Portfolio theory

1. Introduction

1.1. Chapter overview

This chapter begins by defining what we mean by **returns**. Broadly speaking returns are your income and gains as a percentage of your investment. However, you will see that there is more than one way of calculating returns. Different methods considered include **holding period return**, **money-weighted** and **time-weighted**. You will learn the advantages and disadvantages of each method.

The level of returns generated on an investment is not all you should consider. **Risk** is also an important consideration. A low risk investment is one which gives fairly constant returns. A high risk investment is one in which returns are highly variable. Investors who are willing to take on high levels of risk expect high levels of return. This chapter introduces two methods of measuring risk, **standard deviation** and **Beta**.

Standard deviation is a measure of risk on a standalone basis. Another measure of risk for assets in a portfolio is **Beta**, which measures risk relative to other investments. Put simply, the Beta of a stock or portfolio describes how its returns perform relative to a base index. Identifying the appropriate risk measure is critical to assessing performance.

Beta is a vital component to a formula known as CAPM. Once you have mastered this formula you will be able to predict the level of return a particular stock should achieve, given the level of risk taken on. It is one of the most fundamental formulae in investment theory.

Finally, you will learn about risk adjusted measures of performance. A fund manager who achieves a 12% return is not necessarily better than a fund manager who achieves a 10% return. Returns are only half the story.

1.2. Learning outcomes

On completion of this module, you will:

Portfolio considerations

- 15.6.3 Distinguish between strategic and tactical asset allocation

- 15.6.4 Explain the major investment styles prevalent in the fund management industry Socially responsible investing and Environmental social governance investing

- 15.6.5 Explain socially responsible investing (SRI) and environmental social governance investing (ESGI)

- 15.2.1. Identify the correlation between the various asset classes (equity, fixed income, property, cash and alternative investments) and explain its relevance to asset allocation

- 15.2.2 Explain the limitations of correlation analysis in extreme market conditions

- 15.5.1 Explain the relationship between pricing, liquidity and fair value for the asset classes of equity, fixed income, derivatives and alternative investments

- 15.5.2 Identify, explain and calculate transaction costs associated with dealing in:

  - UK equities

- Fixed income securities

- Derivatives

- Alternative investments

- 15.5.3 Evaluate the impact of alternative trading platforms, facilitated by MiFID, on transaction costs associated with equity dealing

- 15.5.4 Contrast trading methods for fixed income securities with equities and analyse the impact on trading costs

Passive vs. active fund management styles

- 15.6.2 Distinguish between active and passive fund management and explain the costs and benefits to the investor

- 15.1.6 Explain tracking error and its limitations

- 15.6.1 Distinguish between a 'top-down' and 'bottom-up' approach to fund management

- 17.1.5 Explain how returns are decomposed and attributed to equities (sector / stock / interaction)

The efficient market hypothesis (EMH)

- 15.4.1 Identify and explain the key concepts of the EMH

- 15.4.2 Explain the limitations of the EMH

- 15.4.3 Evaluate the evidence on market anomalies in relation to EMH

Behavioural finance

- 15.4.4 Explain the basic concepts of the behavioural finance school of thought

- 15.4.5 Evaluate the evidence on market anomalies in relation to behavioural finance

- 15.4.6 Explain the concept of 'financial amnesia' and the role of behavioural factors in its promotion

- 15.4.7 Explain the notion of 'bubbles' in financial markets

Performance measurement

- 17.1.1 Explain the importance of returns analysis in the portfolio management process

- 17.1.2 Identify the components of total return for a bond or equity portfolio

- 17.1.3 Calculate the income, capital and total return over a single period for an equity or bond portfolio

- 17.2.1 Identify the data requirements to calculate a money-weighted return; and time-weighted return

- 17.2.2 Calculate and interpret the money-weighted return or time-weighted return from data provided

Risk and reward

- 15.1.13 Analyse and explain other types of investment risk including inflation, currency, interest rate, fraud and counterparty risk

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- 15.3.4 Define the segmentation of risk into systematic (factor) risk and unsystematic ('investment specific') risk

- 15.3.5 Calculate the total risk given systematic and unsystematic components

Measuring risk

- 15.1.4 Identify the commonly used measures of risk in investment analysis and fund management

- 15.1.5 Explain the shortfalls of standard deviation as a measure of investment risk

- 15.1.9 Explain the importance of correlation in constructing efficient portfolios and the difficulties, limitations and meaning of correlation coefficients

- 15.1.11 Explain diversification and its role in constructing efficient portfolios and its limitations during extreme market conditions

- 15.3.7 Explain how the historic beta may be estimated using a scatter chart of historic returns

- 15.3.8 Calculate the beta of an investment given the systematic risk of the investment and the risk of the market

- 15.3.9 Calculate the beta of an investment given the variance of the market return, and the covariance of the investment return with the market return

- 15.3.10 Calculate the beta of a portfolio given the component betas and the investment weightings

- 15.1.7 Explain the meaning of drawdown as a measure of risk

- 15.1.12 Explain the meaning of Value at Risk (VaR) and its advantages and disadvantages for risk management

- 15.1.8 Explain the impact on changing levels of price volatility over time and how this affects predictions such as tracking error and downside risk

Capital Asset Pricing Model (CAPM)

- 15.3.1 Explain the concept of investments being exposed to a number of common factors which partially explain their return and risk profile ("arbitrage pricing theory")

- 15.3.2 Identify the assumptions behind the single-factor Capital Asset Pricing Model (CAPM) and identify other factors in common use

- 15.3.3 Explain the limitations of the CAPM model

- 15.3.6 Calculate the expected return on a security by applying the CAPM through interpreting the beta of a security

Risk adjusted performance measures

- 17.4.1 Explain the importance of risk analysis in performance evaluation

- 17.4.2 Calculate and interpret the following risk adjusted measures of return: the Sharpe measure; the Treynor measure; the information ratio; Jensen's alpha

- 15.1.1 Explain the 'normal' trade-off between risk and return and the concept of 'dominance' between investment strategies

- 17.4.3 Explain how total return can be decomposed into the following: risk-free return, return due to choice of benchmark, return due to market timing, return due to diversifiable risk, pure selectivity

- 15.1.3 Explain the importance of risk-measurement in the analysis of investments, and why ex-ante and ex-post measures of risk may be very different

Bond portfolios

- 15.7.3 Calculate duration for a bond portfolio

Management of bond portfolios

- 15.7.1 Explain the following bond portfolio management techniques: cash matching /dedication, immunisation, credit risk management, riding the yield curve

- 15.7.2 Calculate the theoretical gain from riding the yield curve

- 15.7.4 Explain the benefits and risks of using barbell and bond portfolio strategies

- 15.7.5 Explain the benefits and risks of an Liability drive Investment (LDI) strategy

- 15.7.6 Explain the process of a liability driven investment strategy

- 15.7.7 Evaluate some of the techniques and basic measures of risk used in LDI

2. Portfolio considerations

2.1. Background

Portfolio construction refers to the activity of collating and managing a collection of different assets, e.g. shares, bonds or real estate.

A fund/portfolio manager working on behalf of a financial institution, such as a unit trust or pension fund, is responsible for ensuring the fund is managed in the best interests of the underlying investors. To this end, the fund/portfolio manager takes into account their investment objectives and manages the portfolio accordingly.

The following factors are taken into account when determining the most suitable asset mix of the fund:

Risk

Different investors are prepared to take on different levels of risk. The role of the fund manager is to attempt to **diversify** risk to an acceptable level. The aim of diversification is to **optimise** the risk/reward trade-off.

Liquidity

Some investors require the ability to convert their investment into cash at very short notice. These funds will consequently invest more heavily in short-term instruments, such as Treasury bills and short-term deposits.

Growth

Funds investing for **future** gains, rather than immediate returns will have a higher proportion of their capital tied up in equity securities rather than bonds. In particular, equities in companies that re-invest profits, rather than pay out dividends, will be attractive to a fund with growth objectives.

2.2. Management style

Traditionally the two main management styles have been growth and value, although other styles have also evolved including small cap, market orientation and socially responsible. The main features of each are summarised below.

Value funds

Fund managers aim to identify undervalued shares. The selection criteria used vary, but can include low price/earnings ratios, high dividend yields, and low price to book and price to sales ratios.

There are a number of sub-styles within the value category:

• Investors seeking stocks with low P/E ratios including those in defensive and cyclical sectors

• **Contrarian** investors looking for companies with low share prices in relation to their book value. These firms are expected to experience a cyclical rebound or company turnaround

• A **conservative** approach looking for high yielding stocks expected to maintain or increase dividends

Growth funds

In this category the manager is looking for companies with high growth prospects generally reflected by a high P/E ratio.

Market orientated funds

These do not have a bias towards growth or value, instead tending to relate more closely to the market average over the business cycle.

Socially responsible investing (SRI)

Although not a specific style, this strategy certainly drives the stock selection process. SRI introduces personal values and social issues into the decision-making process. Two key issues of SRI are:

- Screening: including or excluding securities due to social/environmental criteria such as ignoring an energy company that contributes to depleting the world oil supply

- Shareholder advocacy: active involvement by shareholders to encourage corporate responsibility

Socially responsible investing is also sometimes referred to as **environmental social governance investing** (ESGI).

2.3. Choice of asset classes

Introduction

The key decision for any investor and for the adviser of that investor is which asset classes to choose and in what combination. The client's investment policy statement (IPS) will provide clear requirements such as:

- The required return

- The specified level of risk

- The required level of liquidity to meet spending

Investment mix

Most retail investors' portfolios are often constructed using a mix of cash, stocks and bonds. Alternative investments such as commodities and private equity, although attractive, have traditionally been used by institutional rather than retail investors.

However, with the advent of exchange-traded funds specialising in not just equity indices, but also commodity indices, this element of investment is becoming much more accessible. REITs, authorised property unit trusts or even property income certificates (PINCs) give indirect exposure to property investment. In addition to all this, there are always the collectibles mentioned earlier in the chapter.

All of these can be combined to create a diverse portfolio, where the correlation of returns is reduced through the variety of investments, and regional markets, chosen.

Investment correlation

The approximate correlations of returns between differing asset classes can be seen in the table below:

Table 18. Investment correlation summary table

-	Cash	Gilts	Equity	Commercial Property	Market Neutral Hedge Funds
Cash	1.0	0.2	0.03	-0.09	0.29
Gilts	-	1.0	-0.2	-0.05	0.06
Equity	-	-	1.0	0.18	0.28
Commercial Property	-	-	-	1.0	-0.03
Market Neutral Hedge Funds	-	-	-	-	1.0

Extreme market conditions

Correlation analysis and creating diversified portfolios is undoubtedly good practice. However, it must be noted that in times of extreme market conditions, these established relationships do break down and many assets become strongly positively correlated.

We see this in times of economic uncertainty and crisis, and in times of great optimism.

2.4. Pricing and transaction costs

Introduction

In general terms, costs can be associated with the trade itself, the clearing of that trade and the settlement of that trade. Certainly when referring to exchange-traded securities, the bulk of the cost lies mostly with the trade itself. Studies show that at the time of writing, this is less the case with multilateral trading facilities (MTFs) and dark pools where the cost associated with the trade itself tends to be lower, and so takes up less of a proportion of the total costs.

Markets – how securities are traded, cleared and settled – is a matter for Unit 1 – Investment Environment. However, we do need to be aware of the relationship between pricing, liquidity and fair value as well as associated costs in this unit.

Pricing

We have seen that the pricing of investments, such as units in open ended funds, is relatively easy. We take the net asset value of the portfolio and divide it by the number of units in issue. However, the price of most investments are determined by supply and demand. Supply is generally something that cannot be controlled by investors, so demand has the greatest impact.

Pricing through demand is dictated by the price at which a buyer and seller will agree to trade. The ease with which these buyers and sellers can trade is often determined by the number of buyers and sellers willing to participate and the ease with which they can communicate their ideas on price.

Exchanges like the London Stock Exchange provide a central market place for financial investments. There are exchanges for securities and exchanges for derivatives. These provide central meeting places where buyers and sellers can meet and exchange ideas on price. Where there is agreement between buyers and sellers, a trade occurs.

The more buyers and sellers there are, the greater the capacity for price discovery on the investment. Hence there is a strong link between liquidity and price discovery.

Fair value is also a concept used in pricing. We have looked the fair value of equity and bonds using discounting methods. We also looked at fair value of derivatives through the assessment of the price of the underlying asset plus the cost of carry.

However, many accounting standards have a different assessment, where fair value is the value at which two parties willing agree to transact. Typically this will be a quoted price on an adequately liquid market (a mark to market price). However, where this does not exist, a similar asset trading on a liquid market could be used. Where this is not possible, a more assumption based price can be used (a mark to management price).

However, the price is not all we pay. We also need to consider costs.

Costs

Costs can be divided into explicit costs, which are those that are obvious to the trader, and implicit costs, which are those that may be hidden.

The explicit costs of trading

Commission is charged by brokers on equity, ranging anywhere from 10 to 20 basis points for large institutional trades to between 100 and 150 basis points (1.5%) for smaller trades. There is also a 10% withholding tax on dividends, which is non-reclaimable.

Commission on gilts is typically between 0.5% and 1% for trades below £5,000 nominal value, and for larger trades above £1 million nominal value there is often no commission at all.

Stamp duty on certificated shares at 0.5% rounded up to the nearest £5 and stamp duty reserve tax (SDRT) on dematerialised shares at 0.5% rounded up to the nearest 1p. Market makers are exempt from this charge. Also exempt from this charge are securities that trade on the LSE's Alternative Investment Market (AIM).

The POTAM levy to fund the Panel on Takeovers and Mergers will also be payable on some trades. £1 on all purchases and sales in excess of £10,000 is charged. Market makers are exempt from this charge.

The implicit costs of trading

The **bid-offer spread** reflects the difference between what a market maker will buy the stock for and what he will sell the stock for. As the client, we will be on the losing side of this spread.

The trade itself can have an impact on the price of the security. Market makers know this and limit the size of the trades they are willing to honour their bid-offer spreads. Beyond this size limit they are permitted to adjust their prices to reflect this potential price impact. This is known as the price impact of a trade.

Opportunity cost could be a result of bad timing or inability to find the funds. If an opportunity is identified, but not taken advantage of, the opportunity cost arises.

MiFID

The Markets in Financial Instruments directive set out a variety of rules in relation to financial activities and investments. This included rules that related to the trading venues that these instruments trade on. Since it's implementation there has been rapid growth of both trading channels (e.g. LSE, BATS, Chi-X Europe, Turquoise) and trade clearing venues (e.g. LCH.Clearnet, EMCF, EuroCCP). This has tended to result in reduction of the explicit costs of trading although the effect on implicit costs is still open to debate.

3. Passive vs. active styles

3.1. Passive fund management

A passive style means that the fund manager attempts to replicate the returns to a pre-determined benchmark, such as a market index, e.g. FTSE 100.

Managers of passive funds subscribe to the Efficient Market Hypothesis (EMH). EMH states that the market price of a security is correctly priced and will have already discounted all available market information.

If the EMH is true, then it is not possible to identify mis-priced securities in order to outperform the market.

The rationale, therefore, behind passive management is 'if you can't beat them, join them'; instead of wasting time looking for mis-priced stocks to beat the market return, a fund manager should replicate the market in their portfolio. A portfolio that replicates the market is known as a **tracker fund**.

Tracker funds

A FTSE 100 tracker fund is a portfolio designed to replicate the returns of the FTSE 100. There are a number of ways of achieving this; the most obvious is called **replication** (buying **all** of the FTSE100 shares in the index), as well as **stratified sampling** (buying only the most influential FTSE 100 shares within each sector of the index) **synthetic** (buying FTSE 100 futures and holding cash in the bank) and **optimisation** (using historic analysis to determine which stocks have most accurately tracked the index in the past).

Advantages of passive funds include their low cost relative to active funds, and relatively little management time once set up.

One major disadvantage of passive funds, however, is that they follow bear as well as bull markets. Consequently, if prices (and indices) are falling, no action is taken to avoid a similar fall in the fund.

Tracking error

Note, that there is usually an element of 'tracking error' inherent in passive funds. This results in the fund not achieving exactly the same return as the relevant index. Tracking error may occur due to:

• Costs. The fund will incur costs, such as stamp duty (in the UK) and brokerage or commission, when buying and selling shares. The index itself does not experience any costs; it is simply an average of the share prices

• Changes in the constituents of the index being tracked. The FTSE 100, for example, is reviewed on a quarterly basis by the London Stock Exchange. Although the index reflects any changes immediately, it is not always possible for a passive fund manager to re-construct their portfolios as quickly as the index itself

Tracking error can be assessed as:

Tracking error = total return of portfolio - total return on benchmark.

It may more accurately be calculated as the standard deviation of the returns on the portfolio and the returns on the benchmark.

Tracking error may be positive or negative. If the fund has outperformed the benchmark it will be positive. If it has underperformed it will be negative. Tracking error is often within +/- 50 basis points (i.e. 0.5%).

Setting tracking error limits has both advantages and disadvantages. The restrictions reduce the volatility of the fund to a similar level as the benchmark reducing potential losses. However, it also reduces potential gains and restricts the ability of the fund manager to make positive returns in a falling market.

3.2. Active fund management

There are certain stages in ensuring a portfolio is managed efficiently. The first decision the fund manager makes is with respect to the asset mix of the portfolio, (i.e. shares vs. bonds). For example, income-seeking portfolios invest more heavily in bonds, whilst growth-seeking portfolios invest a higher proportion of the fund in equities. This process is known as **asset allocation** (or **strategic allocation**). Once the strategic allocation has been set (e.g. fixed interest 80%), the next stage is the **tactical allocation** where ranges are specified around the strategic level to enable market timing adjustments to be made by the manager (e.g. fixed interest 70-90%).

The usual process is to decide on asset allocation before focusing on stock selection and market timing. This is called a **top-down** approach.

Top-down

Top-down management involves three stages:

- Asset allocation

- Sector selection

- Stock selection

Asset allocation

The manager will choose what investment mix will be included in the portfolio. This was discussed in the previous chapter. In essence, the manager will look at the proportion of cash, equity, debt and other asset classes within the portfolio.

Asset allocation can be strategic or tactical.

Strategic asset allocation is the long-term allocation created by the manager.

Some of the extra returns by the active manager may be achieved through **tactical asset allocation** (also called **market timing**). Here the fund manager uses their discretion to make small changes to the asset allocation of the fund in order to take advantage of short-term market shifts.

For example, the fund may have a strategic asset allocation of 50% equities and 50% bonds. If the fund manager felt that an equity bear market was imminent they may decide to alter the allocation to 45% equities and 55% bonds. The fund manager's discretion will be constrained within limits agreed initially and reviewed periodically.

Sector selection

Some sectors, such as the technology markets and financial markets, are more sensitive than the markets as a whole. They have high Betas and are considered aggressive stocks that perform well in a rising market. Utility companies tend to be less sensitive than the markets. They have low Betas and are considered defensive stocks performing less badly in falling markets. The manager will need to construct a weighting that he believes will take the best advantage of the current environment.

Stock selection

This involves seeking out mis-priced securities in order to buy undervalued and sell overvalued stock. Stock selection and market timing are therefore particularly important when an active strategy is adopted.

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We will see methods of assessing overvalued and undervalued stocks, such as Jensen's Alpha, later in this chapter.

The joint impact of the timing effect and selection is called the **interaction effect**.

Fundamental analysis

Fundamental analysis is the process of identifying stocks that are undervalued by looking at the underlying investment.

Technical analysis

Technical analysis (or **charting**) focuses on the market rather than the features of the stock. Technical analysts will seek to identify trends in price movements, seeing these trends as indicators of human behaviour. By predicting these trends they hope to outperform the market.

Bottom-up

Some fund managers avoid making a conscious asset allocation decision and move directly into choosing individual shares and bonds that best suit their investment needs. This process is called a **bottom-up approach**.

A bottom-up approach to management focuses on the attractions of individual stocks. Specific company factors, such as whether the company is a takeover target or about to launch an innovative product, are important.

This, in effect, removes the asset allocation and sector selection as primary factors and focuses instead on stock selection often from an event driven or tactical trading basis.

3.3. Tilting: an active/passive hybrid

Some fund managers employ a mix of passive and active strategies. For example, a fund can base its return on a chosen index but may 'tilt' the fund away from the index by using modest active techniques, such as stock selection. This hybrid strategy is known as tilting, or enhanced indexing.

Interestingly, enhanced indexing compares favourably with pure active or passive management styles. In many studies it provides a higher risk adjusted return. However, the main problem with this strategy is deciding where the balance between active and passive should lie.

3.4. Decomposing excess returns

Returns that differ from the benchmark can be caused by many factors. Primarily, these will be:

- Asset allocation – the effect that tactical asset allocation may have had on the returns

- Currency – the effect of currency movement if the assets are invested overseas

- Stock selection – the manager's ability to select undervalued/overvalued stocks correctly

- Interaction – the impact of trading the stocks actively

Return on asset allocation **plus** return on currency exchange **plus** return on stock selection **plus** return on interaction **equals** total return.

We saw a similar decomposition with bonds in the debt valuation chapter. In summary:

- Yield to maturity effect **plus** Interest rate effect **plus** Sector/quality effect **plus** Residual effect **equals** Total return

It is worth pointing out that all factors may not work in favour of the manager, and may contribute negative values.

Summary

Achieving excess returns, however, is difficult to achieve as the relatively high costs of managing an active fund often corrode the extra return achieved by the fund itself. Various studies suggest that, in the long-term, most active managers tend to underperform the market.

4. The Efficient Market Hypothesis

4.1. What do we mean by 'efficient markets'?

A hypothesis is a theory, an idea of how something works. In this case it is an idea or hypothesis about how stock markets work in relation to new and existing information.

If a stock market is perfectly efficient it has certain properties:

• All investors and market participants will have perfect information about each company in the market

• There will be no point in carrying out research on a company because everyone else will already know this information and it will be already priced in by the market

• In a perfectly efficient market there would be no transaction costs

• In a perfectly efficient market there would be no earnings surprises because investors would know the information already

The question is: *are our real life stock markets perfectly efficient*? The answer is most probably no.

4.2. The Three Forms of the Efficient Market Hypothesis (EMH)

The Efficient Market Hypothesis has three forms:

• The Weak Form

• The Semi-strong Form

• The Strong Form

Each form has its own definition of an efficient market. It is important to know each of the three definitions.

The Weak Form of the EMH

The weak form states that the current market price already reflects all historic share price information. If this is true, there is no benefit in looking at historic stock price charts and graphs as everyone else already knows this information.

So the weak form contradicts Technical Analysis – it says looking at past prices for patterns won't work. The fact that people do use technical analysis may indicate that in real life our markets are not perfectly efficient – even at the weak form of the EMH.

The Semi-strong Form of the EMH

The semi-strong form states that the current market price already reflects not only all historic share price information, but also all other publicly available information.

This means that carrying out research about a company's activities and its products will also be of no use, as all other market participants already know the information.

The Strong Form of the EMH

The strong form states that the current market price already reflects not only all historic share price information, all additional publicly available information, but also all private information.

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Private information is 'insider' information, i.e. information known only within the company that is likely to be material (would affect the share price), and not yet released to the markets. The EMH is very bold to suggest that the market has already priced in this private information when the market won't be aware of it yet.

So it is very unlikely that the strong form of the EMH holds, as material insider information is not known to the market and is not likely to be currently priced into the share.

EMH conclusions

The main conclusion is that real life markets are not perfectly efficient. There is some evidence that some aspects of the EMH do hold, but there is also some evidence to the contrary.

We could also conclude that real life markets vary in their efficiency. The larger and more liquid the market the more efficient it is e.g. the FTSE 100 or the S&P 500 should be fairly efficient. This is because larger markets have many analysts following the larger companies so there are fewer surprises (of course these still do happen).

On the other hand, fewer analysts follow the smaller less well known companies, especially those based in lesser followed markets around the world. These markets are often less efficient but at the same time also carry their own specific risks.

5. Behavioural finance

5.1. Behavioural finance

Real life markets are not perfectly efficient, and one key source of market inefficiency is the irrational behaviour that can be exhibited by human beings when interacting with one another within a financial marketplace. Behavioural finance is the field of study that attempts to identify examples of such irrationality, in the hope of better understanding the way in which participants within markets actually act, rather than how models suggest they ought to act.

Irrational decision-making takes place in two key ways. Firstly, investors do not always process information properly, and secondly, even given correct information processing, investors sometimes take sub-optimal decisions with that information.

Examples of information processing errors include:

• **Memory bias**, where investors give too much weight to recent experience compared to prior beliefs when forecasting

• **Overconfidence**, whereby marketplace actors overestimate the precision of their forecasts or beliefs

• **Conservatism bias**, referring to investors being too slow in updating their beliefs when confronted with new evidence

• **Sample-size neglect**, which is where investors infer wider population behaviour from too small a sample of data

Examples of decision-making errors include:

• **Framing bias**, in which the way information is presented to the investor (or 'framed') influences the decision the investor then makes, even though there is no rational grounds for such influence

• **Regret avoidance**, whereby investors resist realising losses on their investments, in the potentially futile hope that their losses will be recovered and thus ultimately avoided

5.2. Financial Amnesia and asset price 'bubbles'

One form of such irrational behaviour that can often arise due to a prolonged period of sustained economic growth is 'financial amnesia', which results in asset price 'bubbles' becoming built up in the marketplace.

Financial amnesia is a situation in which financial market participants behave in such a way as suggests they have forgotten the financial lessons of the past, and this can affect both investors, institutions and regulators. Asset prices can become divorced from the fundamental drivers of their value. For example, property prices rise far beyond those which rental income can support, or share prices rise much more quickly than company earnings. Yields become so low that investors can only continue making money if prices continue to rise – and a so-called 'asset price bubble' has been formed.

So what is it that causes such financial amnesia, and the pervasive belief that investors typically have, that somehow 'this time it's different', causing the rise of such bubbles? There are three key drivers that theorists typically point to:

• **Incentive structures**, whereby senior managers within the financial services industry are incentivised to take decisions that are detrimental to the wider financial system. Lack of accountability and short-termism can exacerbate this problem

- **Moral hazard**, with the wider economy carrying the cost of excessive risk taking by the financial services industry

- **Behavioural finance biases**, such as cognitive dissonance (that is, ignoring evidence that things might be going awry in the marketplace, and bubbles might be inflating), groupthink, herd-like behaviour, overconfidence and regret avoidance

Although to some extent financial amnesia and the growth of asset price 'bubbles' is inevitable, they can be guarded against through sound corporate governance, strong and proactive regulators and an education and appreciation of the history of the financial marketplace.

6. Performance measurement

6.1. Background

It is important that investors, and other interested parties (e.g. trustees of pension funds/unit trusts), are able to monitor the performance of a fund in order to evaluate the manager's performance.

Assessing performance requires the ability to measure the return that a fund has achieved for its clients.

This section focuses on three different methods used to measure portfolio performance:

• The Holding Period Return (HPR) - sometimes referred to as 'Total Return' or 'Holding Period Yield (HPY)'

• The Money Weighted Rate of Return (MWRR)

• The Time Weighted Rate of Return (TWRR)

Before looking at these measures in more detail, note that these measures do **not** take into account the risk that the fund being evaluated has been exposed to.

Consequently, these measures have limited use when comparing the returns on funds with different risk profiles (**note**: risk-adjusted measures are considered later).

6.2. Holding period return

The holding period return (HPR) measures how much the portfolio has increased in value over a particular time horizon.

The HPR identifies the change in value of the fund as a percentage of the start value.

In other words:

$$\text{Holding period return (HPR)} = \frac{\text{End value - Start value}}{\text{Start value}} \times 100\%$$

Although the holding period return is a relatively simple measure to understand it does suffer from the limitation of **not** taking into account the timing of cash flows in, and out of, the fund, i.e. withdrawals and deposits.

Consequently, it is not a particularly useful measure for assessing the returns achieved from open-ended funds, such as unit trusts, OEICs or pension funds where regular cash flows in/out of the fund are a major feature.
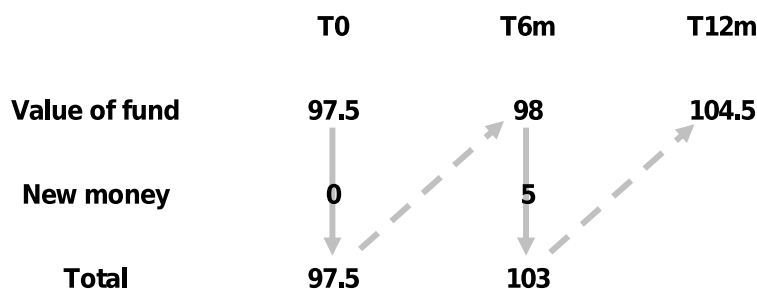
6.3. Money weighted rate of return (MWRR)

The MWRR is used to measure the performance of a fund that has experienced deposits and withdrawals during the period being measured. It is also sometimes referred to as the internal rate of return (IRR) of the fund.

For example, assume a fund starts the period with a value of £97.5m that grows to £98m in six months. At this time, a further cash injection of £5m is deposited. At the end of the twelve-month period, the value of the fund has grown to £104.5m.

Therefore, the total return over the twelve-month period is the rate at which £97.5m for twelve months **plus** £5m for six months has grown to £104.5m.

In other words:

	T0	T6m	T12m
Value of fund	97.5	98	104.5
New money	0	5	
Total	97.5	103	

The money weighted rate of return, r, may be calculated using the equation below along with trial and error:

$$£97.5m(1+r) + £5m(1+r)^{0.5} = £104.5m$$

The £5m was only in the fund for half the total period; it is therefore only raised to the power of 0.5

Trying 0.02 or 2%:

$$£97.5m(1+0.02) + £5m(1+0.02)^{0.5} = £104.5m$$

The money weighted rate of return is 2.00% for the twelve-month period.

As a method of comparing one portfolio's performance against another, the money weighted rate of return is only valid if both portfolios received/withdrew cash **at the same time**, because the timing and the size of the flows will affect the rate of return.

For example, if a client injects cash into the fund at an unfavourable time, the MWRR will tend to be depressed. However, if cash is injected into the fund at a favourable time, it will have the effect of boosting the MWRR.

The MWRR should therefore be used with caution when comparing one fund manager's performance with another.

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6.4. Time weighted rate of return (TWRR)

The money weighted rate of return is designed to take some account of cash inflows and outflows but can still be affected by the timing and size of flows into and out of the fund. This overstates returns when the fund does well and understates returns when the fund does badly. The time weighted rate of return gets around the problem of the money weighted rate of return because it is unaffected by the timing of cash flows into (or out of) the fund.

It is calculated by measuring the change in the value of the fund before the cash injection (or withdrawal), and multiplying this by the change in value after the injection (or withdrawal). This means that the TWRR gives **equal weighting** to the timing of the cash flows.

In the example below the increase in the fund's value before the cash injection is 0.51% (i.e. the fund is 1.0051 times its original value) and after the injection it has increased by 1.46% (1.0146 times its original value) giving an overall increase of 1.98%:

	T0	T6m	T12m
Value of fund	97.5	98	104.5
New money	0	5	
Total	97.5	103	

The time weighted rate of return for the twelve-month period may be calculated using the equation below:

$$\left[\left(\frac{98}{97.5} \times \frac{104.5}{103} \right) - 1 \right] \times 100\%$$

$$\left[\left(1.0051 \times 1.0146 \right) - 1 \right] \times 100\%$$

$$\left[1.0198 - 1 \right] \times 100\%$$

$$0.0198 \times 100\% = 1.98\%$$

Notice that this figure (1.98%) is very similar to that calculated for the money-weighted rate of return (2.00%). This is because there is only one cash-flow into the portfolio, exactly half-way through the period. Had there been several cash-flows, with variable timings, the two figures calculated would have been materially different to one another.

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The fact that the time weighted rate of return is not influenced by the timing of cash deposits and withdrawals makes it a **preferred** measure of fund performance compared to the money weighted rate of return.

7. Risk and reward

7.1. The risk and reward connection

In the investment world it is important to see the connection between risk and reward. The concept of taking risk with the potential to reap rewards is at the heart of all investing.

Taking on a higher level of risk may have the potential for greater rewards but also the potential for greater losses. Higher risk investments normally have higher volatility i.e. a wider range of returns; some of them very good and some of them very bad.

But what if we are not prepared to take a risk? We'll see in this chapter that we need to clearly define which risks are acceptable to investors and the degree of volatility that an investor is prepared to accept.

If an investor wishes to avoid market risk they need to scale down their return expectations to that of the risk-free return. Such investors should also bear in mind that inflation is a hidden risk that erodes the value of their investment.

7.2. Risk premium

What is a risk premium?

A risk premium is the additional return over a risk-free return needed to compensate an investor for taking on the risk of an investment.

For example, an equity risk premium needs to compensate equity investors for:

- The potential variability of stock returns; whilst we hope there are upside profits, there could also be downside losses

- The potential variability of income in terms of dividends

- Giving up immediate access to the funds invested

A fundamental concept in investments is that the riskier the investment the higher the risk premium demanded from investors. For example, venture capital is a particularly risky alternative investment as money is invested in new start-up companies. Therefore the risk premium for venture capital is higher than for more traditionally established equities.

7.3. Systematic risks

What are systematic risks?

Systematic risks affect the financial system as a whole. Because these risk factors affect the financial markets as a whole, they are also sometimes collectively referred to as market risk.

It is very difficult for investors to accurately predict the nature of systematic risks over the short-term, medium-term and long-term. Some investments are more sensitive to the following systematic risks than others.

- Interest rates

- Inflation

- Liquidity

- Currency

Interest rates

The Bank of England sets the level of interest rates in the UK as a monetary tool to manage inflation. In the investment world, changes in interest rates can have a positive and negative effect on differing types of investments. The risk is that the change has a negative impact.

Here are some common effects of interest rate changes:

- Savers with variable interest rate deposits benefit from rate increases and lose from rate decreases

- Savers with fixed rates are protected against interest rate decreases but lose out on interest rate increases

- Fixed income securities such as gilts and bonds generally rise in price from interest rate falls and fall in price from interest rate rises

- Coupons from fixed income securities can be re-invested at higher rates when interest rates rise and at lower rates when interest rates fall

- Companies often find their debt repayments rise when interest rates rise, putting pressure on operating profits and perhaps slowing down new projects and expansion plans

- When interest rates rise, consumers find their mortgage payments go up leaving less to spend - which in turn affects the retailers' profits as we are spending less in the shops

Inflation

Inflation can be damaging to bonds, as the value of fixed future cash flows will be worth less in real terms. Index linked gilts, of course, have some inflation protection.

Inflation is not good news for equities either as companies see the prices of their costs rising, putting pressure on margins and profits.

Investments that often do benefit from high inflation are commodities. As commodity prices rise, so commodity investment returns rise as well.

Liquidity

Liquidity is about being able to sell or buy at a fair market price. The liquidity of any market is determined by the number of buyers and sellers at any time, the volume of trades and the costs of trading.

In a liquid market, it is easy to buy and sell and assets are likely to trade closer to their fair (intrinsic) value. However, if this liquidity dries up and there are far fewer buyers around, a seller may be faced with accepting a reduced market price or having to keep on holding the investment.

In extreme market conditions, it may be very difficult to liquidate a position at all.

Currency

How many of the items we buy are made in the UK? Think about our clothes, our computers, our phones, our cars, toys, even nowadays our food. Many of these are imported from abroad.

Investors are increasingly creating global portfolios to have the opportunity of benefiting from good companies wherever they are.

When we, as a UK investor, invest abroad in a foreign currency we now have two risks to consider:

- Will we make or lose money on the foreign investment itself?

- Will we make or lose money when we come to convert the foreign currency back to sterling?

Even if we make money on our foreign investment in the foreign currency, we may end up losing overall if the foreign currency has depreciated relative to sterling.

UK companies are also exposed to currency risk. For example, if a UK firm is importing raw materials and sterling depreciates, the raw materials will effectively become more expensive as it will take more pounds to pay for them.

7.4. Unsystematic risks

What are unsystematic risks?

Whereas systematic risks are risks that affect the financial system as a whole, non-systematic risks are risks specific to a particular business. All businesses are unique and have their own specific risk factors such as:

- Business risks

- Industry risks

- Management risks

Business risks

What are the elements that contribute to a successful business? Good products and services, skilled and committed staff, the right location, successful ideas, manageable costs, financial strength in difficult times and a strong market for the company's products and services.

Business risk is the risk that any of these elements become unfavourable and uncompetitive, leading to reduced profits.

Industry risks

Each industry carries its own specific risks that affect all companies in the industry. For example, in the airline industry health and safety issues are paramount and are quite different to health and safety issues in the banking industry.

Management risks

When a company performs well, growing its profits, increasing its market share and creating happy customers, it says a lot about how it is being managed – the management must be doing something right.

7.5. Systemic risks

Systemic risks are risks, which, if realised, can cause a cascading effect across the 'system' and lead it into crisis. It is the systemic risk of banks being 'too big to fail' that led to the recent financial crisis and governments having to rescue banks to protect the whole financial system. One of the International Organisation of Securities Commission's (IOSCO) main principles set down for national and international regulators is the reduction of systemic risk.

7.6. Other risks

Other risks worth mentioning for the exam are:

• Fraud risk

• Counterparty risk

Fraud risk

Fraud is a deception deliberately practiced in order to secure unfair or unlawful gain. The financial markets are an environment in which fraud can exist quite comfortably. Financial investment are not fully understood by many of the people investing in them and what seems like a gilt-edged opportunity can turn out to be far from it. The Financial Conduct Authority (FCA) in the UK and all other financial regulators attempt to clamp down on fraud and warn consumers about the dangers. There are many forms of fraud that an investor can be subject to. The FCA has particular warnings about:

• Share fraud and boiler rooms

• Land banking schemes

• Unauthorised firms

• Commodity schemes

It must be noted that not all schemes offering these services are fraudulent, but they do often focus around market where transparency is poor.

Counterparty risk

This is the risk of the person that you have agreed to trade with defaults on their obligations. We saw in the derivatives chapter that this risk is greater over-the-counter, as most exchanges have strict systems to ensure settlement occurs.

8. Measuring risk

8.1. Standard deviation

The risk of a fund's constituents is a key consideration when constructing a portfolio of assets. The higher the return the fund manager is seeking to achieve, the greater the risk he or she must be prepared to take.

Risk is measured as the variability of returns around an expected level. If the expected level of return is calculated as the average return (i.e. the mean), then the risk is measured as the standard deviation of returns over time.

Because it measures the level of dispersion from an expected/average value, the standard deviation is a measure of the **total** risk of an individual security.

A security with low risk will have returns that do not fluctuate significantly around its mean (average) return, and will consequently have a smaller standard deviation.

Alternatively, a security with high risk will have returns that do fluctuate significantly around its mean (average) return, and will therefore have a larger standard deviation.

Standard deviation as a measure of risk
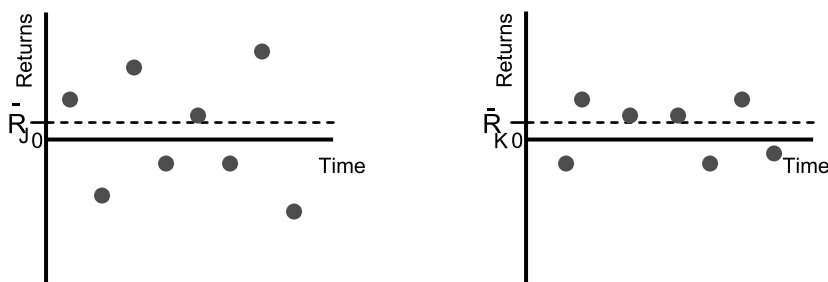
Stock J is clearly more risky than Stock K.

The standard deviation around the mean ($\bar{R}_J$) will be larger for stock J.

Standard deviation (σ) is used to measure the comparative risk of stocks.

The above illustration demonstrates that Stock J is a riskier security than Stock K due to its larger standard deviation of returns.

Problems with standard deviation

There are a number of criticisms of standard deviation as an indicator of risk:

• It is based on historical returns, which may not be representative of future patterns

- It is a measure of upside movements as well as downside movements. An investor is likely to only be concerned with the downside

- It assumes that upside is equally as likely as downside

- Volatility generally is not a complete measure of risk

- Autocorrelation can result in quoted standard deviation being lower than the true risk. Autocorrelation is defined as future returns being significantly related to current returns and is particularly prevalent in assets such as property

There are a number of alternative measures which include:

- Semi-variance: similar to the variance but only considering returns that fall below the mean over the period. This is therefore a downside measure of risk

- Probability of a shortfall: this states the chance of a return over a period falling below a specific level

- Expected shortfall: a measure of the expected loss at a given probability level. Perhaps calculating the expected loss in the worst 5% of cases

Other measures of risk are discussed later in this section.

8.2. Specific vs. systematic risk

As mentioned above, the standard deviation of returns (for an individual stock) is a measure of its **total risk**. The risk associated with investing in risky assets derives from the fact that there is uncertainty about the future cash flows from that asset.

Total risk - as measured by the standard deviation of returns - can be broken down into two component parts: **specific** and **systematic** risk.

i.e. **total risk = specific risk + systematic risk**

For example:

An analyst has calculated that a share has a total standard deviation of 34% and the specific risk element has been calculated as 31%. Calculate the systematic risk.

Answer: Total risk (as var) = systematic risk (as var) + specific risk (as var)

Let s^2 be the systematic risk in variance terms:

$$34^2 = s^2 + 31^2$$
$$s^2 = 34^2 - 31^2$$
$$s = \sqrt{34^2 - 31^2}$$
$$= \sqrt{1156 - 961}$$
$$= \sqrt{195}$$
$$= 13.96 \ \text{i.e.} \ 13.96\%$$

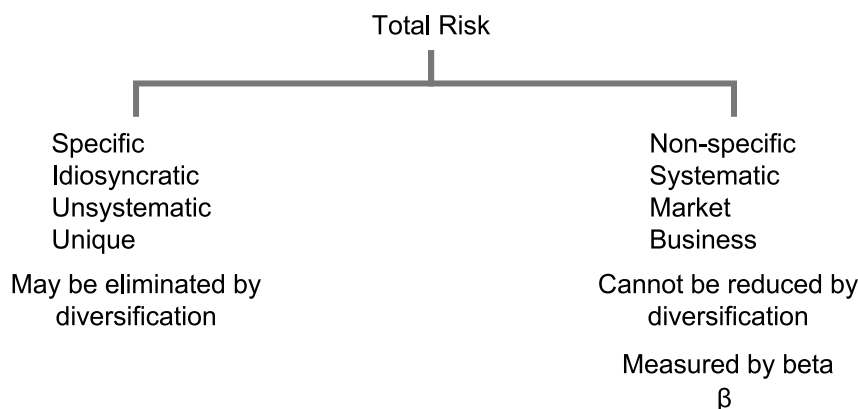## 8.3. Risk and diversification

The aim of diversification is to optimise the risk/reward trade-off. This is achieved by adding stocks to a portfolio which are **not** perfectly correlated with one another (i.e. the returns do not move in perfect harmony with one another).

By adding stocks, it is possible to reduce the overall standard deviation of the portfolio. This is because specific risk is reduced by diversification.

Diversification reduces specific risk because the positive and negative individual characteristics of each asset tend to cancel each other out.

It is not, however, possible to eliminate the risk associated with macroeconomic and political factors. Consequently, systematic risk cannot be diversified away completely. Of course, systematic risk can be **reduced** by diversifying globally, as some of the systematic risk factors in, say, the UK market are not necessarily the same as in other markets. Even so, a globally diversified portfolio can only reduce systematic risk to a 'world systematic risk' level.

The remainder of this section assumes that portfolios achieve the appropriate level of diversification where specific risk has been diversified away. The fund manager is therefore only concerned with the systematic risk of the portfolio.
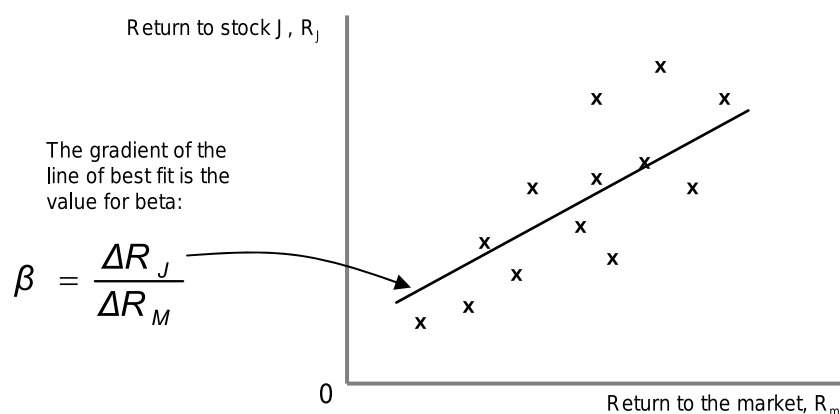
```
                              Total Risk
                                  |
            ┌─────────────────────┴─────────────────────┐
        Specific                                 Non-specific
        Idiosyncratic                            Systematic
        Unsystematic                             Market
        Unique                                   Business

        May be eliminated by                     Cannot be reduced by
            diversification                          diversification

                                                 Measured by beta
                                                        β
```

Beta coefficient

Portfolio managers assess systematic risk by measuring the Beta of a security.

Beta is defined as the 'sensitivity of a stock's return to the return on the market portfolio'.

In other words, Beta measures the (systematic) risk of a security **relative** to the systematic risk of the market as a whole.

The Beta for a given stock is determined by constructing a scattergram of returns achieved by the stock against the returns achieved by the market.

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Return to stock J, R_J

The gradient of the line of best fit is the value for beta:

$$\beta = \frac{\Delta R_J}{\Delta R_M}$$

0

Return to the market, R_m

By using a technique called 'regression analysis', a line of best fit is drawn between the points on the scattergram. The gradient of this line is the stock's Beta:

- If the gradient/Beta is greater than 1, the stock is **more** volatile than the market as a whole, i.e. a Beta of 1.2 reflects 20% more volatility than the market portfolio

- If the gradient/Beta is less than 1, the stock is **less** volatile than the market as a whole, i.e. a Beta of 0.7 reflects 30% less volatility than the market portfolio

- If the gradient/Beta is equal to 1, the stock has the **same** volatility as the market as a whole

Alternatively, the information in the scattergram may be used to express Beta in a more statistical way:

$$\beta = \frac{\text{Covariance} \, (R_J R_M)}{\text{Variance} \, R_M}$$

Where variance = σ^2

The measure of covariance between the return on the stock ('R_j ') and the return on the market ('R_m') indicates the extent to which the two 'move' together.

Since total risk includes systematic and non systematic risk it can be decomposed to calculate the beta. The formula for total risk is as follows:

Variance of portfolio return = $Beta^2$ x Variance of return on the market + Variance of unsystematic risk

Example

For example, a stock with a total variance of return of 100 and unsystematic variance of 40 would have a beta of 1.41 if the market variance was 30. This could be calculated as follows:

- $100 = \beta^2$ x 30 + 40

- $100 - 40 = \beta^2$ x 30

- $60 = \beta^2$ x 30

- 60 / 30 = β^2

- 2 = β^2

- $\beta = \sqrt{(2)}$ = 1.41

Portfolio Betas

So far, only Betas for individual securities have been considered. A fund manager is equally interested in calculating the Beta of the portfolio he, or she, is managing.

A portfolio's Beta is equal to the weighted average Beta of the individual securities within the portfolio.

To illustrate:

	Stock J	Stock K	Stock L	Stock M
Weighting of each stock:	25%	15%	40%	20%
Each stock's beta:	0.71	0.6	1.4	0.9
Stock's beta x weighting:	(0.71 x 0.25) 0.1775	(0.6 x 0.15) 0.09	(1.4 x 0.4) 0.56	(0.9 x 0.2) 0.18
Portfolio's beta:		1.0075		

The above example shows that the combined effect of adding stocks J, K, L and M together is to create a portfolio that is 0.75% riskier than the market portfolio.

8.4. Drawdown as a measure of risk

Another measure of risk is the use of drawdowns. This looks at the difference between any peak in an investment's price and any subsequent trough. This figure can then be used as an indicator of the maximum potential loss on an investment.

For example, if we take the following prices of a share:
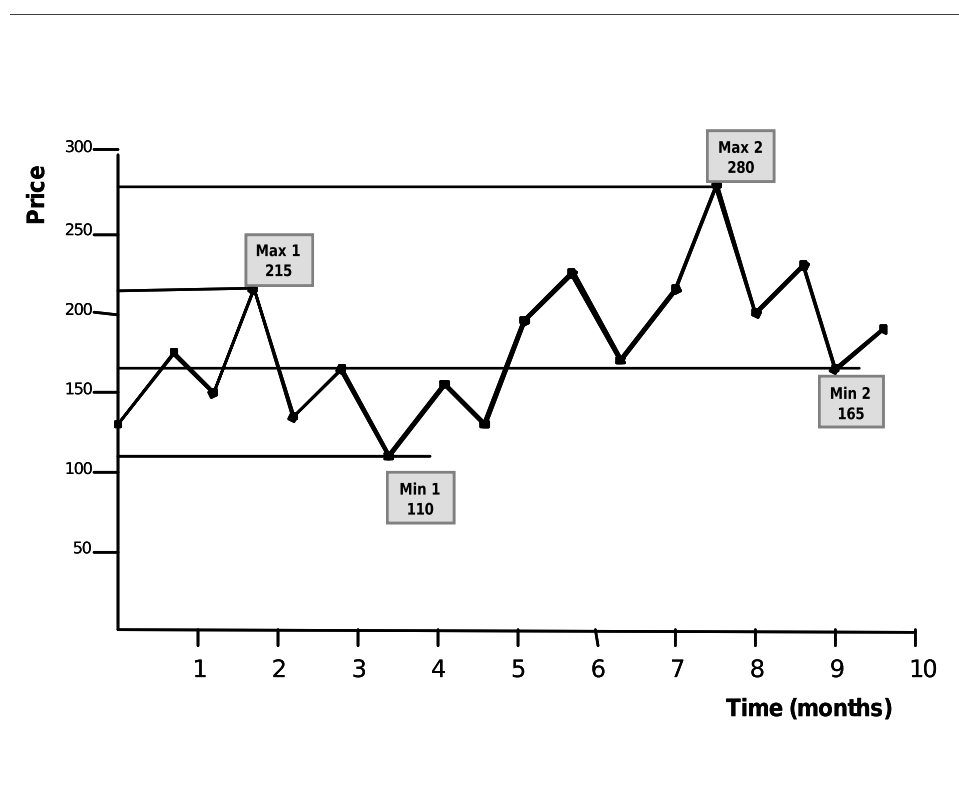
If we look at the first four months of this chart the drawdown would be from the peak of 215 to the subsequent trough of 110, giving a drawdown of 105. Over the next four months there is no drawdown that exceeds this level, so the 105 remains the maximum drawdown for the investment. In the final two months on the chart, there is a drawdown of 115 (from 280 to 165). This becomes the new maximum drawdown for the investment.

Notice, it is the subsequent lowest point that we look at and the previous minimum of 110 is ignored.

Disclosing this drawdown gives an investor the opportunity of identifying the maximum possible loss on an investment. In a worst case scenario a purchase could have been made at 280 and the investment sold at 165, giving a loss of 41%.

We can interpret from a drawdown measure an idea of variability in price. For example, the lower the variability of the share price, the smaller the drawdown measure will be.

8.5. Value at Risk (VaR)

Value at Risk (VaR) is an alternative measure that financial analysts use to quantify market risk. VaR is defined as the maximum potential change in value of a portfolio of financial instruments with a given probability over a certain horizon. VaR measures can have many applications, such as in risk management, to evaluate the performance of risk takers and for regulatory requirements. VaR does not give any information about the severity of loss by which it is exceeded.

When considering a trading portfolio, we know the current market value, but its future market value is unknown. The investment bank holding that portfolio might report that its portfolio has a one-day VaR of $10m at the 95% confidence level. This implies that under normal trading conditions the bank can expect, that 95% of the time the value of its portfolio would not decrease by more than $10m in one day. This is equivalent to saying that there is a 5% chance that the value of its portfolio will decrease by $10m or more during one day.

It is also important to know that here is no indication how much the portfolio will fall by in 5% of the time when it is over $10m.

VaR, like all predictions, is based on assumptions. One of the key assumptions here is a normal distribution of returns. As was discussed in the statistics chapter, this is not always the case - the skewness of the distribution need to be considered.

9. Pricing models

9.1. Capital Asset Pricing Model CAPM

The capital asset pricing model, or CAPM, is a single factor pricing model.

Although the model requires some assumptions and simplifications about financial markets, it is useful because of the simplicity of its predictions.

As such, CAPM is a popular tool for quantifying and measuring risk. At this stage, we will focus on how CAPM is used for equities before turning to bond portfolios later.

CAPM assumptions

CAPM has some built-in assumptions required to derive the conclusions of the model.

These are:

• All market participants may borrow and lend at the same risk-free rate

• All market participants agree on the same investment period

• All market participants are well-diversified investors i.e. specific risk has been diversified away

• There are no tax or transaction costs to consider

• All investors want a maximum return for the minimum risk

• Market participants have the same expectations about the returns and standard deviations of all assets

9.2. Security market line

With the above assumptions in mind, CAPM is used to predict the expected/required returns to a security using its systematic risk, i.e. its Beta.

The CAPM equation that enables this prediction is called the 'security market line' (SML). The expression for the security market line is shown below:

$$R_J = R_f + \beta_J \left(R_M - R_f \right)$$

The 'market risk premium'

Where

R_J is the expected return to stock J

β_J is the beta for stock J

R_M is the expected return to the market portfolio

R_f is the risk free rate of return

If a graph is plotted depicting the expected return to a security against its systematic risk (Beta) using the CAPM equation, then the relationship is revealed as a straight line: the SML. The SML shows that the higher the risk of an asset the higher the expected return.
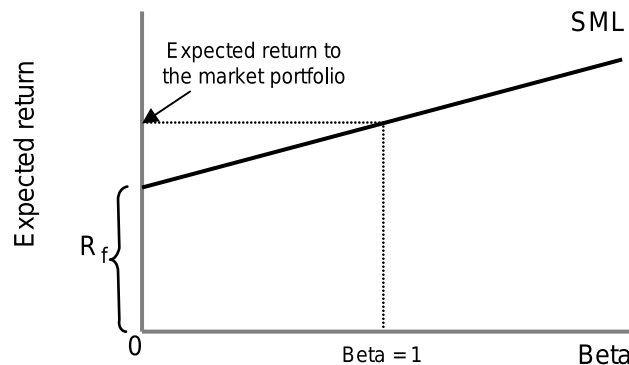
Note that the 'market portfolio' comprises all risky assets, although in practice the portfolio is usually considered to be all those risky assets available for purchase in a particular securities market.

The market risk premium is the amount of return an investor would expect over and above the risk-free rate. This extra return is required for taking on the additional market risk.

The Beta coefficient is the key parameter of the CAPM.

Here is a worked example:

Question: What is the expected return from a stock with a Beta of 1.2 if the risk free rate is 5% pa and the expected return from the market is 15% pa?

Answer: Insert the information from the question into the formula:

$$\text{Expected return} = 0.05 + 1.2(0.15 - 0.05)$$
$$= 0.05 + (1.2 \times 0.1)$$
$$= 0.05 + 0.12$$
$$= 0.17 \text{ or } 17\% \text{ pa}$$

9.3. Alphas

It is possible to represent the security market line in graphical form. Such a graph plots the CAPM expected/predicted returns against different Beta values. An illustration is shown below:
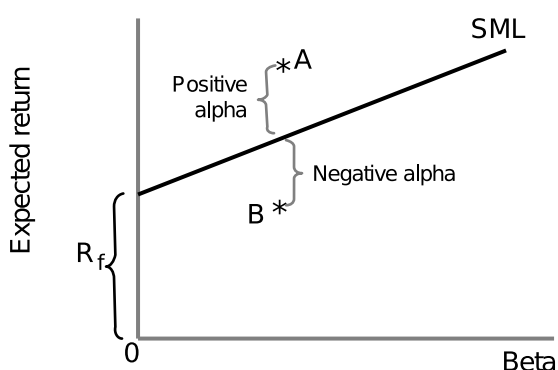
In the diagram above, a stock whose return lies at point A, is achieving a return that is **higher** than CAPM predicts given its level of Beta.

In other words, the actual return of the stock is greater than the CAPM prediction. The stock is said to have a **positive** Alpha.

Stocks with positive Alphas are therefore **underpriced** (according to CAPM), and consequently stock pickers looking for value should buy stocks with positive Alphas. As demand of the stock increases, so will the price, which in turn lowers its yield/return until it is brought back in line with the SML.

Alternatively, a stock whose return lies at point B is achieving a return that is **lower** than CAPM predicts given its level of Beta.

In other words, the actual return of the stock is less than the CAPM prediction. The stock is said to have a **negative** Alpha.

Stocks with negative Alphas are therefore **overpriced** (according to CAPM), and consequently stock pickers should sell stocks with negative Alphas. As supply of the stock increases, the price will reduce, which in turn increases its yield/return until it is brought back in line with the SML.

9.4. Using CAPM

Managers of pension funds and unit trusts can use CAPM Betas to construct portfolios with a risk profile that suits the needs of their clients.

For example, a pension fund with relatively mature liabilities will form a portfolio of equities with a Beta of less than one, while less mature funds may have a Beta greater than one.

Once the client's preference for risk has been established, the fund manager can construct a portfolio with the required Beta. Remember, the portfolio Beta is equal to the weighted average of the Betas of the individual securities within the portfolio, where the weights are the market values of the securities.

By using CAPM, it is possible to form a well-diversified portfolio which tracks a market index. This is achieved by constructing a portfolio with a weighted average Beta of one.

For example, suppose that stock A has a Beta of 0.7 and stock B has a Beta of 1.3. A portfolio with a Beta of one requires 50% of the portfolio invested in stock A and 50% invested in stock B, i.e. (0.5 x 0.7) + (0.5 x 1.3) = 1.

Should the fund manager wish to construct a more risky portfolio he/she would invest more than 50% of the fund in stock B.

9.5. Arbitrage pricing model

The arbitrage pricing theory (APT) is a method of using market risk factors to predict and judge the performance of an asset.

Market risk can be broken down into separate factors; for example, changes in inflation, investor confidence, GNP or the yield curve. The arbitrage pricing model postulates that for any individual company, the sensitivity to each of these factors will be different. The APT allows for these multiple sensitivities to be taken into consideration.

The APT assumes that each investor will hold a unique portfolio with its own particular array of betas. The ultimate goal of APT is to derive a rate of return which will then be used to price the asset correctly. If the price diverges for the assessed fair value, arbitrage should bring it back into line.

10. Risk adjusted performance measures

10.1. Background

Measuring the risk of a portfolio is a crucial element when evaluating portfolio performance.

By measuring both risk **and** return it is possible to calculate a risk-adjusted performance measure.

There are four main methods used to determine the risk-adjusted return achieved by a fund.

These are:

- The information ratio

- The Sharpe measure

- The Treynor measure

- The Jensen measure

All of these measures calculate the return to the portfolio and compare it with the level of risk taken on. It is therefore possible for funds achieving lower returns for low risk to be ranked more highly than funds achieving higher returns for higher risk.

Another important factor in determining the success of a fund manager is to establish how much of the achieved return was due to their skill, and how much was due to excess risk, or even luck. Deconstructing risk adjusted performance measures to determine this is an important aspect of performance evaluation.

10.2. Information ratio

The information ratio compares the excess return achieved by the fund over a benchmark portfolio to the fund's tracking error (calculated as the standard deviation of excess returns from the benchmark). It is calculated as follows:

$$\text{Information ratio} = \frac{ER}{\sigma_{ER}}$$

Where :

ER is the arithmetic mean of excess returns over the benchmark.

σ_{ER} is the standard deviation of excess returns from the benchmark (or tracking error).

A fund's performance may deviate from the benchmark due to manager decisions concerning asset weighting. If the fund outperforms the benchmark the ratio will be positive. A fund that underperforms the benchmark will have a negative ratio.

The tracking error gives us an estimate of the risks the manager takes in deviating from the benchmark. The excess return element tells us how well the fund manager did compared to the benchmark.

A high information ratio is indicative of a successful manager.

10.3. Sharpe measure

The Sharpe measure uses the **standard deviation** of portfolio returns as an estimate of risk in order to calculate excess return to volatility.

Because the standard deviation is used to measure risk, the Sharpe measure is best suited for measuring the performance of a **non-diversified** fund, as such a fund is exposed to **total** risk (i.e. specific and systematic risk). Remember, standard deviation is a measure of total risk.

The Sharpe measure calculates the excess return achieved by a fund (i.e. the return over and above the risk-free rate) for each unit of total risk, (i.e. standard deviation), taken on.

In other words:

$$\text{Sharpe} = \frac{R_p - R_f}{\sigma_p}$$

Where :

R_p is the return to the portfolio.

R_f is the risk free return.

σ_p Is the standard deviation of the portfolio.

For example, assume two fund managers both achieve an average return over one year of 12% on their respective portfolios. Fund A has a standard deviation of 6% and Fund B has a standard deviation of 8%. If the risk-free rate of return is 6% the Sharpe measures for both portfolios are:

Fund A

• Sharpe = (12% - 6%) / 6% = 1

Fund B

• Sharpe = (12% - 6%) / 8% = 0.75

Fund A has therefore given better value than Fund B on a risk-adjusted basis.

Another way to describe this is to say that Fund A has more dominance over Fund B.

Dominance is where one fund achieves a better return than another for the same risk. Alternatively, the dominant fund could achieve the same return as another for less risk. A fund that achieves better return for lower risk than another fund would also, clearly, be a dominant fund.

10.4. Treynor measure

The Treynor measure is similar to the Sharpe measure except it is used to measure the performance of a **well-diversified** fund, i.e. specific risk has been diversified away.

The Treynor measure is based on the CAPM Beta coefficient of the portfolio and is a measure of the portfolio's excess return with respect to its Beta.

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As such, Treynor measures the excess return achieved by a fund (i.e. the return over and above the risk-free rate) for each unit of systematic risk (Beta) taken on.

In other words:

$$\text{Treynor} = \frac{R_p - R_f}{\beta_p}$$

Where :

R_p is the return to the portfolio.

R_f is the risk free return.

β_p Is the beta of the portfolio.

As with the Sharpe measure, the higher the Treynor measure, the better the fund has performed on a risk adjusted basis.

For example, assume two fund managers are both achieving an average return over one year of 15% on their respective portfolios. Fund A has a Beta of 0.6 and Fund B has a Beta of 1.8. If the risk-free rate of return is 6% the Treynor measures for both portfolios would be:

Fund A

- Treynor = (15% - 6%) / 0.6 = 15

Fund B

- Treynor = (15% - 6%) / 1.8 = 5

Fund A has therefore achieved a higher Treynor measure and has given better value for money on a risk-adjusted basis. Fund A is the **dominant fund**.

10.5. Jensen measure

The Jensen measure of performance measures the fund's return in excess of its CAPM predicted return.

The formula for calculating the Jensen measure is:

$$\text{Jensen measure} = R_p - R_{CAPM}$$

Where

R_p is the return to the portfolio

R_{CAPM} is the return predicted by CAPM

To calculate the return predicted by CAPM a Beta is necessary. The Beta used is calculated from the client's asset allocation and risk requirements at the beginning of the period being measured.

This Beta is used to represent a **benchmark portfolio**.

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Jensen measures performance by calculating a CAPM predicted return calculated from the benchmark Beta and comparing it to the return the manager actually achieved. If the difference is positive, the fund manager has performed well. If the Jensen measure is negative, the fund manager has performed poorly.

Those funds with a positive Jensen measure are considered to be dominant over the benchmark.

Notice that the Jensen measure may also be interpreted as the portfolio's Alpha. If the fund has a positive Jensen measure it means it lies above the SML, and therefore has a positive Alpha. Fund managers, when picking stocks, tend to look for stocks with positive Alpha. A negative Jensen measure is equivalent to a negative Alpha.

Decomposing Jensen

Funds with a positive Jensen measure, i.e. positive Alphas, have outperformed the benchmark portfolio.

The information available in the Jensen measure may be used to break down, or decompose, this extra performance to determine which aspects of the fund manager's skills were responsible for this excess return. It can therefore be used to determine relative strengths or weaknesses of a fund manager.

As an example, suppose a benchmark portfolio is established for a client with a Beta of 1.1. Using this, along with a risk free rate of 4% and an expected return to the market of 9% the CAPM equation gives an expected return of 9.5% (expected return = 4 + (9 - 4)1.1 = 9.5).

At the end of a given period, the return to the fund is measured and found to be 14%. The fund manager has a positive Jensen measure and has done well.

But why did the fund manager outperform the benchmark portfolio? The answer may be found by decomposing the return as follows:

• The return due to the risk free rate is identified. This is shown as 4% on the diagram below

• The next portion of the return (5.5%) is due to the risk of the benchmark portfolio

• If the portfolio has been actively managed, its content, and therefore its Beta, will most likely have deviated from the benchmark portfolio. If the Beta has risen above the benchmark the fund has been exposed to more risk and a higher return is due. In the diagram below the manager's active techniques were found to have increased the fund's Beta to 1.4, warranting an extra return of 1.5%

• The remaining return (the top 3% on the diagram) must be due to the fund manager's skills at stock selection
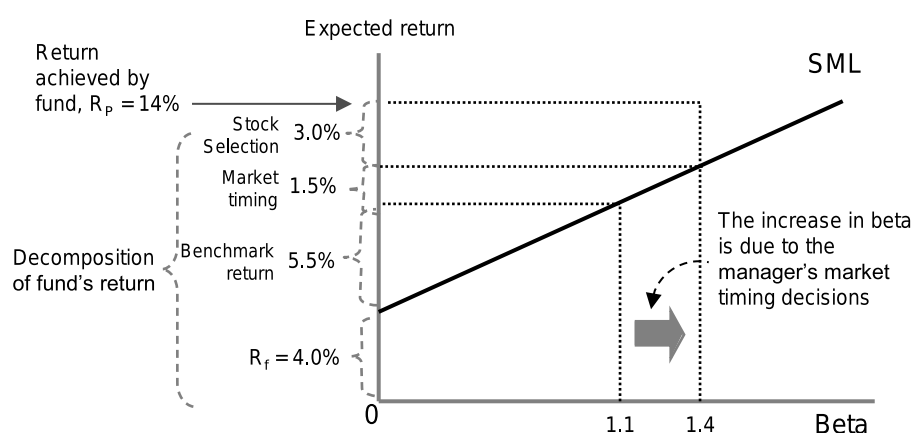
The decomposition of the total return to the fund may be summarised as:

- Return to the portfolio = Risk free return + Benchmark return + Market timing + Stock selection

10.6. Ex-ante and ex-post measures of risk

Most of the risk adjusted performance figures we have seen use an ex-post measure of risk. That is, they look back at the historic measure of risk and performance, and create a measure based on these.

Both Treynor and Sharpe use ex-post measures of risk. Using these methods, the risk measure used is clear, as it has already crystallised. However, the Sharpe and Treynor measures, in looking at the performance after the event, could be seen as giving information when it's too late: the act has already occurred.

Jensen uses an ex-ante risk measure to predict the expected risk and return of an investment. Assumptions will play a major role in this, which is a disadvantage, but the major advantage of this ex-ante method is it sets a visible target before the event.

10.7. Risk adjusted performance measures: summary

The table below summarises the main methods of measuring a portfolio's performance on a risk adjusted basis.

	Pre-specified risk	Non pre-specified risk
Diversified portfolio	$R_p - R_{CAPM}$ Jensen	$\dfrac{R_p - R_f}{\beta_p}$ Treynor
Non-diversified portfolio	N/A	$\dfrac{R_p - R_f}{\sigma_p}$ Sharpe

11. Bond portfolios

11.1. Introduction

Portfolios made up entirely of bonds have their own characteristics and considerations.

Like equity portfolios we can work out expected return, measures of performance and consider different management styles.

Key terms related to bond return include **shift, twist and spread**. Shift measures the degree to which a yield curve has moved upwards or downwards, in parallel, across all maturities. Twist measures the degree to which the yield curve has steepened or flattened. The premium or spread is usually quoted as basis points, and will be related to the bond issuer's yield over the government (risk-free) rate.

11.2. Portfolio duration

The duration of a portfolio is the sum of the weighted duration of the component bonds. For example, a portfolio made up of four bonds A (25%) , B (30%), C (20%) and D (25%) with durations of 1.2, 2.6, 3.4, and 2.1 respectively would be:

Bond A (25 %)	**Bond B (30%)**	**Bond C (20%)**	**Bond D (25%)**
Duration 1.2	**Duration 2.6**	**Duration 3.4**	**Duration 2.1**

Weighted duration	0.25 x 1.2	0.3 x 2.6	0.2 x 3.4	0.25 x 2.1
	0.3	0.78	0.68	0.53

Portfolio duration   2.29

The duration of a bond portfolio is a measure of the interest-rate risk of that portfolio, i.e. how sensitive the fund is to changes in interest rates.

Relative duration

Relative duration is used as part of the calculation in measuring bond portfolio performance.

The measure calculates the return to the portfolio **in excess** of the risk-free return divided by the portfolio's relative duration.

In other words:

$$Performance\ of\ Portfolio = \frac{R_p - R_f}{D_P / D_M}$$

Where :

R_p is the return to the portfolio

R_f is the risk free rate of return

D_P is the weighted average duration of the portfolio

D_M is the weighted average duration of the market

Consider portfolios A and B, both of which have achieved an excess return of 10% over and above the risk-free rate.

Portfolio A has a duration of 14 years and Portfolio B has a duration of 10 years. The duration of the market during this time is six years.

In order to assess the relative performance of A and B, the duration-adjusted performance measure is calculated as follows:

Portfolio A

P = 10% / (14 years / 6 years) = 4.3.

Portfolio B

P = 10% / (10 years / 6 years) = 5.9.

Therefore, on a duration-adjusted basis Portfolio B has outperformed Portfolio A.

11.3. CAPM in bond portfolios

CAPM may be used to calculate the expected return from a bond portfolio.

Instead of using Betas to express the relative volatility to the market, **relative duration** is used instead.

As previously illustrated, relative duration is equal to the duration of the portfolio divided by the duration of the market.

The relative duration of the portfolio takes the place of Beta in the CAPM formula:

$$ER_B = R_f + \frac{D_B}{D_M}(ER_M - R_f)$$

Where

ER_B is the expected return to the bond

$\frac{D_B}{D_M}$ is the relative duration of the bond

ER_M is the expected return the market

R_f is the risk free rate of return

12. Management of bond portfolios

12.1. Active bond portfolio management

An actively managed bond portfolio is one in which the manager is seeking to outperform a benchmark, such as an index.

Policy switch – switching between two different typs of bond, to take advantage of the different features. For example, selling the short-term bonds and buying long-term bonds in order to take advantage of a decrease in interest rates.

Anomaly switch – Switching between two similar bonds to take advantage of what appears to be mis pricing.

Riding the yield curve – see below.

Riding the yield curve

To illustrate, assume a fund manager has liabilities (payments to make) in three months' time; they could meet those liabilities by purchasing a three-month Treasury bill now, and using the proceeds at redemption.

Alternatively, the manager could purchase a six-month Treasury bill today and hold it for three months, at which point they could sell it and use the proceeds to meet the liabilities.

Note that riding the yield curve only works if the yield curve is upwards sloping and **remains** upwards sloping during the process, i.e. buy the higher yielding/lower priced six-month bill and sell it as a lower yielding/higher priced three-month bill.

The advantage of riding the yield curve is that, although it is a risky strategy, it can yield a higher return compared to buying the three-month bill and holding it to redemption (see example below).

Example

Suppose that the three-month T-bill is trading at £99,000, for £100,000 nominal value, and the six-month T-bill is trading at £97,950.

The return over the three months from purchasing, the three-month T-bill is calculated as follows:

Three-month T-bill bought for £99,000 and redeemed at £100,000 gives a cash return of £1,000.

£1,000 expressed as a percentage of the original investment is:

$$\frac{£1,000}{£99,000} = 0.0101 \ \text{ or } \ 1.01\% \ \ (\text{the three month return})$$

Multiply by 4 to get an annualised return of 4.04%

Alternatively, the fund manager buys a six-month T-bill, holds it for three months and sells it after three months. The price received in three months will be £99,000 (assuming the yield curve has not moved during this time).

The return from riding the yield curve is therefore:

The six-month T-bill purchased for £97,950 and sold for £99,000 in three months' time would give a cash return of:

£99,000 - £97,950 = £1,050

Expressed as a percentage of the original investment of £97,950:

$$\frac{£1,050}{£97,950} = 0.0107 \text{ or } 1.07\%$$

This can be annualised by multiplying by 4 to get 4.28%

The **extra** return achieved by the fund manager riding the yield curve is 1.07% - 1.01% = 0.06% over three months, or on an annualised basis 4.28 - 4.04 = 0.24%.

Credit risk management

A fund manager may decide to move out of bonds if they believe that the credit quality of an issuer may deteriorate, and into bonds where they believe that the credit quality of an issuer will improve. This can be due to changes in issuer performance in line with economic cycles. The fund manager may have reduced the risk of bonds in their portfolio going into default and also has the benefit of avoiding price falls or taking advantage of prices rises if they have pre-empted a ratings change.

12.2. Passive bond portfolio management

Introduction

Passive portfolio management means the manager is looking to track an index, or benchmark.

Two major concerns that must be taken into account, particularly for liability driven investments such as defined benefit pension schemes, when managing bond portfolios are the problems of interest rate risk and re-investment rate risk.

Interest rate risk is the risk of interest rate changes (affecting bond prices). In addition, there is a risk of not achieving similar yields when re-investing coupons received from existing bond holdings (re-investment rate risk).

The fund manager can protect the fund from interest rate risk and re-investment rate risk by adopting either a cash matching or immunisation strategy.

Cash matching

A cash matched, or dedicated, portfolio is one where the fund manager chooses bonds that generate cash flows of the same size and timing as the fund's liabilities. The fund manager purchases a collection of bonds with coupons and capital repayments that coincide with the payments the fund must make (i.e. pension liabilities).

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Immunisation

An immunised portfolio is one is designed to protect the fund from changes in interest rates.

Immunised portfolios are created by matching the duration of its constituent bonds with the duration of its liabilities.

Matching duration rather than exact cashflow is often more practically and provides a greater range of bonds with which to implement the strategy. A disadvantage of Immunisation strategy is that it assumes a flat 'term structure of interest rates', i.e. a flat yield curve, that any shifts in the yield curve are parallel, and that the shift occurs before the first cash flow payment.

There are two types of immunised portfolios: bullet and barbell.

Bullet portfolios

A bullet portfolio (or focused) is one where the duration of the bonds within the portfolio is the same (or very similar) to the duration of the portfolio's liabilities.

For example, if the manager has liabilities with a duration close to five years, they will choose bonds that also have five-year durations.

Implementing a bullet strategy is likely to be easier than a cash matched strategy since there are more available bonds that match a fund manager's requirements. The downside is that the portfolio will require rebalancing in order to maintain the immunisation effect.

Barbell portfolios

As the name implies, a barbell portfolio contains bonds that have much shorter and longer durations than the liability but are **weighted** so that the average duration matches that of the liability.

For example, should the manager have liabilities of, say, 10 years, then they may choose some bonds with a duration of five years, some with a duration of 15 years until the 'point of balance' is equal to 10 years.

As the durations in a barbell strategy have a greater range than that of the bullet strategy are even more available bonds that match the fund managers requirements. The downside is that the portfolio will require a greater deal of rebalancing than the bullet strategy.

Contingent immunisation

A technique employed by active managers as a protection in case they fail to achieve the required return through active management.

If the fund performs poorly then they will switch to a passively managed immunised portfolio as an irrevocable approach until the liability date.

12.3. Liability driven investments

A liability-driven investment strategy (LDI) is an investment strategy of a company or individual based on the cash flows needed to fund future liabilities. It is sometimes referred to as a 'dedicated portfolio' strategy. It differs from a 'benchmark-driven' strategy, which is based on achieving returns relative to an external index such as the FTSE All Share or a combination of indices that invest in the same types of asset classes. LDI is designed for situations where future liabilities can be predicted with some degree of accuracy.

The strategy often involves the use of derivative products such as swaps to negate or reduce the negative effects of external factors such as changes in interest rate or inflation. The downside of this is that implementation of such strategies may cause a reduction in overall return on the funds investments.

Constructing and implementing an LDI strategy

The constructions of an LDI strategy requires four main areas to be considered:

• Cash flow forecasts of the funding needs into the future (e.g. pension funding requirements)

• The degree of acceptable risk must be specified by the trustees

• Assessment of ability of active management to outperform market

• Implementation of the LDI strategy and consideration of additional investment vehicles

Risk measures for an LDI strategy

• Duration is the difference between the target return and actual return (tracking error)

• Volatility of surplus measures the probability of a short fall. This is similar to VaR and is deemed to be a more sophisticated measure of risk

13. Portfolio theory: summary

13.1. Key concepts

Portfolio construction

- 15.6.3 Distinguish between strategic and tactical asset allocation

- 15.6.4 Explain the major investment styles prevalent in the fund management industry Socially responsible investing and Environmental social governance investing

- 15.6.5 Explain socially responsible investing (SRI) and environmental social governance investing (ESGI)

- 15.5.1 Explain the relationship between pricing, liquidity and fair value for the asset classes of equity, fixed income, derivatives and alternative investments

- 15.5.2 Identify, explain and calculate transaction costs associated with dealing in:

  - UK equities

  - Fixed income securities

  - Derivatives

  - Alternative investments

- 15.5.3 Evaluate the impact of alternative trading platforms, facilitated by MiFID, on transaction costs associated with equity dealing

- 15.5.4 Contrast trading methods for fixed income securities with equities and analyse the impact on trading costs

Passive vs. active fund management styles

- 15.6.2 Distinguish between active and passive fund management and explain the costs and benefits to the investor

- 15.1.6 Explain tracking error and its limitations

- 15.6.1 Distinguish between a 'top-down' and 'bottom-up' approach to fund management

- 17.1.5 Explain how returns are decomposed and attributed to equities (sector / stock / interaction)

The efficient market hypothesis (EMH)

- 15.4.1 Identify and explain the key concepts of the EMH

- 15.4.2 Explain the limitations of the EMH

- 15.4.3 Evaluate the evidence on market anomalies in relation to EMH

Behavioural finance

- 15.4.4 Explain the basic concepts of the behavioural finance school of thought

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- 15.4.5 Evaluate the evidence on market anomalies in relation to behavioural finance

- 15.4.6 Explain the concept of 'financial amnesia' and the role of behavioural factors in its promotion

- 15.4.7 Explain the notion of 'bubbles' in financial markets

Performance measurement

- 17.1.1 Explain the importance of returns analysis in the portfolio management process

- 17.1.2 Identify the components of total return for a bond or equity portfolio

- 17.1.3 Calculate the income, capital and total return over a single period for an equity or bond portfolio

- 17.2.1 Identify the data requirements to calculate a money-weighted return; and time-weighted return

- 17.2.2 Calculate and interpret the money-weighted return or time-weighted return from data provided

Risk and reward

- 15.1.13 Analyse and explain other types of investment risk including inflation, currency, interest rate, fraud and counterparty risk

- 15.3.4 Define the segmentation of risk into systematic (factor) risk and unsystematic ("investment specific") risk

- 15.3.5 Calculate the total risk given systematic and unsystematic components

Measuring risk

- 15.1.4 Identify the commonly used measures of risk in investment analysis and fund management

- 15.1.5 Explain the shortfalls of standard deviation as a measure of investment risk

- 15.1.9 Explain the importance of correlation in constructing efficient portfolios and the difficulties, limitations and meaning of correlation coefficients

- 15.1.11 Explain diversification and its role in constructing efficient portfolios and its limitations during extreme market conditions

- 15.3.7 Explain how the historic beta may be estimated using a scatter chart of historic returns

- 15.3.8 Calculate the beta of an investment given the systematic risk of the investment and the risk of the market

- 15.3.9 Calculate the beta of an investment given the variance of the market return, and the covariance of the investment return with the market return

- 15.3.10 Calculate the beta of a portfolio given the component betas and the investment weightings

- 15.1.7 Explain the meaning of drawdown as a measure of risk

- 15.1.12 Explain the meaning of Value at Risk (VaR) and its advantages and disadvantages for risk management

- 15.1.8 Explain the impact on changing levels of price volatility over time and how this affects predictions such as tracking error and downside risk

Capital Asset Pricing Model (CAPM)

- 15.3.1 Explain the concept of investments being exposed to a number of common factors which partially explain their return and risk profile ('arbitrage pricing theory')

- 15.3.2 Identify the assumptions behind the single-factor Capital Asset Pricing Model (CAPM) and identify other factors in common use

- 15.3.3 Explain the limitations of the CAPM model

- 15.3.6 Calculate the expected return on a security by applying the CAPM through interpreting the beta of a security

Risk adjusted performance measures

- 17.4.1 Explain the importance of risk analysis in performance evaluation

- 17.4.2 Calculate and interpret the following risk adjusted measures of return: the Sharpe measure; the Treynor measure; the information ratio; Jensen's alpha

- 15.1.1 Explain the 'normal' trade-off between risk and return and the concept of 'dominance' between investment strategies

- 17.4.3 Explain how total return can be decomposed into the following: risk-free return, return due to choice of benchmark, return due to market timing, return due to diversifiable risk, pure selectivity

- 15.1.3 Explain the importance of risk-measurement in the analysis of investments, and why ex-ante and ex-post measures of risk may be very different

Bond portfolios

- 15.7.3 Calculate duration for a bond portfolio

Management of bond portfolios

- 15.7.1 Explain the following bond portfolio management techniques: cash matching /dedication, immunisation, credit risk management, riding the yield curve

- 15.7.2 Calculate the theoretical gain from riding the yield curve

- 15.7.4 Explain the benefits and risks of using barbell and bond portfolio strategies

- 15.7.5 Explain the benefits and risks of an Liability drive Investment (LDI) strategy

- 15.7.6 Explain the process of a liability driven investment strategy

- 15.7.7 Evaluate some of the techniques and basic measures of risk used in LDI

Now you have finished this chapter you should attempt the chapter questions.