensitive to the amount of loss, i.e., the loss stings more or less the same if you lose $100 or you lose $500).

Another aspect of prospect theory is the weighting function. It explains that people don't view probabilities as linear: a 1% chance of cancer is not 1% worse than a 0% chance. Similarly, a 90% chance of winning the lottery is not just 10% worse than a 100% chance. We're hard wired to minimise uncertainty - and we're willing to pay a premium for it.



The subjective probability weighing function is non-linear (as posited by expected utility theory). In fact, it is the *psychologically transformed* probability of a possible outcome.

Also notice that the line stops near 0 or 1 but never actually tells you the subjective probability weighting for such possible outcomes. What it means is for a very low probability, you have a tendency to neglect them completely. Similarly on the upper end, if something has a very high probability, people don't even consider it as a "probability" anymore - they just round it to 1 and consider it a sure outcome.

Actually, people don't deal well with low probabilities. You either ignore it or you exaggerate it. For example, there might be 1 in a million chance of a plane you're on crashing but there will normally be 2 kinds of people - most people don't give it a second thought (ignore it) while few people exaggerate it and believe the odds are much higher than what they actually are.

People are overly concerned with small losses and gains - it's possible to get even a millionaire concerned about a $2 loss (while in reality, you shouldn't even be worrying about it).

Another implication is that people will try to gamble out of losses. If someone loses everything, they'll be more likely to pony up more money to try and win back everything (but obviously, they'll ultimately lose that money too).

In summary, prospect theory is an experimentally based set of knowledge about mistakes that people make.

7.2 Overconfidence

Wishful thinking bias:

- People exaggerate the probability that their team will win
- People exaggerate the probability that the candidate they favour will win.
- About 83% of people think they're above-average drivers.

This bias helps explain why people trade. So many trades occur everyday and you might wonder: why do people need to change their holdings so often? Well, it's because of wishful thinking bias.

There's also a tendency for overconfidence in friends and leaders. For example, every central bank head is thought to be a genius, at least for a while. You might think that all your friends are smarter than average too.

7.3 Cognitive Dissonance

It refers to the mental conflict that occurs when one learns one's beliefs are wrong. Once you make a decision, you kind of identify with that decision and you try to defend it no matter what, even if new information comes to light that reveals that your decision was not the best one. That is, people just want to hear about why they're right; they don't want to hear that a decision they made might have been wrong - they live in avoidance and ignorance (which is really terrible because then you've no way of ever learning from that mistaken decision).

Will Goetzmann and Nadav Peles found that even badly performing mutual funds retain some investors. They hypothesize that investors hang on because they suffer cognitive dissonance since they chose the fund - no one wants to accept that they picked a bad stock which resulted in losses. So, to avoid that internal conflict, they never cash out. In fact, there is a tendency of human thought to try and forget any information that causes conflict with existing beliefs - which is exemplified by the fact that these investors did not remember the poor past performance of this mutual fund. So, our mind just blanks out bad memories of times when you were wrong.

7.4 Mental Compartments

People don't look at the whole portfolio the way CAPM assumed. CAPM theory says that you shouldn't care how each individual stock performs - just look at the expected return and variance of the overall portfolio,

Often, people have 2 portfolios: you have a "safe" part of the portfolio that you would not risk, and a "risky" part of the portfolio that you can have fun with.

7.5 Attention Anomalies

Attention is a fundamental aspect of human intelligence and its limits. You can't pay attention to everything.

There's a social basis for attention too: you tend to pay attention to the same things that other people pay attention to. This creates a possibility that a particular stock will be overpriced - if everybody is focusing on it.

7.6 Anchoring

Anchoring is a tendency in ambiguous situations to allow one's decisions to be affected by some anchor (which can be known to be completely arbitrary and random).

Stock prices are anchored to past values.

7.7 Representativeness Heuristic

People judge things by similarity to familiar types, without regard for base rate probabilities.

There's also an innate tendency to see patterns in what is really a random walk.

7.8 Disjunction Effect

It is the inability to make a decision that is contingent on future information.

People who took one of Samuelson's famous lunch colleague bet (flip a coin: heads you win $200, tails you lose $100) were asked if they would take another. Most took the second bet whether or not they won the first. But most would not take the second bet before the outcome of first was known.

This means that people can't understand how they'll feel later. They don't anticipate their future emotions. So, they can't work through a decision tree correctly.

7.9 Magical Thinking

This is a term coined by B.F. Skinner in 1948.

It was used to describe pigeons, not humans. He had hungry pigeons in cages and they had a mechanical feeder that would drop one pellet of food every 15 seconds into the cage. What he found was that the pigeons started doing bizarre things like dancing around or stomping their feet - because they thought that those actions were the reason that the pellet drops. Then they *learned* that their actions cause the pellet to drop (since a pellet would drop every 15 seconds after they would be stomping) - similar to confirmation bias.

7.10 Quasi-Magical Thinking

People have reason to believe that their decision affects some already pre-determined outcome or a random outcome. For example, people bet more on a coin not yet tossed. People pay more for a lottery ticket in which they choose the number.