AF4 2023/2024
Risk and Risk Management

Being able to identify and manage risk is a key skill that will be tested throughout AF4 and of course is an essential part of an investor's skillset.

The milestones for this part are to understand:

- What is risk
- The main risks found in different investment classes and products
- How to measure volatility using Standard Deviation and Beta.
- The difference between systematic and non-systematic risk
- The difference between positive and negative correlation
- The principles of Modern Portfolio Theory
- The Capital Asset Pricing Model and its limitations
- The concept of the efficient frontier
- The limitations of investment theory and the concept of Behavioral Finance

What is risk?

To many individuals risk signifies danger, something to be avoided. Risk is present in any situation when:

The outcome of an action or decision may be different to what was expected.

If the outcome is certain then there is no risk.

The outcome might be better than expected or it might be worse than expected. In other words, risk is neither negative nor positive, it simply means the outcome is uncertain.

Every financial adviser has met a client who claims they don't want to take any risk. What concerns them is **Capital Risk**; that they may lose money and get back less than they put in. As a result they prefer to remain in cash.

However, cash is not a risk free Investment. Whilst the nominal value will not fall it is subject to **Inflation Risk.** If interest rates are below the rate of inflation, the real or purchasing power of the deposit will fall. If the interest is used to supplement their income savers are subject to **Interest or Income Risk.** Should interest rates fall their income will reduce. They are also subject to **Provider Risk**, the risk that the bank or deposit taker could fail although this is mitigated by the Financial Services Compensation Scheme.

Even “Guaranteed Rate” products are not risk free. Whilst the investor knows what they will get inflation may reduce its true value and if rates increase they might have got better return elsewhere.

The only investments that could be called risk free are possibly National Savings Indexed Linked Certificates. The amount invested will maintain its real value plus a small bonus but there is still an **Opportunity Cost** in that better returns may have produced a better return.

All asset classes are exposed to one or more of these risks.

Capital Risk: The value of the investment will fluctuate
Inflation Risk: The real value of the capital or income will be eroded by inflation.
Income Risk: The income that is being paid will fluctuate.
Interest Rate Risk: The interest rate will change
Currency Risk: The value of assets denominated in another currency will change due to changes in currency rates
Shortfall Risk: the risk that the investments will not attain its target amount
Provider Risk: The risk that the product provider fails
Counterparty Risk: In a product such as an option, the other party to the deal cannot deliver their end of the bargain
Liquidity Risk: The risk that the investor cannot turn their assets into cash

Volatility

An increase in capital can only be achieved if an asset’s value fluctuates up and down. Over the longer term the hope is that the overall trend is upwards but without volatility there can be no growth.

Volatility can be measured by an asset’s (or funds) Standard Deviation **(SD)** and its **beta**

Standard Deviation

The starting point is to calculate the mean or average performance. This may be given to you but it may form part of the question so we’ll go through it now.

The past performance of an investment is measured over a term and the number of times how often each performance is recorded. A probability rating is applied to each possible result.

For example, an investment could have had the following returns over the past 20 years

Annual Return	Number of times this happened
5%	4
10%	7
15%	6
20%	3

From this we can calculate the **probability** of similar returns being achieved in the future

A 5% return was achieved in 4 of the last 20 years so we can say that there is an 4 in 20 chance of this being achieved. The probability is 0.2 (4/20)

The probability of getting a 10% return is 0.35 (7/20)
The probability of getting a 15% return is 0.3% (6/20)
The probability of getting a 20% return is 0.15% (3/20)

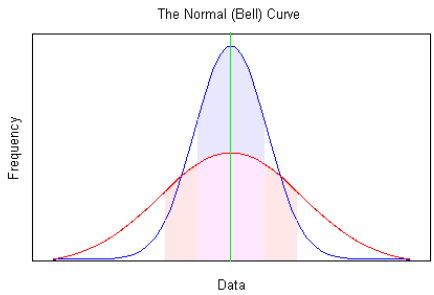
Note that all probabilities must add up to 1

We can now calculate the **weighted probability** by multiplying the annual return by the probability of it happening. Using this method, we get:

Return r	**Probability** p	**Weighted Probability** r x p
5%	0.2	1.0
10%	0.35	3.5
15%	0.3	4.5
20%	0.15	3.0
Total		12.0

The **mean** or **expected return** is 12%

The range of outcomes can be plotted on a graph. The most common event becomes the highest point and the graph turns into a classic bell shape.



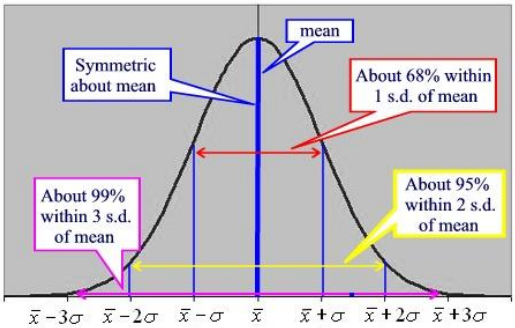
In this chart the blue line shows a situation where all the outcomes are close to the average This would have a low SD. As the range of outcomes becomes wider the curve becomes flatter and the SD increases.

SD is a key tool in statistics and forms the basis of opinion polling. These typically interview a random selection of say 200 people and extrapolate that over the whole population. This is possible because mathematically the probability of future returns or events can be predicted as follows:

68% of the time the actual return is expected to be between the mean +/- 1 SD
95% of the time the actual return is expected to be between the mean +/- 2 SD
99% of the time the actual return is expected to be between the mean +/- 3 SD

This is not predicting the precise return nor the minimum or maximum return, it is simply predicting the range of possibilities.

This can be shown in the diagram below:



Don't worry too much about some of the symbols.

If the mean is 5% and the SD is 8% this means that over a 100 year period:

- in 68 years we would expect the return to be between -3% and 13%
- in 95 years we would expect the return to be between -11% and 21%
- in 99 years we would expect the return to be between -19% and 29%

Clearly no individual investor will have a 100 year investment horizon and we could scale it down to a 10 year view. However, it's also worth looking at this in another way. If this theory is true in practice there should only be a return worse than minus 19% once in every 100 years. That might be sufficiently rare to make it worth accepting.

Each step up in the table above is called a sigma event so the possibility of getting a result between mean +/- 3 SD is called a 3 sigma event. As we have seen that is a rare event that should happen once in a 100 years. In the run up to the 2008 banking crisis financial mathematicians had constructed a trading formula that stated that the chances of catastrophic loss on any one day would be a 6 sigma event. That is one day in 4,039,906 years. A catastrophic event then happened several days in a row and wiped out the bank.

Working out standard deviation

This has been tested a couple of times so it's better to be prepared!

The formula is:

$$\sigma_X = \sqrt{\frac{1}{n}\left\{\sum_{i=1}^{n} X_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} X_i\right)^2\right\}}$$

However for non mathematicians we can break this down into four steps.

1. Work out the mean (average) of the returns.
2. Subtract the mean from each return and square the result.
3. Work out the mean (average) of the squared differences.
4. Calculate the square root of that figure.

The last three year's performance of a fund has been as follows:
3.2%, -0.85%, 4.1%
Calculate the SD

Step 1: Work out the mean (average) of the returns.

3.2%+ -0.85% +4.1%/3 = 2.15%

Step2: Subtract the mean from each return and square the result.

$(3.2\%-2.15\%)^2 = (1.05\%)^2 = 1.10\%$
$(-0.85\%-2.15\%)^2 = (-3\%)^2 = 9\%$
$(4.1\%-2.15\%)^2 = (1.95)^2 = 3.80\%$

Step 3 Work out the mean (average) of the squared differences.

1.10% + 9% +3.8% = 13.93%
13.93%/3 -= 4.64%

Step 4: Calculate the square root of that figure.

√4.64% = 2.15%

There are limitations to using SD.

- It is a difficult concept for the average client to grasp.

- It is based solely on past data and as advisers always make clear, “the past is not necessarily a guide to the future.” However, the past is our only guide and if an asset has consistently returned between 3% and 5% why should it be expected to suddenly produce a return of 18%?
- For the extrapolation of the range of future returns as shown above, the sample must be selected at random. Opinion pollsters go to great lengths to ensure that their interviewees have been selected at random and there is no selective bias. It can be argued that past investment returns aren’t purely random. Each step up in the table above is called a sigma event so the possibility of getting a result between mean +/- 3 SD is called a 3 sigma event. As we have seen that is a rare event that should happen once in a 100 years. In the run up to the 2008 banking crisis financial mathematicians had constructed a trading formula that stated that the chances of catastrophic loss on any one day would be a 6 sigma event. That is one day in 4,039,906 years. A catastrophic event then happened several days in a row and wiped out the bank.

Beta

SD measures the volatility of a security against its past performance. Beta measures volatility against a benchmark.

The most common benchmark used in the UK is the FTSE 100 index. That is given a Beta of 1. If a security reflects absolutely the performance of the index its beta would also be 1. If a security is less volatile the beta is less than 1 and is expressed as 0.xxxx. If it is more volatile than the index its beta is more than 1 and expressed as 1.xxx.

Here are some examples as at August 12 2014, January 2018 and December 2022 sourced from the FT

	August 2014	January 2018	December 2022
Tesco	0.728	0.9651	0.8458
Barclays	1.78	0.779	1.6665
BP	1.67	1.2213	1.1508
Marks & Spencer	1.07	1.1096	1.9689
Glaxo	0.4914	1.1629	0.5794

The main use of beta is to identify volatility and therefore select securities that match the client’s attitude for risk. It can also be used to extrapolate future performance.

Following this theory, based on the 2022 figures, if the index went up by 10%:

- Barclays shares to rise by 16%.
- Glaxo shares would rise by 5,78%

If the index fell by 10%

- Barclays shares would fall by 16%.
- Glaxo's shares would fall by 5.78%

As with SD, beta is based purely on past performance and there is no agreed method of calculating it particularly the period of past performance that is used. As can be seen from this table the beta of Barclays and Glaxo have changed significantly over eight years.

Share prices and its benchmark don't necessarily move in the same direction. Someone buying M&S shares in August 2014 bases purely on its beta might have assumed that they would have received roughly the same return as the FTSE 100 but in the subsequent years they have experienced a greater fall than the benchmark.

Controlling and managing risk

The main way of controlling risk is to have a diversified portfolio. In plain English; don't put all your eggs in one basket.

The value of all assets, other than cash, will always fluctuate. This volatility arises from:

- Systematic Risk
- Non-systematic Risk

These should not be confused with **systemic risk.** That is defined as an event that could trigger a collapse in an industry or economy.

The total risk in any portfolio is the sum of systematic and non-systematic risk

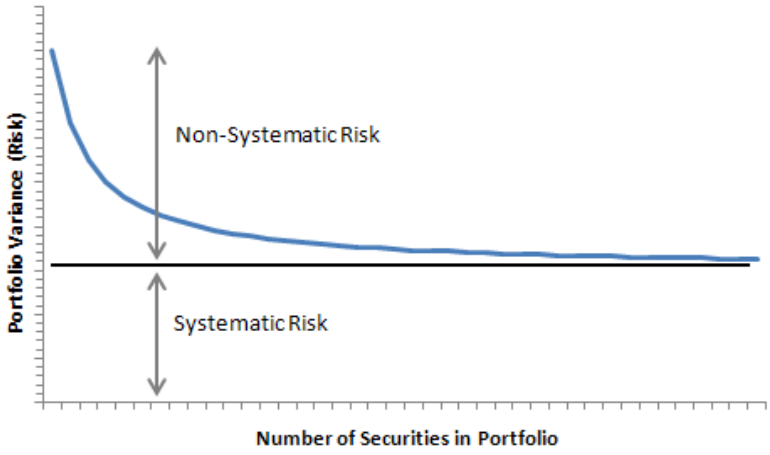
Systematic risk, also known as **market risk**, is the inherent risk of being in assets that fluctuate in value. **Non-systematic risk** is the risk to a particular security. Some examples are:

- A drugs company withdraws its best-selling drug because of reported side- effects.
- A food manufacturer is prosecuted for poor hygiene standards
- A mining company reports that one of its mines has less potential than predicted.

All of these would tend to reduce the company's share price but would not affect the share price of any other company. This distinction is important because it shows the limitations of diversification

Systematic risk cannot be reduced by diversification. A portfolio could hold every share listed on the London Stock Exchange but it would still be vulnerable to falls in the market.

Diversification can though reduce non-systematic risk.



In this chart the vertical axis represents the risk of the portfolio and the horizontal axis the number of securities in the portfolio. As the number of securities in the portfolio increases the level of Systematic risk stays the same because no matter how many shares are held in the portfolio this risk cannot be reduced.

The downward curved line represents non-systematic risk which reduces as the number of securities in the portfolio is increases. The reduction in non-systematic risk is high when the first securities are added but as more are added the reduction is lower. Some argue that the optimum number of securities should be 25 to 35 as there is no significant reduction in risk after that point. There are some limitations to this

Whilst holding 25 to 35 securities will reduce the level of non-systematic risk, it does not follow that the portfolio will produce the market return. If the average beta of all the securities was higher than 1, the portfolio should produce a higher return in a rising market and a higher loss in a falling one. If the average beta was lower than 1 the opposite should happen. A lower return in a rising market and a lower loss if the market fell.

Similarly an investor holding 25 to 35 stocks could still have a significant exposure to non-systematic risk.

In 2019 an investor self-selected a portfolio of 30 shares that was mainly invested in retailers, leisure companies, hotel groups and airlines.

Following the coronavirus outbreak the portfolio suffered losses greater than the market

To be fully effective the assets in a portfolio, whether investing directly or using collectives, should be negatively correlated.

Positive and negative correlation.

The way that two assets move in relation to each other is called **correlation**. This can be:

- **Positive correlation:** This is when different stocks are affected by similar factors and tend to move up and down together.
- **Negative correlation:** This is the opposite and means that stocks tend to move in opposite directions in response to economic factors.
- **No correlation:** This is where the returns on different investments are not connected and we are unable to make a direct comparison as to how they react to economic factors.

As a rough rule of thumb, if the same event is good for one business but bad for another the assets will be negatively correlated. For example, if the price of oil goes up that is good for an oil company but bad for a transport company. Shares in an oil company and a transport company would be negatively correlated.

Shares in a bank and a property company will tend to have positive correlation. Property companies borrow heavily from banks but if the property company fails that will mean the bank will have to write off those loans.

The most effective diversification comes from combining investments whose returns ideally move in the opposite direction to one another, or if in the same direction, at least not to the same extent.

There is published data to show the correlation of different assets. This is based on past performance which may not of course be repeated in the future.

- Perfect positive correlation is shown as +1
- Perfect negative correlation is shown as -1

If you had two assets that had perfect positive correlation then if the first increased by 10% then the second would also rise by 10%. If there was perfect negative correlation then if the first increased by 5% the second would fall by 5%.

Most correlations fall somewhere between these two points as in this table

	X	Y	Z
X		0.4	- 0.3
Y	0.4		-0.7
Z	-0.3	-0.7	

X is positively correlated to Y but negatively correlated to Z

Y is negatively correlated to Z

The numbers help us to predict how the change in one might result in a change to the other so:

If X increases by 10% we would expect Y also to increase by 4%
If Y increases by 10% we would expect Z to fall by 7%
If Z fell by 10% we would expect X to increase by 3%

Problems in assessing correlation

As with Standard Deviation and beta correlation statistics refer to historic data and may not necessarily be a guide to future performance. The problem is that if assets no longer perform as expected how can the correlation of investments be assessed?

It has always been a basic principle of financial planning that Bonds and Equities were negatively correlated. If shares rose investors would shun Bonds as they provided lower returns. Conversely in times of uncertainty investors would move to Gilts and Bonds as they could provide more secure returns. In short share prices fall, bond prices rise and vice versa. However, in recent years both share and gilt prices have risen.

Pre covid, historic data on shares in oil and aviation companies would show them to be negatively correlated as a rise in the price of oil is good news for an oil company but bad news for companies running an airline business. In the initial impact of the Pandemic shares in both fell as travelling was effectively banned and with less demand the price of oil fell.

Pre covid there could be an argument that shares in pharmaceuticals and cruise companies were positively correlated. Both could benefit from an aging population that would push up demand for drugs and also increase the popularity of cruise based holidays. Covid sent shares in pharma soaring and cruise company shares crashing.

What can be deduced from this is that identifying which asset class or sectors will be negatively correlated in the future is getting more difficult. This is important because holding negatively correlated assets is one of the cornerstones of **Modern Portfolio Theory.**

Modern Portfolio Theory

Whilst this is called "Modern Portfolio Theory" it dates back to 1952. The key principles are:

- The key to achieving good returns is identifying the best asset allocation rather than selecting individual stocks. In other words, the starting point should be to identify what percentage of a portfolio should be in cash, bonds, equity or property.
- Given that we can identify the client's risk appetite it is possible to construct a portfolio that will give the highest level of return. Alternatively given a client's desired return, a portfolio can be constructed that will deliver this at the lowest level of risk
- Portfolios should mainly consist of assets that have negative correlation

One of the central principles of MPT is the **Capital Asset Pricing Model**

Capital Asset Pricing Model (CAPM)

CAPM is a tool that aims to predict the possible return on an investment. It should not be seen as an accurate predictor but rather as a way investors can assess whether it is likely to deliver the return they require.

The starting point is that no rational investor would invest in anything that delivered a return that was lower than a "risk free" return. What that rate should be is open to debate but is usually taken as being in the UK, short term Treasury Bills or even 10 year gilts

In the CAPM formula this is compared with the "market return". In the UK this is probably going to be the FTSE 100. The difference between the market return and risk free return is called the **risk premium**, in other words the extra return an investor demands for taking more risk. A practical problem is the market return and over what period should it be calculated.

So far then we have two factors:

- Risk free return
- Market return

These two are fixed amounts. The final factor and the one variable is the beta of the security.

Formulas tend to frighten many candidates as they seem to be written by mathematicians to intimidate everyone else. Therefore, it will probably be easier if it is written in full rather than using abbreviations or symbols:

Expected return = risk free return + Beta (market return less risk free return)

Here's how it would be calculated.

Risk free return = 4%
Market return 5%
Beta = 0.75

ER = 4% + 0.75(5%-4%)
ER = 4% + 0.75 x 1%
ER = 4% + 0.75%
ER = 4.75%

Therefore, if the investor was looking for a return of 7.5% this share might not be suitable.

CAPM has been criticised because it is too simplistic and based on unrealistic assumptions. These are:

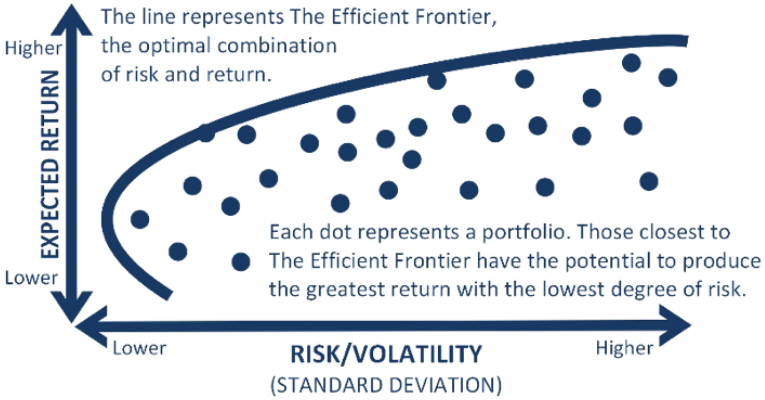
- All investors are rational making decisions on the basis of risk and reward
- All investors have identical holding periods
- There are many buyers and sellers and no one can influence the price
- There are no transaction costs.
- Information is free and available to all
- All investors can borrow, and unlimited amounts can be borrowed at the risk free rate
- Liquidity of any asset can be ignored

Studies have also shown that the actual returns made by different securities do not reflect what was predicted by CAPM. A further objection to CAPM is that it is a single factor model in which the only thing that changes is the beta of the security. Other models such as the **Arbitrage Investment Theory** are multi models since the return on an asset is not just determined by its beta but also by inflation, risk premium, industrial production and interest rates.

Another outcome of MPT is the concept of the **efficient frontier**

Efficient Frontier

In assessing individual assets or portfolios the two key elements are expected return and risk measured by its standard deviation. As the risk increases we would expect the return to increase. Shown on a graph it would look like this.



The curve rises as the amount of risk increases. The expected return rises rapidly at first but as risk increases the subsequent gain in expected return becomes less.

The optimal portfolio will be the one whose expected return lies on the curve, the efficient frontier. A portfolio can be considered efficient if it is not possible to obtain a higher return without increasing the risk. It is inefficient if the expected return can be increased without increasing the risk.

The basis of MPT is that the combined effect of the assets in a portfolio is what matters, not the risks and returns of the individual investments within the portfolio.

Although this theory uses rigorous and proven mathematics it does have its drawbacks:

- Models rely on past risk and correlation data and therefore may not predict the optimum portfolio for the future.
- It relies on investors being able to decide on the exact level of risk they are prepared to take.
- An optimized portfolio only takes account of risk and reward. It does not cater for any other client's needs such as income

Is it just a theory?

MPT is, in some ways, common sense. No one would dispute that it makes sense to have a diversified range of assets. However, much of risk theory is based on the premise that both individual investors and markets behave rationally. Some economists argue that this is not true, that investors and markets are swayed by emotion. They argue that the two key drivers of markets are **fear and greed.**

Past performance does seem to bear this out. There are many examples of sectors or companies coming "into fashion" and their share price starts to soar. New investors pile in on the "fear of missing out" which pushes the price up further. Then the fundamentals of the business are questioned, the enterprise is seen to be built on sand and the share price crumbles.

Here is a short experiment that indicates most individuals tend to act emotionally rather than rationally.

Two individuals are told that a donor will split £100 between them. The conditions are:

- The donor will decide how it is split
- Both recipients must agree to accept their share otherwise nothing is paid.
- The offer is final and neither can rearrange the share.

The donor offers £99 to one and £1 to the other
Naturally the one receiving £99 agrees but usually the one offered £1 refuses and nothing is paid out.

By refusing £1 individuals are acting irrationally. They would be £1 better off and if this was given to them as a gift they would accept but because it seems unfair that the other person got £99 they refuse.

The belief that individuals do not always act in a rational way has developed into a concept called **Behavioural Finance.** This states that when individuals make decisions they are influenced, either consciously or unconsciously by various biases which will now be considered.

Herding

This is the tendency for private individuals and fund managers "to follow the crowd". In August 2020 Amazon and Tesla were two of the best performing shares in the US. They have since fallen but how many investors were buying shares because everyone else was doing it?

It might be argued that a fund manager whose fund is benchmarked to the S & P 500 would be acting irrationally by not buying the shares. They may collapse at some point in the future

but in the meantime the investors will complain about the poor performance compared to other funds.

The danger with herding is that individual investors only come in when the market is at its peak then panic and sell when there is a downturn. This is an example of another bias, loss aversion

Loss Aversion

It's normal that most of us want to avoid making a loss. This can stop individuals investing in non-cash assets until prices have reached a peak.

It may also cause investors to panic when there is turbulence, as in the immediate aftermath of coronavirus, and liquidate everything. Conversely if they hold an asset that is steadily falling they will refuse to sell and make a loss on the grounds that it might recover.

Another manifestation of loss aversion is that losses make individuals more unhappy than making the equivalent gain. Having assets that are negatively correlated makes sense but by definition some will fall in value or not make as bigger gain. The loss averse investor tends to focus on the losses. Of course, this bias may be as a result of personal experiences. Perhaps they lost money during the dotcom boom or put their money into split capital investment trusts.

Confirmation or hindsight bias

Both private investors and fund managers are prone to this. Having taken a view that an asset class will always perform in a certain way or that a strategy or investment approach does not work, this becomes an article of faith. This is compounded by what is termed **confirmation bias.** Any research or article that supports this view is welcomed as further proof of their belief, anything that goes against it is dismissed as being irrelevant.

Hindsight bias occurs when an adverse event occurs and "experts" claim the reason was obvious and provide a detailed explanation which may or not be correct. This could lead individuals to reason that the advice given to them was incorrect or that if they change their behaviour to fit the new theory then they will prosper.

Overconfidence bias

Studies show that individuals overestimate their ability. They put any success down to their ability and failures are down to bad luck. It also manifests itself in the cult of the "star fund manager".

Misunderstanding of probability

Most people are not good at calculating probabilities. For example. if the winning lottery numbers are a set of consecutive numbers it's seen as a rare event but the probability of it happening is exactly the same as any other sequence. If probability is not understood investors may avoid investments with a low probability of high loss.

Anchoring

This gives too much weight to certain numbers. For example if the FTSE 100 goes below 7,000 it is seen as being significant but in reality it is of no more consequence than any other number.

Some investors might see that a company's share price is 960p whereas the price of another company in the same sector is 300p. The latter might seem to offer better value but the share price on its own tells us nothing about the worth of the business

Endowment effect

This usually occurs when an investor already owns an asset or has inherited it and they have an emotional attachment to it. They are reluctant to sell it even though the performance has been poor
That concludes this part so you should now understand:

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- The main risks found in different investment classes and products
- How to measure volatility using Standard Deviation and Beta.
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