Portfolio and Fund Management

Unit 1 Financial Planning, Financial Instruments, Risk and Return

Contents

Unit Overview

In this unit you will examine the key components of an investment policy, which is the statement of an investor's financial objectives, time horizons, and level of risk aversion. You will then analyse the financial instruments that form the building blocks of any investment portfolio, including short-term, low-risk money market instruments; longer-term debt instruments including government bonds and corporate bonds; and equity. The unit also considers the use of derivatives, and the role played by property and commodities in an investment portfolio. You will then examine the most commonly used measures of reward (the expected return) and risk (the variance and standard deviation of returns). You will also consider the historical long-term average returns on equities and bonds.

Learning outcomes

When you have completed your study of this unit and its readings, you will be able to:

- discuss the formulation of an investment policy, taking into account the investor's financial objectives, time horizons and risk tolerance
- identify and describe the investment characteristics of money-market instruments, including treasury bills, certificates of deposit, commercial paper, and repo agreements
- analyse the investment characteristics of bonds and equities
- explain the investment characteristics of basic derivative securities, including forward and futures contracts, options and swaps
- discuss the opportunities offered to investors by alternative asset classes, including property and commodities
- calculate and explain nominal and real rates of interest
- calculate and explain various measures of the rate of return on a risky security
- interpret the expected return and standard deviation, and calculate estimates of these measures using historical security returns data
- comment on the long-term investment performance of treasury bills, government bonds and equities.

Reading for Unit 1

Zvi Bodie, Alex Kane & Alan J Marcus (2018) Chapters 2 'Asset classes and financial instruments' and 5 'Risk, return, and the historical record'. In: *Investments*. 11th Edition. New York: McGraw-Hill Education.

René M Stulz (2004) 'Should we fear derivatives?'. *Journal of Economic Perspectives*, 18 (3), 173–92.

Elroy Dimson, Paul Marsh & Mike Staunton (2016) 'Long-term asset returns'. In: D Chambers & E Dimson (Eds.) *Financial Market History:*

Reflections on the Past for Investors Today. Charlottesville VA: The CFA Institute Research Foundation. pp. 2–26.

1.1 Introduction

Investment decisions are typically made by individuals and institutional investors in a context where higher returns can only be earned at a cost of accepting greater risk. Investment choices therefore involve trade-offs between return and risk. In order to make good choices, the investor needs to formulate an investment policy, which incorporates the investor's financial objectives or goals, time horizons, and level of risk aversion. The key components of an investment policy are discussed in Section 1.2.

The next five sections describe the key characteristics of the financial instruments that are the fundamental building blocks of any investment portfolio. Section 1.3 describes money market instruments, including treasury bills, certificates of deposit, commercial paper, and repo agreements. These money market instruments are usually considered to be either risk-free, or very low-risk investments. Section 1.4 describes government and corporate bonds, which are longer-term instruments. Bonds vary from being virtually risk-free, in the case of government bonds issued in developed countries with stable financial and economic systems, to high risk, in the case of corporate bonds issued by companies with a poor credit rating or a high probability of insolvency before the bond reaches maturity. Section 1.5 describes equity. The holder of equity has an ownership stake in the company. Profits revert to shareholders in the form of dividends, or capital appreciation in the case of retained earnings. Shareholders hold a residual claim on the company's income and assets, making equity a relatively risky investment. Section 1.6 covers derivative securities, in particular forward and futures contracts, options and swaps, whose payoffs derive from the value of other securities. Finally, Section 1.7 discusses property and commodities, which are relatively illiquid investment vehicles that may offer significant diversification benefits when combined with other assets or securities in an investment portfolio.

Sections 1.8 and 1.9 focus on computational aspects of the measurement of returns and risk. Returns may be measured in either nominal or real terms; the method of calculation depends on the frequency of compounding. Risk is typically measured using the variance or the standard deviation of returns. Section 1.8 defines the nominal and real rate of interest payable on a completely safe, or risk-free, investment. This is followed by a discussion of various measures of returns on risky investments, which take account of the regular interest, coupon or dividend payments, as well as any appreciation or depreciation in the price or value of the security during the period over which it is held by the investor. Section 1.9 examines forward-looking measures of potential reward in the form of the expected return, and risk in the form of the variance or standard deviation, together with the backward-

looking measures (sample mean and standard deviation) that are commonly used to estimate the 'true' expected return and standard deviation.

Finally, in Section 1.10, you will consider some long-term comparisons of the average returns achieved by investments in treasury bills, government bonds, and equities, based on US and UK data. During the period since the start of the twentieth century as a whole, equity investments have outperformed bonds in most countries by a substantial amount; however, the same pattern does not always hold when comparisons are drawn over shorter periods.

1.2 Financial Objectives, Time Horizons and Risk Tolerance

The management of investments requires the investor to establish an investment policy, which details the investor's objectives and constraints. The investor may be a private individual, or the manager of a fund such as a mutual fund or pension fund. The objectives and constraints include any specific targets for the rate of return and the capacity and tolerance for risk, taking account of the investor's financial position. The investment policy also needs to specify the time horizons: When will the resources invested be required to finance consumption or other expenditure? Are there any liquidity needs within these time horizons? Other issues that may be relevant to the investment policy include the investor's tax status, and any legal or regulatory constraints on the types of investment that may be undertaken.

An investor's financial goals or objectives may be broken down into required goals, desired goals and aspirational goals. Required goals are non-negotiable, revolving around the need to maintain financial independence and a minimum standard of living, and cover any essential outlays on education, health care, and so on. Desired goals are non-essential but desirable, either personally or for immediate family members, such as owning a second home, or accumulating assets to pass on to children. Aspirational goals are considered once all personal and family objectives have been realised, and may include donations to charities or other good causes.

The identification of goals also requires careful consideration of the investor's time horizons. For an individual investor, planning for payment of school fees over a defined period of five years, for example, requires avoidance of any large capital losses within the required period; but inflation protection is a lesser concern. In contrast, planning for retirement in thirty years' time requires provision for protection against inflation; but the investor can withstand losses in the value of the pension fund in individual years that are compensated by gains over the full term. For an institutional investor, it is crucial to ensure that investments will yield sufficient income to ensure that liabilities to make payments are always covered, whenever they fall due.

After having specified goals or objectives and time horizons, the investor needs to decide whether the goals are achievable within the time horizons by investing in risk-free assets; or whether a higher return will be required,

necessitating investments that carry some level of risk. Risk implies uncertainty concerning the return an investment will deliver: the actual return could be higher or lower than the return the investor expected at the time the commitment to invest was made. Risk capacity refers to an investor's ability to withstand, financially, returns that are less favourable than anticipated. Risk tolerance refers to an investor's psychological or emotional ability to cope with uncertainty, disappointment or loss. For many investors, the desire to avoid losses may be a more powerful emotion than the desire to achieve gains. Risk perception refers to the view taken by an investor of risk, dependent on personality and experience. This includes opinions or beliefs, which may be either rational or irrational, about the probability of a particular event occurring within a given time period, and the extent or magnitude of its effects. In Unit 4 you will examine the influence of investors' risk preferences in portfolio selection. And in Unit 5 you will study how investors' beliefs and preferences are formed.

1.3 Money Market Securities

The money market exists to enable investors to trade in a range of short-dated fixed-interest securities. Most of these instruments are traded in large volumes by institutional investors. Individual investors can gain exposure to money market securities by investing in money market funds, which are mutual funds that pool the resources of many small investors. Mutual funds, including money market funds, are described in more detail in Unit 2.

A treasury bill is a short-term debt instrument, with a maturity of up to one year, issued by the government. UK treasury bills are issued in denominations of £5,000 in nominal value, usually with a maturity of three months; although other maturities between one and six months are sometimes offered. Treasury bills are issued at a discount to their nominal value. The discount is the source of the investor's return. UK treasury bills are issued to selected institutional investors in a weekly (Friday) auction; they can also be offered to government departments at any time.

A certificate of deposit (CD) is a bank deposit, on which the bank pays a fixed rate of interest and repays the principal to the depositor on maturity. A CD cannot be redeemed before maturity, but it can be sold to another investor. CDs usually pay higher rates than deposits that can be withdrawn on demand.

Commercial paper is a short-term promissory note, issued by a large company, usually with a high credit rating, that wishes to borrow funds for a short period, typically up to nine months. There is no collateral; instead, the investor relies upon the issuer's reputation. Commercial paper typically offers a higher yield than corporate bonds. Asset-backed commercial paper is another short-dated security, usually with a maturity between three and six months. A company wishing to raise funds instructs a bank to issue asset-backed commercial paper to investors, backed by monies owed to the

company in payment for goods or services supplied to its customers. As these receivables are collected, the proceeds are passed to the bank, which in turn repays the investors.

Under a repo (sale and repurchase) agreement, a bank (or other party wishing to raise short-term funding) sells a security, such as a government bond, corporate bond or company share, to an investor, and agrees to repurchase the same security from the same investor at a later date, often the next day. The repurchase price is slightly higher than the sale price: the difference is equivalent to an interest payment on an overnight deposit of funds. The security serves as collateral for the transaction. The purchaser under a repo agreement (the lender) retains or can sell the security if the seller (the borrower) defaults on the commitment to repurchase. Typically, the sale price is set below the value of the underlying security, giving the seller (the borrower) an incentive not to default on repurchase. The 'haircut' is the percentage subtracted from the market value of the asset being used as collateral, dependent on the perceived risk associated with holding the security.

Reading 1.1

Please now read Chapter 2, Section 2.1 'The money market', pages 27–33 of your key text by Bodie *et al.* This section provides further information on the money market instruments described above and several others, written mainly from a US perspective.

Bodie *et al* (2018) Section 2.1 'The money market' from Chapter 2 'Asset classes and financial instruments' in *Investments*. pp. 27–33.

1.4 Bonds

Bonds or fixed-income securities are longer-term debt instruments, which enable investors to provide loans to governments or companies. The loan or bond, in most cases, will be repaid on redemption at a later date, known as the maturity date. A small proportion of bonds, known as perpetuities, are undated. The investor provides the loan by purchasing a bond, and is paid a fixed rate of interest, known as the coupon, on a regular (usually semi-annual) basis. The investor is repaid the nominal value of the bond, also called the principal, on maturity. Investors in bonds expect to receive a return that compensates for two risk factors:

- a default or credit premium, which reflects the risk that the issuer of the bond may encounter financial difficulties leading to default
- a maturity premium, which compensates for the length of the time period until maturity and redemption.

Government bonds, also known as treasury bonds, gilt-edged securities, or gilts, are considered to be relatively safe investments, because the government can exercise its direct or indirect control over the supply of money to raise sufficient funds to ensure that all bonds it has issued previously are serviced (the coupons are paid) and redeemed. However, treasury bonds are not completely risk-free: governments can and sometimes do default on their own debt; and inflation can erode the real value of bonds that are already issued. To address the inflation problem, index-linked government bonds or gilts

were introduced in the 1980s to provide investors with a safe means of hedging against the risks of inflation. This was a direct response to the high inflation experienced in many countries during the 1970s. Index-linked gilts pay a guaranteed fixed return, plus a variable return equivalent to the rate of inflation, thereby providing an overall return that is fixed in real terms.

Corporate bonds enable companies to borrow funds directly from investors, without the need to dilute ownership of the company by issuing new equity. Default risk depends directly on the risk that the original issuing company enters liquidation, and the market prices of many corporate bonds reflect a substantial default premium, depending on the market's assessment of the company's prospects. Credit-ratings agencies such as Standard & Poor's, Moody's and Fitch IBCA provide assessments of default risk for individual companies that are widely used by investors. Note that corporate taxation is levied on the company's profits or earnings that remain *after* interest payments to bondholders have been deducted.

Secured bonds are backed by specific collateral that reverts to the bondholder in the event of liquidation; debentures are unsecured bonds that are not backed by collateral. Debenture holders have higher priority than ordinary shareholders for repayment in the event that the company is unable to meet its financial obligations to its investors and other creditors. But debenture holders have lower priority than short-term lenders such as banks, as well as other creditors, employees, and the tax authorities. Convertible bonds are bonds that can be converted to equity, usually at the holder's discretion, at a specified conversion rate (number of shares per bond) at specified times prior to the bond's maturity. If the company performs well, the option to convert is likely to be exercised; if the company underperforms, the option to convert is likely to be unexercised.

An important motive for investment in bonds is reduction of risk through diversification of the investor's portfolio. Returns on shorter-dated, high-quality bonds (*eg* treasury bonds with a term-to-maturity of less than five years) tend to be less highly correlated with returns on equities than returns on longer-dated lower-quality bonds (*eg* corporate bonds with a longer term-to-maturity). Therefore short-dated treasury bonds offer a greater potential gain from diversification than longer-dated corporate bonds, whose performance is likely to be similar to equity in the same companies. In Unit 4 you will examine the benefits from diversification, and the importance of the correlation between returns on different securities.

International bonds, also known as eurobonds, enable companies to borrow funds abroad, and investors to lend funds to foreign issuers. The international bond market is centred on London. The term eurobond is used to refer to any bond denominated in a currency other than that of the country in which it was issued: the currency does not have to be the euro. For example, eurodollar and euroyen bonds are issued in London, and denominated in US dollars and Japanese yen, respectively.

Asset-backed securities are another important type of bond, and are securities backed by income streams from an underlying pool of loans or other assets. Mortgage-backed securities are securities where the underlying loans are mortgages on residential property. The creation of an asset-backed security is known as securitisation. In return for a lump-sum payment to acquire the security, the investor receives regular payments from the income streams arising from the underlying assets. Mortgage-backed securities are the largest single component of the market for asset-backed securities, but any assets or activities that are expected to generate a future income stream can be securitised in a similar manner, including car loans, student loans, and credit-card fees and interest payments.

After bonds have been issued, they are traded on secondary markets. The nominal value, the interest or coupon payment, and the maturity date remain fixed. But the market price of the bond in the secondary market, and the yield-to-maturity, may fluctuate due to variations in demand and supply of the bonds, driven by changes in the economic environment or the fortunes of a particular company. The yield-to-maturity represents the return offered by the bond over its life (Bodie *et al*, 2014). As noted, payments on the bond include the coupon (if applicable) and repayment of the principal at maturity. The present value of these future payments is calculated by discounting them. The yield-to-maturity is the discount rate that makes the present value of the bond's future payments equal to the market price of the bond. There is an inverse relation between the market price and the yield-to-maturity. If the market price of a bond falls, the corresponding yield-to maturity increases: the right to receive the future payments of the bond can be purchased for a lower market price, so the return on the bond increases.

In common with other securities, dealers in bonds quote a bid price and an ask price. The bid price is the price the investor would pay to buy the bond from the dealer; and the ask price is the price the dealer would pay to acquire the bond from an investor. The bid-ask spread represents the dealer's compensation. Since different bonds pay different coupon rates, direct comparisons based on price may be misleading; and investors typically focus on the yield-to-maturity. Different yields-to-maturity are quoted based on the bid price and the ask price; since the ask price is slightly lower than the bid price, the ask price yield-to-maturity is higher than the bid price yield-to-maturity.

1.5 Equity

Ordinary shares, also known as common stocks or equities, confer on the holder an ownership stake in the company. Each share entitles the holder to a share of the company's current and future profits, and to vote on matters of corporate governance that are put to a ballot of shareholders, including the election of a board of directors to oversee the company's management and ensure it operates in the shareholders' best interests. Shares in most large companies are publicly held, meaning that some or all of the shares are

listed and traded publicly on a stock exchange. Shares in privately-held companies are not publicly traded, and are often held by the company's founders, management or employees. In contrast to publicly-held companies, the shareholders of a privately-held company often play an active role in the company's management.

Profits may be returned to the ordinary shareholders in the form of dividend payments, or in the case of earnings that are retained, by appreciation in the capital value of the shareholding. Dividends are paid out of net or after-tax earnings. This implies an important difference in the tax treatment of fixed-interest payments to bondholders, which are an allowable expense for tax purposes, and dividend payments to shareholders, which are not tax-deductible.

Ordinary shareholders are said to hold a residual claim on the company's income and assets, meaning that they hold the property rights in any income that is left after all commitments to other stakeholders (employees, creditors, the tax authorities and bondholders) have been discharged. Similarly, in the event of liquidation of the company, ordinary shareholders hold a residual claim on any of the company's assets that remain after all other claimants have been paid off. While ordinary shareholders stand at the back of the queue for repayment when things go wrong, they also benefit from limited liability, meaning that the most they can lose in the event of the company's liquidation is the value of their own shareholdings. Ordinary shareholders are not personally liable for any further losses or debts the company may have incurred.

Preference shares or preferred stock has certain characteristics similar to ordinary shares, and others similar to corporate bonds. Like a bondholder, the preference shareholder is entitled to a fixed dividend payment each year. However, payment of the dividend is not a contractual obligation for the company, and non-payment does not trigger bankruptcy proceedings. Instead, unpaid preference share dividends accumulate, and must be paid off before any dividends can be paid to ordinary shareholders. The preference shareholders' entitlement to a share of the assets in a company that is liquidated ranks higher than the ordinary shareholders' entitlement, but below that of the bondholders. Dividends on preference shares, like those on ordinary shares, are paid from net (after-tax) profits.

Bonds and equity are the two principal instruments a company can use to finance its assets in the long term. A company that chooses to increase its long-term borrowing by issuing new bonds also increases its leverage. This means the returns earned by the company's shareholders become more volatile. The relationship between leverage and volatility is illustrated in the following highly stylised example.

Example

Company A holds assets of £100 financed by bonds of £80 and equity of £20. Company A pays its bondholders 5% per annum, equivalent to £4, on the nominal value of their holdings. Company A earns profits of either £8, £6, or

£4, equivalent to a return on assets of either 8%, 6% or 4%. This means Company A's shareholders achieve a return on equity of either

$$\frac{8-4}{20}=20\%,\ \frac{6-4}{20}=10\%$$

$$or\ \frac{4-4}{20}=0\%.$$

Now suppose Company A decides to increase its assets to £200. The purchase of additional assets is to be financed by a new bond issue with a nominal value of £100. Company A's assets of £200 are now financed by bonds of £180 and equity of £20. Company A continues to pay its bondholders 5% per annum, equivalent to £9, and earns profits of either £16, £12 or £8, equivalent to the same returns on assets as before. This means Company A's shareholders now achieve a return on equity of either

$$\frac{16-9}{20}=35\%,\ \frac{12-9}{20}=15\%$$

$$or\ \frac{8-9}{20}=-5\%.$$

In the example, Company A increases leverage by changing its capital structure, measured by the ratio of debt to equity, from

$$\frac{80}{20}=4\ \text{to}\ \frac{180}{20}=9.$$

As a consequence, the range of possible returns achieved by Company A's shareholders increases. Initially the range of possible returns was from 0% to 20%. With the additional leverage the range widens, and becomes from −5% to 35%. The returns on Company A's equity become more volatile as a consequence of the increase in leverage.

Reading 1.2

Please now consolidate your understanding of the principal characteristics of bond and equity investments by reading from Bodie *et al*, Chapter 2, Section 2.2 'The bond market' and Section 2.3 'Equity securities', pages 33–43.

Bodie *et al* (2018) Sections 2.2 'The bond market' and 2.3 'Equity securities' from Chapter 2 'Asset classes and financial instruments' in *Investments*. pp. 33–43.

Optional Reading 1.1

If you are interested in the detail of bond pricing and calculating yield-to-maturity, these are explained in Chapter 14 in Bodie *et al*, Section 14.2 'Bond pricing' and Section 14.3 'Bond yields', but this is Optional Reading.

Review Question 1.1

Please now check your understanding of what you have studied so far in this unit by providing short answers to the following questions.

1. What features of money market securities make the prospect of large capital gains and the risk of large capital losses minimal or negligible?

2. In what ways are preference shares like long-term corporate bonds? In what ways are preference shares like ordinary shares?
3. Explain the concept of leverage, and its implications for the risk of equity investment.

1.6 Derivatives

Derivatives are securities that produce payoffs which depend on the values of other securities or assets, such as bond or equity prices, market index values, or commodity prices. Derivative securities include forwards and futures, options, and swaps.

1.6.1 Forward and futures contracts

A forward or futures contract obliges the holder to buy or sell a specific asset at a specific price on a specific delivery date. By accepting an obligation to buy under a futures contract, an investor takes a long position; by accepting an obligation to sell, the investor takes a short position. In contrast, options (as you will see below) allow the holder to choose whether to buy or sell. Futures contracts are standardised, and are traded through exchanges. The first exchange to trade in futures was the Chicago Mercantile Exchange in 1972; LIFFE, the London International Financial Futures Exchange, was established in 1982. Traditionally, trades were matched and executed in the pit of the exchange; but electronic trading has eliminated the need for any physical location. Futures contracts are highly liquid, and can be bought and sold at any time before expiration. Futures can be written on financial assets (stock market indexes, treasury bonds, interest rates, currencies) or physical commodities (agricultural products, metals, petroleum). For physicals, the grade or quality of the commodity must be specified.

The terms of a futures contract are adjusted daily so as to maintain a zero market value. For example, suppose you hold a futures contract today obliging you to buy an item at a price of 100 after 30 days. Tomorrow an otherwise identical contract falling due after 29 days is available at a price of 105. In this case, +5 is credited to your account tomorrow. This process of debiting or crediting is known as marking to market. The trader maintains an account with a broker, and sums are credited or debited daily. A minimum balance, known as the initial margin, must be maintained. The account must be topped up immediately if losses cause the balance to fall below the maintenance margin, set usually at around 75% of the initial margin. If this threshold is breached, the trader receives a margin call, requiring the balance to be replenished. The additional deposit is called the variation margin. The exchange bears and manages the credit risk. There is no bid-offer spread, but a brokerage fee is payable to the exchange member (broker) who facilitates the trade. The fee contains a margin that reflects the credit risk of the client.

Forward contracts are not standardised: terms are subject to negotiation between the two parties. Forward contracts are available on a wide range of asset types. The size of the contract is determined by negotiation/agreement.

Forward contracts are more flexible than futures, but they are also less liquid. The purchaser of a forward contract deals direct with a counterparty (such as a bank or other financial institution) which writes such contracts. Forwards are traded in OTC (over-the-counter) markets, enabling the purchaser to compare terms offered by different counterparties. The counterparty bears the credit risk.

The price at which the forward contract will be settled contains a bid-offer spread (*ie* the counterparty would sell gold in 90 days' time at a higher price than the price at which it would buy gold). Prices can differ between different counterparties. The contract is initially priced so that its value is zero. The value subsequently becomes positive or negative, depending on the movement of the expected price of the asset at expiration relative to the forward price (the price at which the forward contract is to be settled). There is no marking to market, and forward contracts create no cash flows before the expiration date.

1.6.2 Options

A call option gives the holder the right, but not the obligation, to buy an asset or security, often a specified number of company shares, at a specified exercise price or strike price on (or in some cases before) a specified expiration date. A put option gives the holder the right, but not the obligation, to sell an asset at a specified exercise price on (or in some cases before) the expiration date. A call option will only be exercised if the exercise price is below the market price of the underlying security on the exercise date. Otherwise the call option will expire and be left unexercised. Likewise a put option will only be exercised if the exercise price is above the market price of the underlying security on the exercise date.

European options give the holder the right to exercise only on the expiration date. American options give the holder the right to exercise on or before the expiration date. A call option is said to be in-the-money if the current share price is above the exercise price, and out-of-the-money if the current share price is below the exercise price. Similarly, a put option is in-the-money if the current share price is below the exercise price, and out-of-the-money if the current share price is above the exercise price.

Review Question 1.2

What is the difference between a call option, and a long position in a futures contract?

Readings 1.3 and 1.4

For further details on futures and options, including some useful examples illustrating how prices for these derivative contracts are quoted, please now read Bodie *et al*, Chapter 2, Section 2.5 'Derivative markets', pages 50–52.

For a more comprehensive survey of derivative securities and markets, please also read the article 'Should we fear derivatives?' by Stulz (2004).

Based on your reading, write down some reasons as to why derivative securities might be either helpful or damaging to the stability of the financial system.

Bodie *et al* (2018) Section 2.5 'Derivative markets' from Chapter 2 'Asset classes and financial instruments' in *Investments*. pp. 50–52.

Stulz (2004) 'Should we fear derivatives?' *Journal of Economic Perspectives,* 18 (3), 173–92.

1.6.3 Swaps

The reading by Stulz (2004) introduced swaps with an example concerning mortgage payments, and how an interest rate swap can be used to convert variable interest rate mortgage payments into fixed interest rate payments. A swap is an agreement between two parties to exchange two different schedules of payment obligations. Two basic types of swap agreement are interest rate swaps and currency swaps. Swaps are also available on payment streams associated with other assets, *eg* equity or commodity indexes, government or corporate debt. A plain vanilla swap involves an exchange of fixed interest rate and floating interest rate payments (this could apply to payments denominated in different currencies). At the end of each period, if the floating rate is higher than the fixed rate, then the party that pays floating and receives fixed has to pay the other party. If the floating rate is lower than the fixed rate, the party that pays fixed has to pay the other party. Swap markets have grown enormously since swaps were first transacted, in the early 1980s. The International Swap Dealers Association (ISDA, formed in 1985) organises the swaps market.

1.7 Property and Commodities

Commercial or residential property is considered to be investment grade if it attracts the interest of large institutional investors, such as insurance companies, pension funds, or real-estate investment trusts (REITS). Institutional investors are attracted to large properties that carry the potential to generate significant revenue streams, such as shopping malls or apartment blocks situated in prosperous urban locations. Property offers relatively stable income streams to the investor. Capital values tend to be more volatile, especially when they are based on actual prices, rather than valuations. Most property market indexes are based on valuations, which are subject to smoothing and therefore understate volatility. Returns on property market indexes tend to exhibit low correlation with those for other asset classes, suggesting that property investment offers a diversification gain; but the diversification effect may be overstated due to smoothed property valuations that do not accurately reflect property prices. Property income should offer a hedge against inflation, because rents can be adjusted for inflation regularly.

However, there is no guarantee that property prices or values will always increase in line with inflation. Property is a relatively illiquid investment, due to the time it takes the purchaser to complete due diligence in any transaction; and due to a common reluctance of buyers and sellers to transact at current market-clearing prices, particularly when prices are stable or declining.

Tradeable commodities fall into three main categories.

1. Metals, including gold, silver, platinum and copper
2. Energy, including oil and gas
3. Agricultural products and livestock, including corn, wheat, coffee, cotton, sugar and cattle.

Returns on commodity investments depend on price fluctuations, which in turn depend on variations in market demand and supply. In general there is low correlation between returns on commodities and the returns on other financial instruments, suggesting that investment in commodities can be a useful means of diversification. In some cases, however, the diversification gain is constrained by the heavy representation of certain commodities in market indexes, *eg* energy companies in the FTSE-100. Commodities investments may also be undertaken as a hedge against inflation, or as a means of gaining direct exposure to the commodity concerned. Direct purchase of commodities can involve significant transaction, storage and insurance costs. Alternatively, investment exposure to some natural resources, such as oil and gas, can be achieved by buying shares in publicly-held energy companies, such as Shell or BP. Other ways of achieving exposure to commodities include investments in commodities futures, and investments in mutual funds, investment companies, equity-based commodity exchange-traded funds (which track a commodities stock market index), or exchange-traded commodities (which track the price of the commodity itself).

1.8 Rate of Interest and Rates of Return

In this section you will examine the various ways in which interest can be expressed, including the allowance for inflation and taxation, the equivalent annual rate, and the annual percentage rate. You will also examine continuous compounding, and the holding-period rate of return.

1.8.1 Rate of interest

A rate of interest is a promised regular payment on a bank deposit, or other security, denominated in some currency unit over a specified time period, and specified as a proportion or percentage of the sum on deposit, or the nominal value of the security. A risk-free interest rate is one for which there is no risk that the bank, or the issuer of the security, will default on its commitments to pay the depositor or holder of the security. An interest rate that is risk-free in nominal terms (*ie* in terms of the currency unit in which it is denominated, such as dollars or pounds) will not be risk-free in real terms,

due to uncertainty over inflation, which erodes the purchasing power of currency units expressed in nominal or monetary units.

The nominal rate of interest, denoted *rn* and expressed as a decimal, is the rate expressed in monetary terms. For example, a nominal rate of 5% is equivalent to *rn* = 0.05.

The real rate of interest, denoted *rr*, is the nominal rate adjusted for the loss of purchasing power due to inflation. Using the notation in Bodie *et al* (2014), an approximation for the real rate of interest is

$$rr \cong rn - i \tag{1.1}$$

where *i* denotes the rate of inflation in decimals. The exact formula for the real rate of interest is:

$$rr = \frac{rn - i}{1 + i} \tag{1.2}$$

Accordingly, if the nominal interest rate is 5% and inflation is running at 2%, so *i* = 0.02, the real rate of interest is

$$rr = \frac{0.05 - 0.02}{1 + 0.02} = 0.0294$$

or 2.94%.

The approximation is

$$rr \cong 0.05 - 0.02 = 0.03$$

or 3%.

According to the theory of loanable funds, originally attributed to the nineteenth-century Swedish economist Knut Wicksell and formalised by Robertson (1937) and Ohlin (1937), the equilibrium real rate of interest is determined at the intersection of the supply and demand for funds. This is shown in Figure 5.1 in Bodie *et al* (2018: p. 120). The supply of funds is upward-sloping, because a higher real interest rate encourages households to save. The demand for funds is downward-sloping because a lower real interest rate makes borrowing costs cheaper in real terms, encouraging firms to undertake more investment projects. Government borrowing is also included in the demand for funds. If the government wishes to run a larger budget deficit, this increases the demand for loanable funds at every interest rate (shifting the demand function to the right) and causes the equilibrium real interest rate to increase.

According to the Fisher (1930) equation, the equilibrium nominal interest rate is the equilibrium real rate adjusted for expected inflation:

$$rn = rr + E(i) \tag{1.3}$$

The nominal rate should compensate the lender of funds for the erosion of their real value caused by inflation; the real rate reflects the lender's reward for supplying funds *after* compensation for inflation. If the expected rate of

inflation exceeds the nominal rate of interest, the real rate of interest becomes negative. Taxes are payable on nominal interest income, which implies the net (after-tax) real interest rate is inversely related to the rate of inflation. The tax code fails to recognise that part of the nominal rate is compensation for inflation. Using the approximation, the net real interest rate is

$$rm(1-\tau)-i=(rr+i)(1-\tau)-i=rr(1-t)-i\tau \tag{1.4}$$

For example, if the nominal interest rate is 5%, the rate of inflation is 2%, and the rate of tax on nominal interest income is 20% or $\tau = 0.2$, then

$$rr(1-\tau)-i\tau = 0.03\times 0.8-0.02\times 0.2=0.02$$

or 2%. The (approximate) pre-tax real interest rate is 3%. Therefore, in this example, a rate of tax of 20% on nominal interest income is equivalent to a tax rate of 33% on real interest income.

1.8.2 Rates of return

A rate of return measures the overall return obtained by the investor from holding a security, taking into account interest or coupon payments, and any movement in the price of the security between the time of purchase and the time the security either matures, or is sold. A zero-coupon security with a nominal value of 100, a maturity of T years, and a purchase price of $P(T)$, offers a return of $r(T)$ such that

$$P(T)\times(1+r(T))=100 \tag{1.5}$$

By rearrangement

$$r(T)=\frac{100}{P(T)}-1 \tag{1.6}$$

The *equivalent annual rate* (EAR) is the annual rate that would compound to produce the same value after T years:

$$(1+EAR)^T=(1+r(T)) \tag{1.7}$$

This implies the formula for the EAR is

$$EAR=(1+r(T))^{1/T}-1 \tag{1.8}$$

For example, if the price of a zero-coupon treasury security that matures in three months (one quarter of one year) is

$$P(1/4)=99.4$$

then

$$r(1/4)=0.00604 \text{ or } 0.60\%$$

And

$$EAR = \left(1.00604\right)^4 - 1 = 0.0244$$

or 2.44%.

If the price of a ten-year zero-coupon treasury security is

$$P\left(10\right) = 70$$

then

$r\left(10\right) = 0.4286$, or 42.86%.

And

$$EAR = \left(1.4286\right)^{1/10} - 1 = 0.0363$$

or 3.63%.

The *annual percentage rate* (APR) is often quoted alongside interest rates calculated over shorter periods (*eg* monthly) on credit cards or overdrafts. The APR is the per-period rate $r(T)$ multiplied by the number of compounding periods per year.

In the previous example, for the three-month zero-coupon treasury security,

$$APR = 0.00604 \times 4 = 0.02416$$

or 2.42%. The APR is fractionally lower than the EAR, because effectively the APR is calculated using simple interest while the EAR is calculated using compound interest.

The relationship between EAR, APR and $n = 1/T$, where n is the number of compounding periods per year is as follows:

$$1 + EAR = \left(1 + T \times APR\right)^{1/T} \tag{1.9}$$

The *continuously compounded* rate of return, denoted *rcc*, is obtained by allowing T to tend to zero, or (equivalently) by allowing n, the number of compounding periods per year, to tend to infinity. As T tends to zero, the term

$$\left(1 + T \times APR\right)^{1/T}$$

tends to

$$e^{r_{cc}}$$

where e is the natural exponential, equal to 2.71828.

Accordingly

$$1 + EAR = e^{r_{cc}} \tag{1.10}$$

or

$$\ln\left(1 + EAR\right) = r_{cc} \tag{1.11}$$

where ln is the natural logarithm (the logarithm to base e)

For the three-month zero-coupon treasury security introduced earlier, the continuously compounded rate is

$$r_{cc} = \ln(1.0244) = 0.0241$$

or 2.41%.

The continuously-compounded rate is fractionally lower than the EAR, because the EAR is based on compounding that takes place every three months, but the continuously-compounded rate assumes compounding at every instant. Therefore a smaller continuously compounded rate is required to achieve the same return over a one-year period as the EAR.

For non-zero-coupon bonds and for shares that pay dividends, the calculation of the realised return must take account of any coupon or dividend payments received by the investor. For a share that pays dividends, the realised *holding-period return* (HPR) is defined as

$$HPR = \frac{\text{Ending price} - \text{Starting price} + \text{Dividends}}{\text{Starting price}} \qquad (1.12)$$

where the ending price is the price of the security at the end of the holding period, and the starting price is the price at the start of the holding period.

Reading 1.5

To consolidate your understanding of interest rates and rates of return, please now read from Bodie *et al*, Chapter 5, Section 5.1 'Determinants of the level of interest rates' and Section 5.2 'Comparing rates of return for different holding periods', pages 118–24.

Bodie *et al* (2018) Sections 5.1 'Determinants of the level of interest rates' and 5.2 'Comparing rates of return for different holding periods' from Chapter 5 'Risk, return, and the historical record' in *Investments*. pp. 118–24.

1.9 Measuring Reward and Risk

In this section you will examine measures of reward and risk. In theory the measures of reward and risk would be based on the probability distribution of returns – the possible returns and the probability of the returns occurring. But in practice it is not possible to specify this distribution accurately, and instead we use measures of reward and risk that are estimates based on historical observations of returns.

1.9.1 Forward-looking measures

When an investor purchases a security, the dividends and the ending price are uncertain. However, the investor may take a view concerning the expected value of the HPR, and concerning the extent to which the realised HPR might diverge from this expected value, either above or below.

In theory, the *expected rate of return*, $E(r)$, often called simply the expected return, is calculated by assigning probabilities, $p(s)$ to each possible value the realised HPR might take under any possible scenario, denoted s, and

calculating the probability-weighted average of the returns under each scenario

$$E(r) = \sum_s p(s) r(s) \tag{1.13}$$

The *variance of the rate of return*, σ^2, a widely-used measure of risk, is the average value of the squared difference between each possible HPR and the expected return

$$\sigma^2 = \sum_s p(s)\left[r(s) - E(r)\right]^2 \tag{1.14}$$

The *standard deviation of the rate of return*, σ, is the square root of the variance.

In the following example you can verify the calculations for the expected return, variance and standard deviation. Table 1.1 shows five possible scenarios, the HPR in each scenario, and the probability of each scenario occurring.

Table 1.1 HPR in five possible scenarios

Scenario, *s*	Very good	Good	Usual	Poor	Very poor
HPR	0.07	0.05	0.03	0.01	–0.01
p(*s*)	0.05	0.25	0.40	0.25	0.05

The expected return is calculated as

$$E(r) = 0.05 \times 0.07 + 0.25 \times 0.05 + 0.40 \times 0.03 + 0.25 \times 0.01 + 0.05 \times (-0.01) = 0.03$$

or 3%.

The variance of the return is

$$\begin{aligned}\sigma^2 &= 0.05 \times (0.07 - 0.03)^2 + 0.25 \times (0.05 - 0.03)^2 + 0.4 \times (0.03 - 0.03)^2 \\ &\quad + 0.25 \times (0.01 - 0.03)^2 + 0.05 \times (-0.01 - 0.03)^2 \\ &= 0.00036\end{aligned}$$

And the standard deviation of return is

$$\sigma = \sqrt{0.00036} = 0.01897$$

or 1.90%

For a risky security, the *risk premium* is the difference between the expected return for the security and the return on a risk-free security held over the same period. The risk-free security could be treasury bills or treasury bonds. The *excess return* is the difference between the realised HPR for the security and the return on the risk-free investment.

1.9.2 Backward-looking measures

In practice, it is difficult to assign probabilities accurately to a range of possible future scenarios, in order to calculate a forward-looking expected return or standard deviation for a security. Investors often base their assessments of expected return and standard deviation on a backward-looking

analysis of a historical time series of realised returns, each of which is calculated over a fixed interval, such as daily, weekly, monthly or yearly.

Let $r(t)$ denote the realised return in period t, defined for $t = 1$ to $t = T$ in the same way as the HPR. An estimator of the expected return is the *arithmetic mean return*, defined as the arithmetic mean or simple average of the series of realised returns

$$\bar{r} = \frac{1}{T}\sum_{t=1}^{T} r(t) \tag{1.15}$$

It is important to note that if the arithmetic mean return is compounded over T periods, it fails to reproduce the HPR or end-value that would have been achieved by holding the security over the entire period from $t = 1$ to $t = T$

$$HPR = \left[1 + r(1)\right] \times \left[1 + r(2)\right] \times \ldots \times \left[1 + r(T)\right] \neq \left(1 + \bar{r}\right)^{T} \tag{1.16}$$

The *geometric mean return* or *time-weighted average return*, denoted g, is the per-period rate of return that would compound to the end-value that is actually achieved by the time series of realised returns

$$HPR = \left[1 + r(1)\right] \times \left[1 + r(2)\right] \times \ldots \times \left[1 + r(T)\right] = \left(1 + g\right)^{T} \tag{1.17}$$

An expression for the expected difference between the arithmetic mean return and the geometric mean return is (Bodie *et al*, 2014)

$$E\left(\text{geometric mean return}\right) = E\left(\text{arithmetic mean return}\right) - \tfrac{1}{2}\sigma^2 \tag{1.18}$$

Therefore the difference increases with σ^2, the variance of the per-period returns.

An estimator of the variance of the per-period returns is the *sample variance*, calculated using the time series of realised returns

$$\hat{\sigma}^2 = \frac{1}{T-1}\sum_{t=1}^{T}\left(r(t) - \bar{r}\right)^2 \tag{1.19}$$

The corresponding estimator of the *standard deviation* is $\hat{\sigma}$, the square root of the sample variance.

Assuming that the returns on a security in each period are determined randomly, and are therefore uncorrelated with one another, we can examine the relationship between the expected return, variance and standard deviation for a lower-frequency (*eg* yearly) series of observed returns, and a higher-frequency (*eg* monthly) series for the same security observed over the same period.

For the expected return the relation is

$$\left[E(r) \text{ for yearly series}\right] = 12 \times \left[E(r) \text{ for monthly series}\right] \tag{1.20}$$

For the variance the relation is

$$\left[\sigma^2 \text{ for yearly series}\right] = 12 \times \left[\sigma^2 \text{ for monthly series}\right] \tag{1.21}$$

And for the standard deviation the relation is

$$\left[\sigma \text{ for yearly series}\right] = \sqrt{12} \times \left[\sigma \text{ for monthly series}\right] \tag{1.22}$$

Reading 1.6

Please now read from Bodie *et al*, Chapter 5, Section 5.4 'Risk and risk premiums' and Section 5.5 'Time series analysis of past rates of return', pages 126–34, to review and reinforce your understanding of the contents of this section. The Sharpe ratio is introduced towards the end of this reading. It is the ratio of the risk premium to the standard deviation of excess returns, and captures the trade-off between reward and risk. You will study the Sharpe ratio in detail later in the module, in the context of optimal portfolio selection (Unit 4), portfolio management (Unit 7) and performance (Unit 8).

Bodie *et al* (2018) Sections 5.4 'Risk and risk premiums' and 5.5 'Time series analysis of past rates of return' from Chapter 5 'Risk, return, and the historical record' in *Investments*. pp. 126–34.

Review Question 1.3

a) An investment earns an annual rate of return of 5% in the first year, 4% in the second year, and 8% in the third year. What is the equivalent annual rate (EAR) over three years?
b) What is the continuously compounded rate of return that corresponds to the EAR calculated in (a)?
c) A credit-card company charges 1.5% interest per month on unpaid balances. What is the annual percentage rate (APR)?
d) A security will produce holding-period returns of 8%, 4% or 0% under three alternative states of the world (optimistic, neutral and pessimistic). The probabilities assigned to the three states are 0.2, 0.5 and 0.3, respectively. Calculate the security's expected return and standard deviation.

Solutions

a) After three years an investment of \$1 would be worth

$$\left(1+0.05\right)\times\left(1+0.04\right)\times\left(1+0.08\right)=\$1.17936$$

so the equivalent annual rate is

$$\left[\left(1+0.05\right)\times\left(1+0.04\right)\times\left(1+0.08\right)\right]^{1/3}-1=0.056531$$

or 5.6531%.

b) The relation between the equivalent annual rate and the continuously compounded rate is given by

$$1+EAR=e^{r_{cc}}$$

and

$$r_{cc}=\ln\left(1+EAR\right)=\ln\left(1+0.056351\right)=0.054991$$

or 5.4991%.

To confirm this, with continuous compounding at a rate of 5.4991% over three years an investment of \$1 would be worth

$$e^{\left(3\times 0.054991\right)}=\$1.17936$$

c) The APR corresponding to a monthly rate charged on credit cards is reported as 12 times the monthly rate. In this case the monthly rate is 1.5% and

$$APR = 12 \times 0.015 = 0.18$$

or 18%.

The equivalent annual rate is

$$EAR = \left(1 + 0.015\right)^{12} - 1 = 0.195618$$

or 19.56%.

You can check the relation between the EAR and the APR from

$$APR = \frac{\left(1 + EAR\right)^{T} - 1}{T} = \frac{\left(1 + 0.195618\right)^{1/12} - 1}{1/12} = 0.18$$

d) The expected rate of return is calculated as the weighted average of the returns in the possible scenarios, with the weights provided by the probability of each scenario occurring

$$E\left(r\right) = 0.2 \times 0.08 + 0.5 \times 0.04 + 0.3 \times 0.00 = 0.036$$

or 3.6%.

The variance of the return is the weighted sum of the squared deviations of the return in each scenario from the expected return

$$\sigma^2 = 0.2 \times \left(0.08 - 0.036\right)^2 + 0.5 \times \left(0.04 - 0.036\right)^2 + 0.3 \times \left(0.00 - 0.036\right)^2$$
$$= 0.000784$$

And the standard deviation of the return is the square root of the variance

$$\sigma = \sqrt{0.000784} = 0.028$$

or 2.8%.

1.10 Treasury bills, Government Bonds and Equities: The Historical Record

There is a popular belief that investing in equities provides the investor with the most favourable return in the long term. In a series of publications, Elroy Dimson, Paul Marsh and Mike Staunton of the London Business School have published data that permits international comparisons on nominal and real rates of return on treasury bills, government bonds and equities since the start of the twentieth century. According to Dimson *et al* (2016), between 1900 and 2015, investors in treasury bills earned annualised real (inflation-adjusted) returns of 0.8% in the US, and 1% in the UK. The annualised real rates of return for government bonds were 2% in the US, and 1.7% in the

UK. The annualised real rates of return for equities were 6.4% in the US, and 5.4% in the UK.

Another way of drawing comparisons is to calculate the cumulative inflation-adjusted value achieved in 2015 of $1 or £1 invested in each type of security in 1900.

On this basis, $1 would have grown to $1,271 if invested in US equities, but only $10 if invested in US government bonds, and $2.70 if invested in US treasury bills.

And £1 would have grown to £415 if invested in UK equities, £7 if invested in UK government bonds, and £3.30 if invested in UK treasury bills.

These very large differences between the returns on bills, bonds and equities are based on an assumption that all dividends paid on equities are reinvested in equities. Furthermore, the calculations ignore transaction costs that would, in reality, be incurred in maintaining a portfolio of equity investments over a 116-year period. The figures illustrate the power of compounding over long periods: a relatively small difference of 1% between the annualised real rates of return on US and UK equities leads to a very large difference in the cumulative value of the investments following compounding over a period of 116 years!

In comparisons across 21 countries drawn by Dimson *et al* (2016), the US is ranked third in terms of annualised real rate of return on equities, surpassed only by Australia and South Africa. It is noticeable that countries severely damaged during the First and Second World Wars, including Germany, Austria, Italy and Japan, all perform relatively poorly on this comparison. One possible explanation for the strong performance of US equities is volatility: perhaps the US stock market was more volatile than those of other countries, and the relatively high average returns in the US were associated with higher risk.

This conjecture is not supported by the data, however: the standard deviation of annualised real returns for the US, at 20.1%, is the sixth-lowest out of 21 countries. The UK figure is similar, at 19.7% (fifth-lowest). Again, countries that suffered severe war damage and/or hyper-inflation in the first few decades of the twentieth century are among the highest-ranked for volatility.

The superiority of equities as an investment in comparison with treasury bills and government bonds is suggested by these very long-term comparisons. But the same result does not always hold when comparisons are drawn over shorter periods. For individual decades, for example, UK government bonds produced real returns very similar to UK equities during the 1990s, and bonds outperformed equities during the 2000s. In the first two decades of the twentieth century, UK equities produced a negative real rate of return. At times in the past, therefore, an investor would have to be extremely patient to have appreciated the advantages of equity investments over bonds or bills.

For international investors, the overall return on an investment denominated in a foreign currency depends not only on the return produced by the instrument itself, but also on movements in the relevant exchange rate. Movements in nominal exchange rates are driven partly by differences between rates of inflation in the countries concerned. The average annualised inflation rate over the period 1900–2015 was 2.9% in the US and 3.7% in the UK. In 1900 the nominal exchange rate was \$1 = £0.208. By 2015, sterling had depreciated to a nominal exchange rate of \$1 = £0.67. This represents an average depreciation of 1% per year. In real terms, however, after adjusting for the difference in average inflation between the US and the UK, the average depreciation is only 0.22% per year. This implies that a UK resident who invested in US equities would have earned an annualised real return of

$$1.064 \times 1.0022 - 1 = 0.066$$

or 6.6%, while a US resident who invested in UK equities would have earned a real return of

$$1.054 \times 0.9978 - 1 = 0.052$$

or 5.2%. In general, cross-country differences in stock market returns reflect differences in domestic stock market performance to a much greater extent than differences in real exchange rates.

Readings 1.7 and 1.8

Please now read Bodie *et al*, Chapter 5, Section 5.8 'Historic returns on risky portfolios', pages 140–47, which provides further details on the historical record for investments in treasury bills, government bonds and equities in the US, including comparisons between equities in different categories (large or small capitalisation, high or low book value-to-market value ratio). This reading refers to the normal distribution. You will examine the normal distribution and how it can be used in portfolio theory in detail in Unit 4.

Bodie *et al* (2018) Section 5.8 'Historic returns on risky portfolios' from Chapter 5 'Risk, return, and the historical record' in Investments. pp. 140–47.

Please also read the article 'Long-term asset returns' by Dimson *et al* (2016), which presents comparisons of long-term historical rates of return for treasury bills, government bonds and equities for 21 countries, over a 116-year period from 1900 to 2015.

Dimson *et al* (2016) 'Long-term asset returns'. *Financial Market History: Reflections on the Past for Investors Today.* pp. 2–26.

Please read this paper, and then comment on the factors that appear to have been most influential in determining the rankings of countries in terms of their average historical real rates of return on equities. You should consider the importance of factors such as volatility, inflation, and war.

1.11 Conclusion

In this unit you have studied financial planning, financial instruments, and the measurement of reward and risk. In financial planning, the formulation of an explicit investment policy helps inform the choice of financial instruments that will deliver a preferred combination of reward and risk. Financial instruments that form the building blocks of any investment portfolio include short-term, low-risk money market instruments, typically traded in large volume. Government and corporate bonds are long-term debt instruments.

Equity, which confers an ownership stake in the company, is typically a higher risk instrument. Located further towards the upper end of the risk spectrum, the payoffs from derivatives depend on changes in the value of the underlying assets or securities. Property and commodities are relatively illiquid investment vehicles that offer potential diversification gains. Having completed this unit, you should be able to calculate expected return and the standard deviation of returns, the most commonly used measures of reward and risk. You should also be able to comment on the long-term historical performance of bonds and equities as investment vehicles.

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