Bond Market: An Introduction

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1st edition

ISBN 978-87-403-0593-7

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1 Context & Essence

1.1 Learning outcomes

After studying this text the learner should / should be able to:

1. Understand the slot the bond market occupies in the financial system.
2. Be acquainted with the general terminology of the bond market.
3. Dissect the bond market definition into its elements.
4. Discuss the characteristics of the plain vanilla bond.
5. Calculate interest payments of a plain vanilla bond.

1.2 Introduction

The purpose of this text is to provide an overview of the bond market and its role in the financial system. We start with a brief introduction to the financial system, and then contrast the money market with the bond market, although together they make up the debt market. We then describe the characteristics of the most common bond, the so-called plain vanilla bond. We then just mention the bond derivatives.

The following sections are presented:

- The financial system in brief.
- The money market in a nutshell.
- The bond market in a nutshell.
- Essence of the plain vanilla bond.
- Bond derivatives.

1.3 The financial system in brief

As seen in Figure 1, the financial system is essentially concerned with borrowing and lending. Lending occurs either directly to borrowers (e.g. equities held by an individual) or indirectly via financial intermediaries (e.g. an individual holds units and the unit trusts holds as assets the liabilities of the ultimate borrowers). Although this is the main function, there are many related others as reflected in the following definition of the financial system:

The financial system is a set of arrangements / conventions embracing the lending and borrowing of funds by non-financial economic units and the intermediation of this function by financial intermediaries in order to facilitate the transfer of funds, to create additional money when required, and to create markets in debt and equity instruments (and their derivatives) so that the price and allocation of funds are determined efficiently.

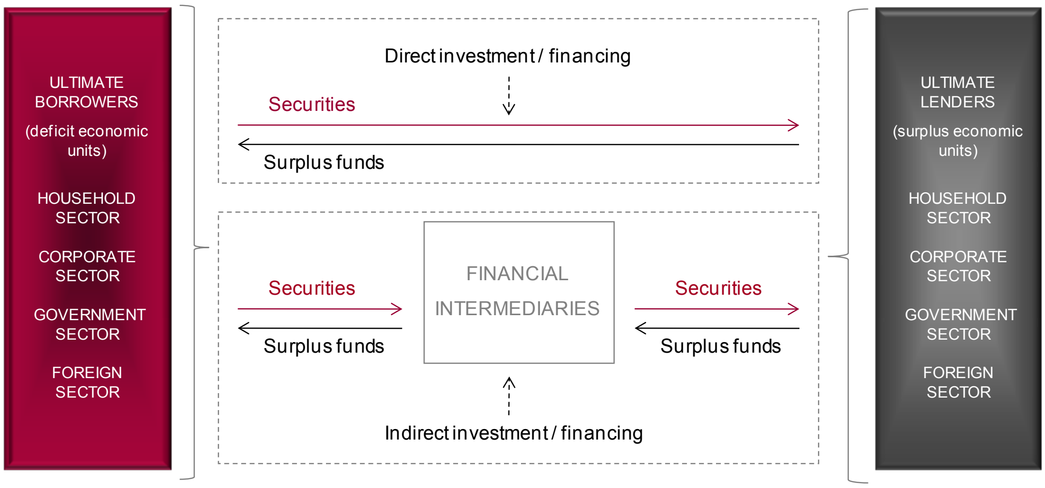


Figure 1: simplified financial system

Dissecting this definition reveals six essential elements:

- First: *lenders* (surplus economic units or surplus budget units) and *borrowers* (deficit economic units or deficit budget units), i.e. the non-financial economic units that undertake the lending and borrowing process. There are four groups of lenders and borrowers: household sector, corporate sector, government sector and foreign sector, and many members of these groups are lenders and borrowers at the same time.
- Second: *financial intermediaries* which intermediate the lending and borrowing process. They interpose themselves between the lenders and borrowers.
- Third: *financial instruments*, which are created to satisfy the financial requirements of the various participants; these instruments may be marketable (e.g. treasury bills) or non-marketable (e.g. participation interest in a retirement annuity).
- Fourth: the *creation of money* when demanded. Banks have the unique ability to create money by simply lending because the general public accepts bank deposits as a medium of exchange.
- Fifth: *financial markets*, i.e. the institutional arrangements and conventions that exist for the issue and trading (dealing) of the financial instruments;
- Sixth: *price discovery*, i.e. the price of shares / equity and the price of money / debt (the *rate of interest*) are "discovered" (made and determined) in the financial markets. Prices have an allocation of funds function.

In this series of modules on the bond market we will not cover *money creation* and the *genesis of short-term interest rates* (this takes place in the money market). We do cover the other elements briefly here as they form the context of the bond market. We begin with the financial intermediaries.

The financial intermediaries that exist in most countries are shown in Box 1 in categories. The individual intermediaries or categories are then presented in Figure 2 in terms of their relationship to one another.

BOX 1: FINANCIAL INTERMEDIARIES

MAINSTREAM FINANCIAL INTERMEDIARIES

DEPOSIT INTERMEDIARIES

Central bank (CB)
Private sector banks

NON-DEPOSIT INTERMEDIARIES

Contractual **intermediaries (CIs)**

Insurers
Retirement funds (pension funds, provident funds, retirement annuities)

Collective investment schemes (CISs)

Securities unit trusts (SUTs)
Property unit trusts (PUTs)
Exchange traded funds (ETFs)

Alternative investments (AIs)

Hedge funds (HFs)
Private equity funds (PEFs)

QUASI-FINANCIAL INTERMEDIARIES (QFIs)

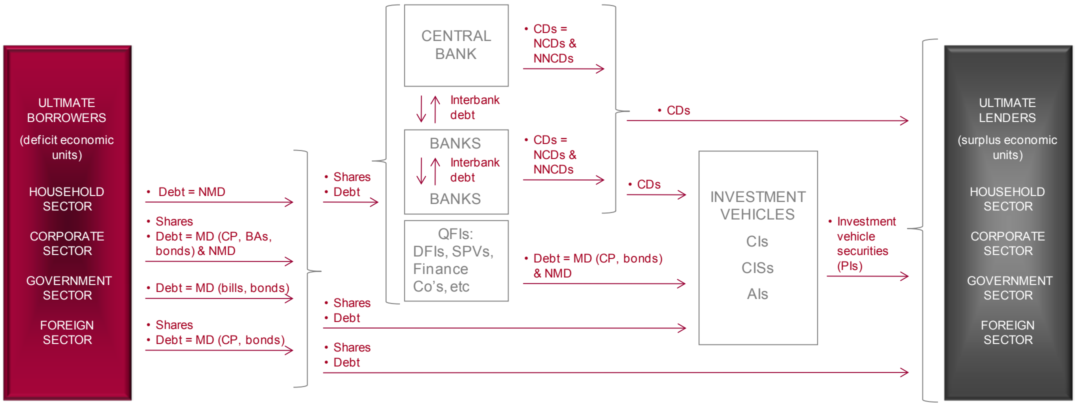
Development finance institutions (DFIs)
Special purpose vehicles (SPVs)
Finance companies
Leasing companies
Investment trusts / companies
Micro lenders
Buying associations

The *financial instruments* issued by the ultimate borrowers and the financial intermediaries are also shown in Figure 2. They can be categorised into:

- debt instruments
- deposit instruments (which are a variation of debt instruments)
- equity instruments.

We focus here on the debt instruments because bonds are such instruments.

Debt instruments represent either marketable debt (MD) or non-marketable debt (NMD) and are either short-term or long-term in term to maturity. The former is usually defined as up to a year and the latter as longer than a year. The MD and the NMD of short duration are part of the money market while only the MD of long-term duration makes up the bond market.



MD = marketable debt; NMD = non-marketable debt; CP = commercial paper; BAs= bankers' acceptances; CDs = certificates of deposit (= deposits); NCDs = negotiable certificates of deposit; NNCDs = non-negotiable certificates of deposit; foreign sector issues foreign shares and foreign MD (foreign CP & foreign bonds); PI = participation interest (units)

Figure 2: financial intermediaries & instruments / securities

The issuers of bonds (long-term MD) are:

- corporate sector
- government sector
- foreign sector
- QFIs.

The detail in this regard will be returned to later.

It will be evident from the above that there exist two *financial markets*: the debt and equity markets; they are depicted in Figure 3 together with the foreign exchange market. Note that:

- The money market is the short-term arm of the debt market; it comprises of short-term NMD and MD.
- The bond market is part of the long-term debt market; the latter is made up of long-term NMD and MD while the bond market is the MD arm.
- The money market (= the short-term arm of the debt market) and the long-term debt market make up the debt market.
- The debt market is also known as the interest-bearing market and the fixed-interest market. The terms *interest-bearing* and *fixed-interest* differentiate the debt market from the equity market because the returns on shares are dividends and dividends are not fixed – they depend on the performance of companies. (Here we are ignoring fixed-interest preference shares.)

- The bond and equity markets make up the *capital* market; called as such because companies and governments access long-term non-permanent capital (through bond issues) or permanent capital (through share issues; companies only) in these markets. (Here we ignore exceptions such as perpetual bonds and redeemable preference shares.)
- The foreign exchange (forex) market is not a financial market, but a conduit for foreign investors into local financial markets and for local investors into foreign financial markets.

To the debt and equity (and forex) markets we may add the derivative markets. Although lending and borrowing also do not take place in the derivative markets, they play an important role in the financial system in terms of enabling participants in the real[1] economy to hedge (thereby creating stability in production).

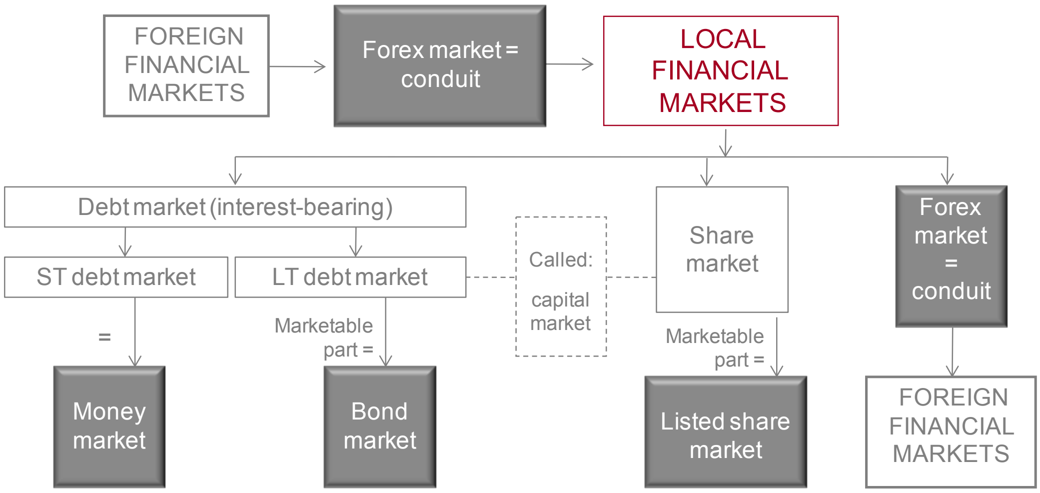


Figure 3: financial markets

Financial markets can be categorised into primary and secondary markets. The former is the market for the issue of new securities and the latter the market for the trading of securities that are already in issue. It will be apparent that non-marketable debt instruments only have primary markets (e.g. a participation interest in a retirement fund) and that MD are issued in the primary markets and traded in the secondary markets (e.g. treasury bills).

Financial markets are either OTC (over-the-counter), such as the money market, or exchange driven, such as the equity market. Next we define the money market which leads to a detailed description of the bond market.

1.4 The money market in a nutshell

The money market is usually defined as the market for marketable short-term debt instruments and the bond market as the market for marketable long-term debt instruments. However, as hinted at above, it is our opinion that the money market is far more than this. It is comprised of the following markets:

- The primary markets that bring together the supply of retail and wholesale short-term funds and the demand for wholesale and retail short-term funds (marketable and non-marketable).
- The secondary market in which existing marketable short-term instruments are traded.
- The creation of new money (deposits) and the financial assets that lead to this (loans in the form of NMD and MD securities).
- The central bank-to-bank interbank market (cb2b IBM) and the bank-to- central bank interbank market (b2cd IBM) where monetary policy is played out and interest rates have their genesis (i.e. where repo is implemented).
- The bank-to-bank interbank market (b2b IBM) where the repo rate has its secondary impact, i.e. on the interbank rate.
- The money market derivative markets (= an addendum).

This is why we define the money market as comprising the entire short-term debt market. Another strong reason is that short-term interest rates are not primarily "discovered" in the short-term marketable debt market; rather they are discovered in the non-marketable debt market (starting with the repo rate, which then influences the interbank rate, then the bank call rates and so on…), and marketable short-term debt rates then take their cues from these rates. It will be evident that the short end of the yield curve is established in the money market.

1.5 Essence of the bond market

1.5.1 Introduction

The long-term debt market is an extension of the money market. The bond market is a part of the long-term debt market: it is the market for *marketable* long-term debt; i.e. debt that is issued in the form of tradable securities. Few borrowers are able to access this market, mainly because of the demands of the lenders in terms of credit risk, marketability, etc. (this will become clearer as we progress this discussion). Formally, we define the bond market as:

The bond market is the mechanism / conventions that exist for the issue of, investing in, and the trading of instruments that represent the long-term undertakings (usually of a fixed capital nature) of the issuers.

If this definition is dissected, we arrive at the following key words:

- Bonds.
- Market mechanism.
- Issue (primary market).
- Investing.
- Trading (secondary market).
- Long-term undertakings of a fixed capital nature.

Each of these key words will be explained briefly.

1.5.2 Bonds

Bonds may be defined as marketable long-term debt obligations of the issuers. Each issuer undertakes to repay the face value at the end of the stated redemption (maturity)[2] period of the bond, plus interest at specified intervals or at the end of the period, and the interest rate may be fixed or floating.

The holder of a bond has a claim on the assets and revenue of the issuer in the event of bankruptcy. This means that the corporate bondholder has a prior claim on assets in relation to equity. In many cases the bond certificate states that the holder has such a claim.

1.5.3 Market mechanism

The *market mechanism* is the structure, systems and conventions that exist to facilitate the issue and trading of bonds. As we have seen, there are two types of market, i.e. the OTC market and the exchange-regulated market. Most bond markets around the world are OTC markets.[3]

1.5.4 Issue (primary market)

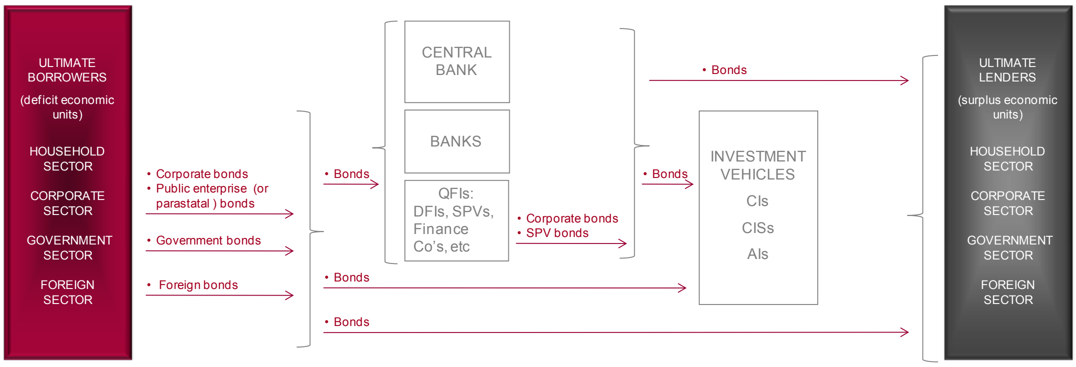


Figure 4: bond issuers

There are five broad classes of *issuers* in the bond market:

- Government sector (usually three levels).
- Corporate sector entities (private sector-owned).
- Corporate sector entities (public sector-owned; called public enterprises or parastatals).
- Special purpose vehicles (SPVs).
- Foreign sector entities (inward listings).

The place of each of the five broad classes of issuers in the financial system may be depicted as in Figure 4. The detail will be provided later.

The largest issuer of bonds in almost all countries is the government sector; in some cases this is 100%.

1.5.5 Investing

The *investors* in (or holders of) bonds are also depicted in Figure 4. Of the ultimate lenders, the foreign sector is the largest investor. The other three ultimate lender sectors are insignificant holders and may be largely ignored in the big picture scenario we are creating. All the mainstream financial intermediaries are investors in bonds, but the largest holders are the retirement funds (a CI), the long-term insurers (a CI) and the bond unit trusts (a CIS).

1.5.6 Trading (secondary market)

Trading in bonds (i.e. secondary market broking and dealing) is a sizeable business in most financial markets. As noted earlier the secondary market is either OTC or exchange-driven. The market is "made" / facilitated by a number of players:

- *Members of bond exchanges* where such exchanges exist.[4] The members are the *banks*, smaller *broker-dealers* and *interdealer brokers*. In some countries the banks act as primary dealers (a subset of market makers), which is dealt with later. The broker-dealers are smaller firms that trade for own account or for clients. Interdealer brokers exist in some markets; they offer a brokerage service exclusively between the members of the exchanges.[5]
- *Discount houses.* In some countries where exchanges do not exist and the banks are reluctant to make a market in bonds, the discount houses (which are specialised banks) act in this capacity.
- *Banks.* In some countries where exchanges do not exist the banks act as market makers / primary dealers.
- *Issuers*. Certain issuers make a market in their own paper, with the objective of enhancing the liquidity of their paper, thus reducing the rate of interest (cost) for them.
- *Speculators / arbitrageurs*. These may be members of exchanges (the members that only deal for themselves) or non-members. Most of them trade intra-day in order to avoid settlement outlays. Their usefulness lies in increasing the turnover in the bond market, leading to efficient price discovery.
- *Investors*. The investors play a significant role in the bond market. The major investors as noted are the retirement funds and insurers), the foreign sector (mainly foreign retirement funds) and bond unit trusts.

1.5.7 Long-term undertakings of a fixed capital nature

The *long-term undertakings of a fixed capital nature* of issuers are what give rise to the issue of bonds. Many companies and governments and public enterprises (also called parastatals) have a requirement for long-term funds to finance projects such as infrastructure (roads, telecommunications systems, deep mining, etc). The financial planning side of a long-term project would be problematical if the company was only able to issue short-term instruments (like commercial paper – CP). There would be two main financial considerations (and inconveniences) in this regard:

- The uncertainty of obtaining the funds at each rollover at maturity.
- The uncertainty of the rate of interest to be paid at each rollover date.

The ability to issue long-term bonds removes these uncertainties. The issuer has a fixed (i.e. a known) rate that is paid at known intervals and the funds are available for the full long-term period.

1.6 Essence of the plain vanilla bond

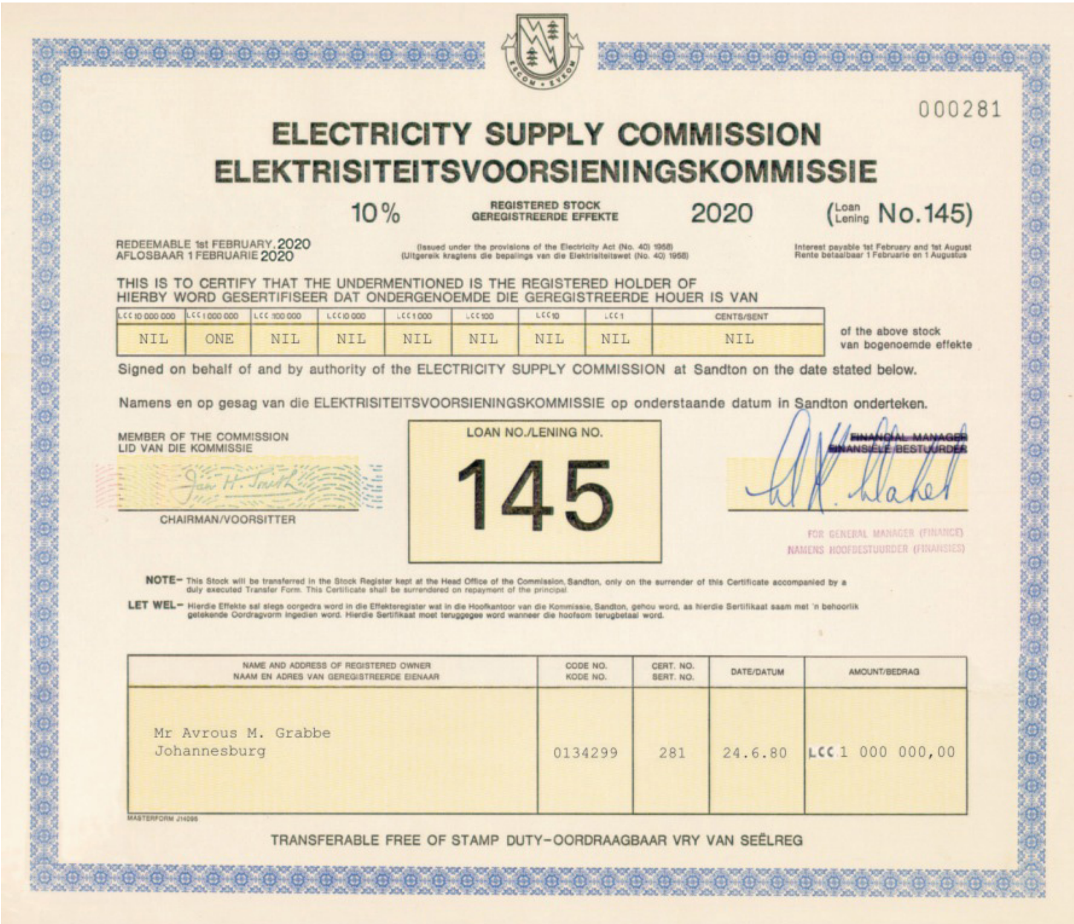
There are many types of bonds in the bond markets of the world, and we mention them here (they are discussed in detail later):

- Plain vanilla bonds
- Bearer bonds versus registered bonds
- Perpetual bonds versus fixed term bonds
- Floating rate bonds versus fixed rate bonds
- CPI bonds
- Zero coupon bonds versus coupon bonds
- Call bonds
- STRIPS
- Convertible bonds
- Exchangeable bonds
- Bonds with share warrants attached
- General obligation bonds
- Revenue bonds
- Serial bonds
- Catastrophe bonds
- Asset-backed bonds

- Senior, subordinated, junior and mezzanine bonds
- Junk bonds
- Guaranteed bonds
- Pay-in-kind bonds
- Split coupon bonds
- Extendable bonds
- Foreign bonds
- Eurobonds
- Global bonds
- Retail bonds.
- Islamic bonds

About 95% of all bonds in issue are of the *plain vanilla* variety; in some countries this number is 100%. This variety of bond is elucidated below with the assistance on an actual bond (see[6] Box 2).

BOX 2: EXAMPLE OF PLAIN VANILLA BOND


000281

ELECTRICITY SUPPLY COMMISSION
ELEKTRISITEITSVOORSIENINGSKOMMISSIE

10% REGISTERED STOCK / GEREGISTREERDE EFFEKTE 2020 (Loan / Lening No. 145)

REDEEMABLE 1st FEBRUARY 2020
AFLOSBAAR 1 FEBRUARIE 2020

(Issued under the provisions of the Electricity Act (No. 40) 1958)
(Uitgereik kragtens die bepalings van die Elektrisiteitswet (No. 40) 1958)

Interest payable 1st February and 1st August
Rente betaalbaar 1 Februarie en 1 Augustus

THIS IS TO CERTIFY THAT THE UNDERMENTIONED IS THE REGISTERED HOLDER OF
HIERBY WORD GESERTIFISEER DAT ONDERGENOEMDE DIE GEREGISTREERDE HOUER IS VAN

LCC 10 000 000	LCC 1 000 000	LCC 100 000	LCC 10 000	LCC 1 000	LCC 100	LCC 10	LCC 1	CENTS/SENT
NIL	ONE	NIL	NIL	NIL	NIL	NIL	NIL	NIL

of the above stock
van bogenoemde effekte

Signed on behalf of and by authority of the ELECTRICITY SUPPLY COMMISSION at Sandton on the date stated below.

Namens en op gesag van die ELEKTRISITEITSVOORSIENINGSKOMMISSIE op onderstaande datum in Sandton onderteken.

MEMBER OF THE COMMISSION
LID VAN DIE KOMMISSIE

CHAIRMAN/VOORSITTER

LOAN NO./LENING NO.
145

~~FINANCIAL MANAGER~~
~~FINANSIËLE BESTUURDER~~

FOR GENERAL MANAGER (FINANCE)
NAMENS HOOFDESTUURDER (FINANSIES)

NOTE– This Stock will be transferred in the Stock Register kept at the Head Office of the Commission, Sandton, only on the surrender of this Certificate accompanied by a duly executed Transfer Form. This Certificate shall be surrendered on repayment of the principal.

LET WEL– Hierdie Effekte sal slegs oorgedra word in die Effekteregister wat in die Hoofkantoor van die Kommissie, Sandton, gehou word, as hierdie Sertifikaat saam met 'n behoorlik getekende Oordragvorm ingedien word. Hierdie Sertifikaat moet teruggegee word wanneer die hoofsom terugbetaal word.

NAME AND ADDRESS OF REGISTERED OWNER / NAAM EN ADRES VAN GEREGISTREERDE EIENAAR	CODE NO. / KODE NO.	CERT. NO. / SERT. NO.	DATE/DATUM	AMOUNT/BEDRAG
Mr Avrous M. Grabbe Johannesburg	0134299	281	24.6.80	LCC 1 000 000,00

TRANSFERABLE FREE OF STAMP DUTY–OORDRAAGBAAR VRY VAN SEËLREG

This plain vanilla bond[7] has a number of features:

- The *issuer* is Escom. Escom is the borrower. The bond is a debt obligation of Escom.
- The face value of the bond is LCC1 million. Face value is also referred to as *nominal value, par value* and *maturity value*. This is the amount payable to the holder on maturity date, which of course is a *future value* (this is discussed further in a separate section).
- The *maturity date* (due date or redemption date) of the bond is 1 February 2020.
- The *loan number* is 145. This is an internal administration number and is also used by the exchange (if there is one) to designate (code) the bond (e.g. E145).
- The *certificate number* (000281) is also an internal administration number.
- The *name and address of the registered owner* is obvious. The bond is registered in the name of Mr Avrous M Grabbe. *Registered* means that a register is kept by a Transfer Secretary and by the issuer in which the holders (owners) and their holdings (nominal value) appear.[8]
- The *coupon rate* is 10% per annum. This is significant in that this rate of interest is *fixed* for the term of the bond. Every year, the holder of this bond will receive interest of LCC100 000 (LCC1 000 000 × 0.10).
- The *interest dates* (which are difficult to read on the certificate) are 1 February and 1 August. This means that the interest amount of LCC 100 000 is paid in instalments of LCC50 000 on each of the two dates.

- The words "This stock will be transferred in the stock register kept at the head office of (Escom)… only on the surrender of this certificate accompanied by a duly executed Transfer Form… This certificate shall be surrendered on repayment of the principal" mean that the certificate represents proof of ownership. This of course does not apply in the case of immobilisation and dematerialisation.
- The word *stock* is an outmoded name for *bond*.

The two main characteristics of this bond are the *fixed term* and the *fixed rate*. These plain vanilla bonds are therefore also referred to as *fixed-rate, fixed-interest bonds.*

It should also be clear that the coupon rate of 10% pa is *not the true rate of return* on the bond for the purchaser (unless the market rate on the issue date was 10% pa), and this is so for three reasons:

- In real life the bond would most likely have been purchased at a discount to face value (i.e. for less than LCC1 million) or at a premium to face value (i.e. for more than LCC1 million).
- Compounding takes place because the cash flows prior to maturity date are reinvested.
- The reinvestment rates are not known in advance.

These "complications" indicate the need for a different measure of the rate of return, and this is the *average annual rate for the period*, termed the *yield to maturity* (ytm). To this interesting measure we shall return later.

In conclusion it is important to reiterate that over the life of the bond the *coupon does not change*. However, the market rate (ytm) changes in the secondary market on a second-to-second basis, making the price of the bond less or more than LCC100%, i.e. the value of the bond changes continuously.

1.7 Bond derivatives

In the many bond markets of the world there exist vibrant markets for the derivative instruments that have been created for the purpose of transferring interest rate risk / transforming assets and liabilities. We merely mention them here:

- Forwards.
- Futures.
- Options:
  - options on "physicals"
  - bond warrants[9].
- Swaps:
  - interest rate swaps
  - bond-equity swaps.

- Hybrids:
  - options on futures
  - swaptions.

1.8 Summary

Debt is comprised of short-term debt (part of the money market) and long-term debt. The marketable instruments of the latter group are called bonds. The bond market and the equity market together are referred to as the capital market.

There are four groups of bonds: corporate bonds (private and public sector bonds), government bonds (of different levels), foreign bonds and SPV bonds (the bonds issued by special purpose vehicles – product of securitisations).

The bond market can be described as the mechanism / conventions that exist for the issue of, investing in, and the trading of instruments that represent the long-term undertakings (usually of a fixed capital nature) of the issuers.

The most common bond is the fixed-interest rate, fixed-maturity date bond. A change in the rate (called yield to maturity – ytm) on a bond changes the price, given the fixed coupon rate.

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2 Issuers & Investors

2.1 Learning outcomes

After studying this text the learner should:

1. Understand the reasons for issuing bonds as opposed to short-term securities.
2. Know the categories of bond issuers and understand the factors that may influence their issuing activities.
3. Understand the relationship between government debt and fiscal policy.
4. Identify the holders of bonds and their reasons.
5. Have an appreciation of the risks faced in holding bonds.

2.2 Introduction

The main participants in the bond market are of course the issuers of and the investors in bonds. The value of the bonds in issue represents supply, while the value of bonds held by the investors represents satisfied demand. The rates of interest on bonds (ytm) at any point in time are "discovered" rates reflecting information relevant to the bond market, particularly short-term rates and expectations regarding future short-term rates (we cover this further later).

In the following section we cover the economics of long-term finance, i.e. the reasons why long-term finance is required by investors in the infrastructure of business and government.

In the section on the issuers of bonds we cover the categories of issuers and the factors that may influence their issuing activities.

In the section on the investors in bonds we identify the various holders, their motivations for holding bonds, as well as the risks they face in holding bonds.

2.3 The economics of long-term finance

There are many reasons for borrowing in the bond market, but the fundamental reason is to acquire long-term funds, usually for long-term capital projects (such as the building of a factory or constructing a highway or setting up the infrastructure for a gold mine). The bond market thus facilitates capital formation.

By long-term is meant periods of longer than a year and up to 30 years. In some countries, bonds are also issued for 40 years, and in a few countries (e.g. the UK and the USA) perpetual bonds (also called consoles) were issued in the past (these bonds do not have a maturity date). The other reasons for borrowing long-term (i.e. the advantages of borrowing long-term) are:

- Short-term borrowing entails a series of borrowings, i.e. a new borrowing is required every few months; it is administratively burdensome.
- The rate of interest may be higher when the rollovers take place.
- Short-term funds may not always be readily available on the rollover dates.
- An issuer's creditworthiness may decline at some stage in the short term borrowing cycle, and funds may not be available at all under this changed circumstance.
- Equity finance (which is long-term finance) may at times be too expensive.

The bond market overcomes these financially harmful possibilities. It therefore plays a significant role in the economy, in terms of making fixed investment projects possible, i.e. it facilitates capital formation.

2.4 Issuers of bonds

2.4.1 Introduction

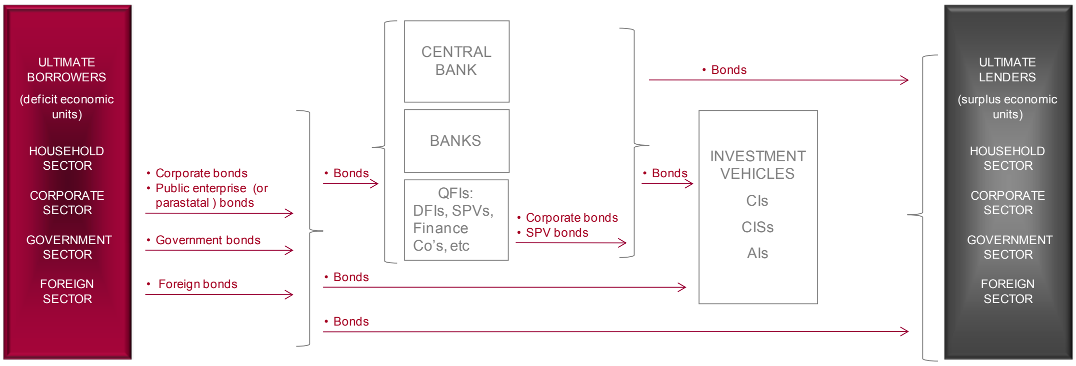

Figure 1: bond issuers

We present a depiction of the financial system and the issuers of bonds that would exist in most countries in Figure 1, and Table 1 displays the same information in table form. This represents our view of the way bonds should be categorised.

ULTIMATE BORROWERS	
HOUSEHOLD SECTOR	-
CORPORATE SECTOR	
Private sector companies (non-financial)	Corporate bonds
Public sector companies (parastatals -non-financial)	Parastatal bonds
GOVERNMENT SECTOR	
Central government	Central govt bonds
Provincial (state) governments	Prov (state) bonds
Local governments (local authorities)	Local govt bonds
FOREIGN SECTOR	
MAINSTREAM FINANCIAL INTERMEDIARIES	
DEPOSIT INTERMEDIARIES	
Central bank (CB)	-
Private sector banks	Corporate bonds
NON-DEPOSIT INTERMEDIARIES (INVESTMENT VEHICLES)	
Contractual intermediaries (CIs)	
Insurers	Corporate bonds
Retirement funds	-
Collective investment schemes (CISs)	
Securities unit trusts (SUTs)	-
Property unit trusts (PUTs)	-
Exchange traded funds (ETFs)	-
Alternative investments (AIs)	
Hedge funds (HFs)	-
Private equity funds (PEFs)	-
QUASI-FINANCIAL INTERMEDIARIES (QFIs)	
Development finance institutions (DFIs)	Parastatal bonds
Special purpose vehicles (SPVs)	SPV bonds
Finance companies	Corporate bonds
Leasing companies	Corporate bonds
Investment trusts / companies	-
Micro lenders	-
Buying associations	-

Table 1: Bond issuers

Thus we have four main categories and a number of subcategories of bonds as follows:

- Government bonds:
  - Central government bonds.
  - Provincial (state) government bonds.
  - Local government bonds.

- Parastatal bonds (issued by public enterprises).
- Corporate bonds (issued by private sector companies).
- SPV bonds (bonds issued by special purpose vehicle).
- Foreign bonds (inward listings).

To summarise, we have, according to *issuer*, five main categories of bonds. The details of each of these sectors / categories are covered below.

2.4.2 Central government

In most countries the central government is the largest single issuer of bonds. Its bonds are generally referred to as *government bonds*. The reason a government issues long-term debt obligations is to finance (partly) the budget deficit. This is justified on the grounds of the creation of infrastructure (which is not always the case).

The rates of interest on central government securities (treasury bills and bonds) are generally referred to as risk-free rates. By this is meant that they are credit risk free – in the sense that central governments have the right to raise revenue and/or borrow further in order to honour interest and capital payments.

2.4.3 Provincial / state governments

Some countries have three levels of government. Almost all countries have central governments and local governments, but some also have provincial or state governments. In some countries the provincial / state governments are permitted to raise revenue through bond issues, while in others this is not the case. These bonds are generally referred to as *provincial* or *state government bonds*.

Provincial / state government bonds in some countries are guaranteed by central government.

2.4.4 Local authorities

There are different categories of local authorities in many countries, for example:

- Metropolitan Councils (the large cities)
- District Councils
- Municipalities (or municipal authorities)
- Water Boards.

These bonds are generally referred to as l*ocal authority bonds*. The motivation of local authorities to issue bonds is usually investment in local infrastructure such as sewerage plants.

The bonds of local authorities may or may not be guaranteed by central government.

2.4.5 Public sector companies / enterprises (parastatals)

Public sector companies (i.e. companies whose equity is held by central government to the extent of 100%) are also referred to as *public enterprises* or *parastatals*. The bonds they issue are usually referred to as *parastatal bonds* or *public enterprise bonds*. From here we refer to them as parastatal bonds.

There are two subcategories here:

- Non-financial parastatals.
- Financial parastatals.

Examples of non-financial parastatals are transport companies (e.g. rail and airport) and power supply companies. Their motivation for issuing bonds is, for example, the creation of capital assets such as roads, rolling stock, electricity supply infrastructure (e.g. pylons, power stations and hydro-electric schemes), waterway infrastructure, etc.

Examples of financial parastatals are development banks, land banks, enterprise finance companies and industrial development corporations (which are often referred to as DFIs – development finance institutions). We categorise them under QFIs (quasi-financial intermediaries). Their motivations for issuing bonds are, for example, the provision of finance for emerging farmers, loans to new industrial undertakings, etc.

2.4.6 Private sector companies

The *corporate sector* in many countries is an issuer of bonds and these are logically called *corporate bonds.* There are three sub-categories:

- Non-financial companies.
- Financial intermediaries.
- Quasi-financial intermediary companies (which we categorise as QFIs).

The motivation of the non-financial companies for issuing bonds is generally to finance undertakings that have a long life (capital assets), for example, the building of a car manufacturing plant, the sinking of a mining shaft.

The obvious mainstream financial intermediaries that issue bonds are the banks and the life insurance (also called assurance) companies. Their motivation for issuing bonds is to acquire capital in order to comply with the statutory requirements (sometimes called second tier capital) as they expand business.

Examples of private sector company QFIs are finance companies [such as (fictitious) Fine Car Finance Company Limited and Fine Apparel Finance Company Limited] and leasing companies. Their motivation for issuing bonds is to provide instalment and leasing finance to the purchasers of their products.

The largest issuers of corporate bonds are the banks.

2.4.7 Special purpose vehicles

Special purpose vehicles (SPVs) are also large issuers of bonds in many countries. Generally, the banks create or encourage the creation of SPVs. These vehicles are generally created by banks in order to lighten their capital requirements. SPVs are the products of securitisations, and by the latter is meant the creation of marketable securities (in this case bonds) from non-marketable financial assets that have a regular cash flow.

An example of a securitisation will enhance comprehension, but before we get there we need to clear up the confusion that surrounds SPVs. The terminology surrounding SPVs includes securitisation, CMOs, CDOs, CLOs, MBSs, asset backed securities, securitisation bonds and so on. Research has indicated that definitions differ from country to country. It is our understanding that SPVs are created from securitisations; therefore all bonds issued by SPVs are securitisation bonds. Securitisation was described earlier. All bonds issued by SPVs are also asset-backed bonds (clear from below). The rest of the terminology is cleared up by mentioning the types of securities issued by SPVs:[10]

- Residential property backed securities [also termed collateralised mortgage obligations (CMOs) and mortgage-backed securities (MBSs)].
- Vehicle backed securities.
- Collateral debt obligations [also termed collateralised debt obligations (CDOs); sometimes referred to as repackaged corporate credit; and sometimes referred to as the debt issued by SPVs that hold as assets a portfolio of fixed-income assets].
- Credit card backed securities [sometimes referred to as collateralised loan obligations (CLOs)].
- Aircraft backed securities.
- Equipment backed securities.
- Corporate loan backed securities (also CLOs).
- Commercial property backed securities (also CLOs).

We now return to the elucidation and example. A SPV [also called a special purpose entity (SPE) in some countries] is a corporate body (usually a limited liability company) created by a *sponsor* (e.g. a bank) to fulfil a specific or a temporary objective (for example for a bank to take certain assets off its balance sheet in order to release capital for other lending purposes). The SPV issues debt obligations (bonds in this case) to finance its assets and the assets provide the return (cash flow) to the bondholders.

The SPV is not owned by the sponsor of the deal and is therefore bankruptcy-remote from it, i.e. the bondholders carry the credit risk. The SPV is managed by an administration company that is independent of the sponsor. An example will clarify the above (see Figure 2).

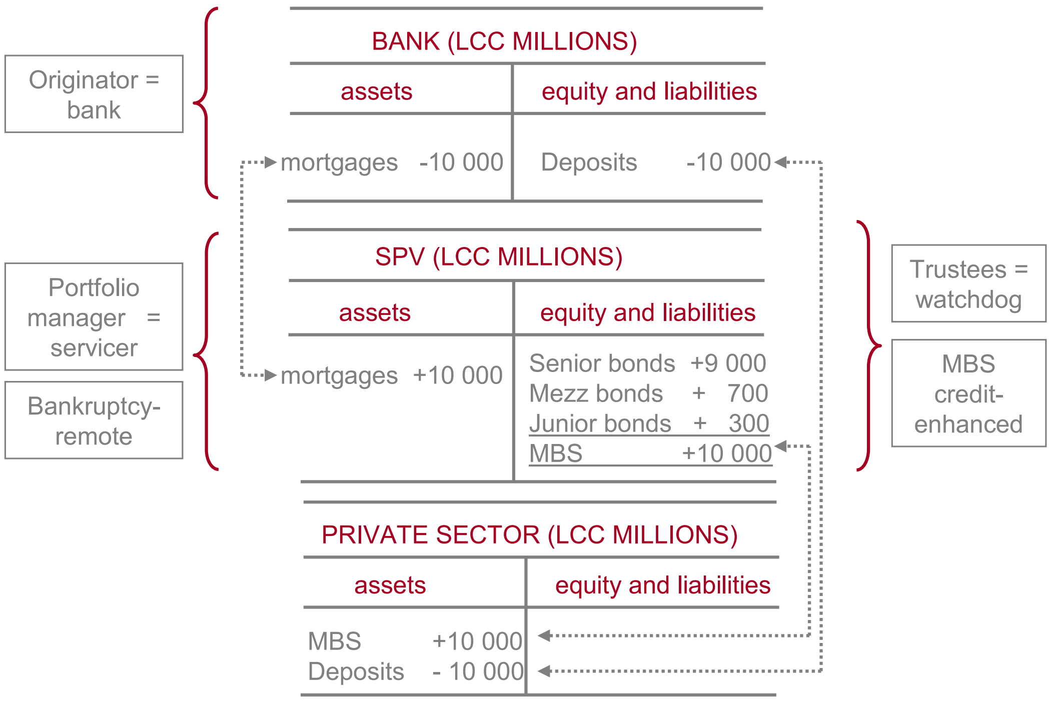

Figure 2: example of bank securitisation of mortgages

The sponsor bank sells mortgages to the SPV; the SPV issues three tiers of bonds (here called MBS) in proportions according to the requirements of the rating agency and subordinates the mezzanine bonds to the senior bonds and the junior bonds to the mezzanine bonds as indicated in the figure. This means that in the event of bankruptcy of the SPV the holders of the senior bonds have first call on the assets, followed by the mezzanine bond holders, and followed by the junior bond holders. This is called credit enhancement – the senior bonds have been *credit-enhanced*[11]. This is why they are usually highly rated (depending on other factors). The mezzanine bonds are rated lower than the senior bonds (but still at investment grade) while the junior bonds are usually unrated (and are usually taken up by some risk-taker because the rate is high)[12].

2.4.8 Foreign sector

In many countries bonds are issued by foreign entities. They are denominated in the local currency and are referred to as *foreign bonds*. Other types of foreign bonds are *Eurobonds* and *Global bonds*. These bond types are discussed in section 3.

All the issuers of bonds may be summarised as shown in Figure 3.

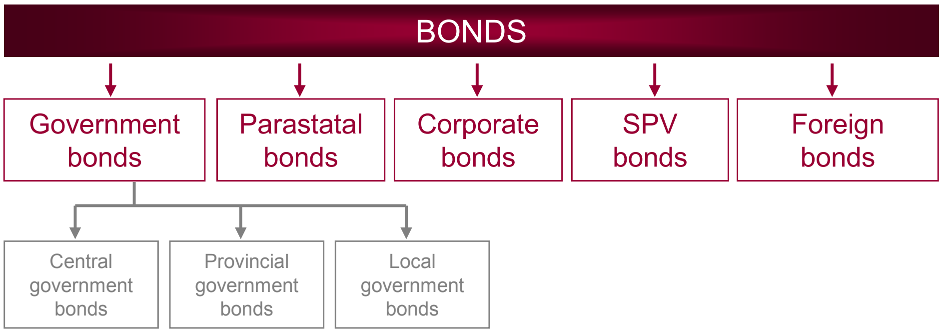

Figure 3: classification of bonds

2.5 Government debt and fiscal policy

As the largest issuer of bonds (in most countries) the central government deserves special mention. Because the central government is the largest issuer by a large margin, the local bond market essentially is a central government bond market (we call it the LCC bond market), and all other non-central government bonds are referenced on the government bonds. This is so in respect of rates and terms to maturity (often called look-alikes).

The amount of LCC bonds in issue is a reflection of the accumulation of the government budget deficits. LCC bonds are not the only instruments used to fund the deficit (the others are treasury bills and foreign loans in the main), but they constitute the main instrument. The *deficit plays an important role in fiscal policy* (defined as the taxing, spending and deficit financing programmes of government and their influence on economic growth and employment).

The management of the outstanding debt of government (called *debt management policy*) also plays a major role in the financial sector of the economy and therefore has an influence on the real sector. For example, a huge debt in relation to GDP will tend to "crowd out" the private sector. Also, the distribution of the debt and the term of the debt play a role in terms of *money creation* by banks. Debt management policy can be used to contribute to the broad economic goals of government or detract from sound policies if poorly managed.

It is notable that central governments in many cases have a legal obligation to carry out fiscal and debt management policy in a proficient manner. In South Africa, for example, the Public Finance Management Act of 1999 determines that:

"The National Treasury must – (a) promote the national government's fiscal policy framework and the co-ordination of macro-economic policy; (b) co-ordinate intergovernmental financial and fiscal relations; (c) manage the budget preparation process; (d) exercise control over the implementation of the annual national budget, including any adjustments budgets; (e) facilitate the implementation of the annual Division of Revenue Act; (f) monitor the implementation of provincial budgets; (g) promote and enforce transparency and effective management in respect of revenue, expenditure, assets and liabilities of departments, public entities and constitutional institutions; and (h) perform the other functions assigned to the National Treasury in terms of this Act."

2.6 Investors in bonds

2.6.1 Introduction

In this section we cover the following:

- Holders of bonds and ownership distribution.
- Motivations for holding bonds.
- Risks faced in holding bonds.
- Role of rating agencies.

2.6.2 Holders of bonds and ownership distribution

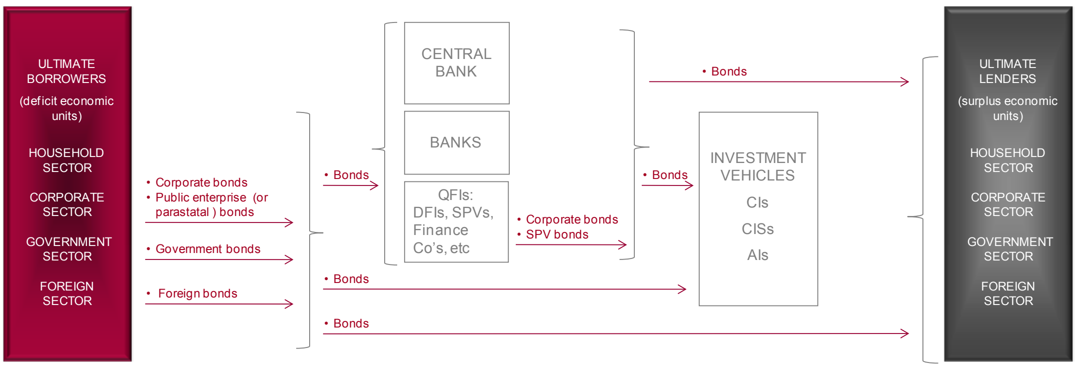

Figure 4: investors in bonds

Figure 4 and Table 2 indicate the holders of / investors in bonds.

ULTIMATE BORROWERS	
HOUSEHOLD SECTOR	To a small degree
CORPORATE SECTOR	
Private sector companies (non-financial)	To a small degree
Public sector companies (parastatals -non-financial)	No
GOVERNMENT SECTOR	
Central government	No
Provincial (state) governments	No
Local governments (local authorities)	No
FOREIGN SECTOR	
MAINSTREAM FINANCIAL INTERMEDIARIES	
DEPOSIT INTERMEDIARIES	
Central bank (CB)	Yes
Private sector banks	Yes
NON-DEPOSIT INTERMEDIARIES (INVESTMENT VEHICLES)	
Contractual intermediaries (CIs)	
Insurers	To a large degree
Retirement funds	To a large degree
Collective investment schemes (CISs)	
Securities unit trusts (SUTs)	Bond funds only
Property unit trusts (PUTs)	No
Exchange traded funds (ETFs)	No
Alternative investments (AIs)	
Hedge funds (HFs)	Some specialised HFs
Private equity funds (PEFs)	No
QUASI-FINANCIAL INTERMEDIARIES (QFIs)	
Development finance institutions (DFIs)	No
Special purpose vehicles (SPVs)	No
Finance companies	No
Leasing companies	No
Investment trusts / companies	No
Micro lenders	No
Buying associations	No

Table 2: Investors in bonds

In most countries the largest holders of bonds are the retirement funds (up to 60%) followed by the insurers at about 20%. Next in line are the banks at around 10%. They are followed by the bond funds (i.e. specialised securities unit trusts) at about 3% and the central bank at about 2%.[13]

2.6.3 Motivations for holding bonds

2.6.3.1 Introduction

Above we identified the following holders of bonds:

- Household sector
- Corporate sector
- Foreign sector
- Central bank
- Private sector banks
- Insurers
- Retirement funds
- Securities unit trusts
- Investment trusts / companies
- Hedge funds.

2.6.3.2 Household sector

This sector is a holder of bonds, but to a limited extent, mainly because individuals are not familiar with the bond market compared with the equity market. The latter market enjoys a high profile, whereas the bond market does not. The few that do hold bonds are high net-worth individuals. A number of individuals are also speculators in the bond market, but they tend to work in the financial markets and speculate in their personal capacities.

Over the past few years a number of central governments have encouraged the household sector to invest in bonds through advertising campaigns and the launching of retail bonds (i.e. small denomination bonds).

2.6.3.3 Corporate sector

Non-financial corporates are usually not in the business of investing in the financial markets, but there are a few that have surplus funds at times and make use of this market. Examples are cash-rich companies, such as mining houses and cell phone companies. These companies usually have treasury divisions, or outsource this function to specialist treasury management companies.

2.6.3.4 Foreign sector

In many countries with efficient bond markets the foreign sector is a large holder of bonds. For foreign investors to be attracted to foreign (to them) bond markets a number of criteria must be satisfied, including:

- Safety of the market in terms of settlement practices, scrip handling, scrip custody services and so on (a regulated exchange-traded market is a major attraction).
- A highly liquid market, i.e. they are able to enter and exit the market with ease.
- Existence of a repurchase agreement (repo) market in which bond positions can be "carried" (i.e. funded locally).
- No restrictions on repatriating profits.
- A stable exchange rate.

Foreign investors' motivations for holding bonds are interest rates and capital gains.

2.6.3.5 Central bank

Generally central banks are large holders of bonds as a proportion of their total assets but are small holders in relation to other financial intermediaries. Their motivation for holding bonds is that these instruments are sometimes used in open market operations (particularly short-term bonds).

2.6.3.6 Private sector banks

Many banks hold large amounts of bonds. Their motivations for holding bonds can include:

- Bonds are part of their investment portfolio. Banks earn the coupon rate and they endeavour to profit from capital gains when the prices of bonds increase (rates decrease), which may be termed opportunistic profits.
- In the case of the primary dealer banks: in order to perform this function of market making effectively.
- In order to comply with the liquid asset requirement. The banks tend to hold substantially more short-term bonds (which rank as liquid assets) than long-term bonds (which do not rank as liquid assets). This applies in most countries
- All government bonds, irrespective of term to maturity, may be used to acquire central bank accommodation.

2.6.3.7 Insurers

The long-term insurers in most countries hold bonds to the extent of about 20% of total assets. This is higher than in the case of short-term insurers, and the reason is that a larger proportion of their liabilities is of a long-term nature (insured pension commitments, life policies, retirement annuities, etc.), i.e. they have a different risk profile to the short-term insurers. Their liabilities are virtually certain compared with the *potential* liabilities (claims) in the case of the short-term insurers.

2.6.3.8 Retirement funds

Generally retirement funds are the largest holders of bonds (in many countries about 40% of total assets). Their motivation for holding bonds is obvious: they have long-term liabilities in the form of annuities (pensions), lump sum payments upon retirement of members and lump sum payments upon death.

2.6.3.9 Securities unit trusts

The specialist securities unit trusts, bond funds, hold the majority of their assets in bonds, and they vary the proportions of long- and short-term bonds according to their interest rate views.

2.6.3.10 Hedge funds

Hedge funds are involved in all financial markets as holders of securities. As opposed to “long-only” funds such as securities unit trusts, they also “go short” of securities, borrow funds and make use of derivative instruments. A few hedge funds specialise in bonds.

2.6.4 Risks faced in holding bonds

2.6.4.1 Introduction

The risks faced by bondholders are as follows:

- Counterparty risk.
- Market risk.
- Credit risk.
- Call risk.
- Reinvestment risk.
- Liquidity risk.
- Volatility risk.
- Exchange rate risk.
- Incident risk.
- Inflation risk.

2.6.4.2 Counterparty risk

Counterparty risk is twofold: the risk of tainted scrip entering the market, and settlement risk. The former involves the sale of tainted (fraudulent) certificates by a seller to a buyer. The latter involves the reneging on a deal by the counterparty to the deal resulting in the buyer / seller having to buy / sell a particular bond at an inferior rate (price).

It is notable that the introduction of an exchange-traded market, accompanied by the certificates of the issuers being dematerialised or immobilised in a CSD, eliminates the risk of tainted scrip entering the market and settlement risk.

2.6.4.3 Market risk

Market risk (also incorrectly called interest rate risk[14]) is the risk of bond rates rising and the holder making a capital loss. This is the same as the price of bonds falling, because the two are inversely related. The risk increases as the term of the bond increases. This risk cannot be avoided except by using the derivatives market to hedge, but the price of derivatives detracts from the yield enjoyed.

An example of the loss incurred in the case of a rate rise is as follows:

Bond:	L186 (a fictitious code)
Maturity date:	21/12/2029
Coupon rate:	10.5% pa
Nominal amount:	LCC10 million
Deal date (buy):	20/06/2005
Rate (ytm) (buy):	12.0% pa
Deal date (sell):	21/06/2005
Rate (ytm) (sell):	12.5% pa
Price on 20 June:	LCC88.19108%
Price on 21 June:	LCC84.82036%
Consideration on 20 June:	LCC8 819 108.00
Consideration on 21 June:	LCC8 482 036.00
Difference (loss -):	-LCC337 072.00.

The above is a true example. It will be apparent that the investor in bonds is also able to make handsome capital profits if rates fall (prices rise).

What is the principle that underlies the inverse relationship between *rate* (ytm) and *price*? It is straightforward, if a ridiculous example is used, as follows:

Bond:	L001 (due 21/12/2009)
Nominal amount:	LCC1 000 000
Coupon rate:	12.0% pa (payable in arrears on 21/12/2009)
Deal date (buy):	21/12/2008 (at 10am)
Rate (ytm) (buy):	12.0% pa (at 10am)
Deal date (sell):	21/12/2008 (i.e. same day, but at 11am)
Rate (ytm) (sell):	24.0% (at 11am)
Price on 21/12/2008 (10am):	LCC100% (or 1.0)
Price on 21/12/2008 (11am):	LCC50% (or 0.5)
Consideration on21/12/2008 (10am):	LCC1 000 000.00
Consideration on 21/12/2008 (11am):	LCC500 000.00
Difference (loss -):	-LCC500 000.00

The bond is issued on 21/12/2008, is due on 21/12/2009, has a coupon rate of 12% pa, and is bought by the investor at a rate of 12%. This means that the investor pays a price of 1.00 for the bond. This s/he does at 10 am and pays LCC1 million for the bond. After one year s/he will receive LCC120 000 in interest. At 11 am a catastrophe occurs and the rate for this bond in the secondary market rises to 24% pa. The investor panics, because s/he is of the opinion that the rate will increase to an even higher level later, and sells the bond at 24% pa.

The *market rate* of 24% pa means that there are buyers that are prepared to accept a return on the investment at this level. The coupon rate cannot change because it is a *fixed rate*. Thus, the element that has to give way is the *price* of the bon*d*. A return of 24% means that the price of the bond has to fall to 0.5 in order for the buyer to get a return of 24% pa (12.0 / 0.5). Thus, the new buyer pays LCC500 000.00 for the LCC1 million nominal value bond. On due date s/he receives LCC120 000.00 interest which means that the return is 24.0% [(LCC120 000 / LCC500 000) × 100].

If the 1-year bond rate had fallen to 6% pa, the price of the bond would have increased to 2.0. The bond would cost LCC2 000 000.00, because the new buyer wanted a return of 6% pa [(LCC120 000 / LCC2 000 000) × 100].

Thus, price and rate are inversely related. The following will now be evident:

- When the coupon rate is equal to the market rate, the price is par, i.e. 1.0.
- When the coupon rate is higher than the market rate, the price is higher than par, i.e. it is *trading at a premium*
- When the coupon rate is lower that the market rate, the price is lower than par, i.e. it is *trading at a discount*
- Changes in the price and rate of a bond are inverse.

The two main features of bonds that impact on rate/price are:

- Term to maturity
- Coupon rate.

In general, the longer the bond and the lower the coupon rate, the more price sensitive it is to changes in the market rate.

Because of the abovementioned features of bonds, investors require a measure of the price sensitivity of bonds in relation to changes in market rates. The measure developed for this purpose is called *duration*, and this will be discussed in some detail in a separate section.

Market risk is the chief risk faced by bondholders.

2.6.4.4 Credit risk

Credit risk is the risk of the issuer of the bond *defaulting* on its issued bonds, i.e. not being able to pay all or part of the maturity value and/or the interest on the bond. It is common wisdom that government bonds are risk-free, i.e. that governments never default on their issues of securities. This is not necessarily factual. As recently as 2002, a government defaulted on its debt. Other holders of government bonds have had the same fate in the distant past.

However, generally speaking, when countries are stable politically and economically, it is almost impossible for their governments to default on their debt. Thus in the stable parts of the world the rates on government securities are regarded as risk-free rates. All other rates on bonds are referenced on these risk-free rates.

The rates on a non-central government bonds are made up of two elements: the *risk-free rate* and the *risk premium*. The latter is the premium paid by the non-government issuer at issue (demanded by the buyer at issue and in the secondary market) as compensation for taking on a measure of the risk of default.

In mature bond markets non-central government issuers of bonds have their bonds rated by a rating agency (and possibly by more than one agency). Investors rely on the ratings of the credit rating agencies to gauge the quality of the borrower and to "set" the risk-premium demanded.

In conclusion we mention two variations of credit risk that flow from the above:

- Rating-downgrade risk.
- Risk-premium risk.

Rating-downgrade risk is where the business of the issuer undergoes changing business conditions (or a "shock") which leads to a downgrading by the rating agency/agencies. This of course leads to an increase in the *risk premium* on the particular bond.

Risk-premium risk refers to the risk of the overall risk-premium on corporate bonds increasing as a result of changing business conditions generally. For example, in economic recession periods, corporate bond investors may feel that the risk of companies defaulting on principal and/or interest increases. This leads to an increase in the risk premium demanded, which means that the prices of corporate bonds fall.

2.6.4.5 Call risk

Call (or prepayment) risk applies to bonds that have call provisions, i.e. the issuers have the option to "call" (prepay) their bonds. The corollary is that the holder is uncertain in respect of the future cash flows on the bond.

Issuers that have a call provision on their paper usually call the paper when the market rate has dropped below the coupon rate. The consequence of this is that the benefits of capital gains are smaller than in the case of option-free bonds, i.e. when rates decline they decline less on callable bonds.

It will be apparent that call bonds are also exposed to *reinvestment risk* (see next). When a bond is called the investor is left with the problem of investing the proceeds of the called bond in other bonds, the rate on which may be lower than the rate enjoyed on the call bond. However, this is only part of reinvestment risk, to which we now turn.

2.6.4.6 Reinvestment risk

Reinvestment risk is the risk of investing the proceeds of called call bonds at lower rates (as mentioned in the previous section) and the investment, in the case of plain vanilla bonds, of coupon interest at lower rates than the *assumed reinvestment rate*. As will be seen in the mathematics section, the bond pricing formula assumes that the coupons received are invested at the rate paid for the bond, i.e. this is an important assumption of the formula. However, this is not certain, and the rate may be lower. It is for this reason that certain investors favour zero coupon bonds.

2.6.4.7 Liquidity risk

Liquidity risk is the risk that a bond is sold below its true value, i.e. at a price that is lower than the prices of recent trade in bonds of the same maturity/duration (which is the same as selling the bond at a rate which is higher than recent trades in the relevant bond or similar bonds). This may happen if the bond market happens to be less liquid at the time of selling. The most accepted measure of liquidity risk is the spread between buy and sell rates. The wider the spread, the higher the liquidity risk.

2.6.4.8 Volatility risk

Volatility risk only applies in the case of a call bond, as in the case of *call risk*. Volatility in bonds (i.e. the extent of price/rate changes around the mean in the past) and expected volatility is one of the major inputs in the price of an option. Thus, the rate/price of a call bond will change as volatility and expected volatility change. In general:

Price of a call bond = price of option-free bond – price of embedded call option.

The higher volatility is the higher is the value of the call option. The reverse also holds, i.e. in the case of putable bonds:

Price of put bond = price of option-free bond + price of embedded put option.

2.6.4.9 Exchange rate risk

Exchange rate risk only applies in the case of bonds that are not denominated in the local currency of the holder. The holder has the risk that the currency in which the bonds are denominated depreciates, in which case the holder will receive less periodic interest and less of the principal amount on maturity in the local currency. This risk is also referred to as *currency risk*.

2.6.4.10 Incident risk

Incidents may take place that affect the interest and/or principal payments on bonds. There are many examples of this variety of risk but most analysts categorise them as follows:

- *Regulatory risk*. Laws or regulations may change that affect the status of a security and therefore its rate. For example, in some countries government bonds of a maturity of 3 years or less rank as liquid assets for banks (who are required to hold a certain minimum of these); if this status changes, the supply of these securities will increase, driving up the rate (driving down the price).
- *Political risk*. A new government may alter the terms and conditions of repayment of existing issues of bonds.
- *Disaster risk*. A company may be affected by a natural disaster (e.g. an earthquake), which could impair its ability to pay the interest on and/or principal of its issued bonds.
- *Takeover risk*. A company may be taken over and this could prejudice its obligation to bond holders.

2.6.4.11 Inflation risk

Inflation risk is the risk that the *real rate* of interest earned on a bond falls, due to inflation. For example, if an investor buys a bond at a rate of 10% pa and the annual inflation rate is 2% pa, s/he is earning a *real rate* of 8% pa. At the time of purchase the real rate is known and accepted by the purchaser. However, if the inflation rate rises to 4% pa, the holder receives a real rate of only 6% pa. This is because the rate on the bond is a *fixed rate* of return.

2.6.5 Role of rating agencies

The ratings assigned by rating agencies to the bonds of non-central government issuers have a major impact on the *rate premium* that they are obliged to pay above the benchmark risk-free rates.

The agencies collect and analyse all available accounting and other financial subjective and objective information in order to arrive at a rating that reflects the issuer's ability to pay the interest and repay the principal of the debt. Another way of putting this is that they endeavour to arrive at a *probability of default*. They make use of complex financial ratio analyses, industry analyses and economic analyses.

The financial ratios used are many, including profitability, leverage, coverage, and liquidity ratios. The three principal agencies are Moody's, Standard & Poor's (S&P) and Fitch IBCA. The rating categories of the first two agencies, as well as brief explanations of selected categories, are shown in Table 3.

	Moody's	S&P
Best quality; smallest degree of risk	Aaa	AAA
High Quality; slightly more long-term risk than top rating	Aa1	AA+
	Aa2	AA
	Aa3	AA-
Upper medium grade; possible impairment in the future	A1	A+
	A2	A
	A3	A-
Medium grade; lack outstanding investment characteristics	Baa1	BBB+
	Baa2	BBB
	Baa3	BBB-
Speculative issues; protection may be moderate	Ba1	BB+
	Ba2	BB
	Ba3	BB-
Very speculative, small likelihood of interest and principal payments	B1	B+
	B2	B
	B3	B-
Issues in poor standing; may be in default	Caa	CCC
Speculative in a high degree; with marked shortcomings	Ca	CC
Lowest quality; poor prospects of attaining real investment standing	C	C
Source: Saunders and Cornett (2001).		

Table: Moody's and S&P ratings and succinct explanation

2.7 Summary

This section discusses the many advantages long-term bonds offer over short-term securities for borrowers that borrow for capital projects. There are five groups of borrowers: government, parastatals, the corporate sector, the foreign sector and SPVs. They each have particular motivations for issuing bonds

The largest issuer is the central government and their motivations are tied in with fiscal policy.

The groups of bond holders are the four sectors that make up "ultimate lenders" and the various financial intermediaries. Each has a particular motivation for holding bonds. The largest holders are the retirement funds and insurers because of the duration of their liabilities: they seek to match them.

Bonds have many risks inherent in them such as market risk and credit risk. The rating agencies play a major role in the establishment of the risk premium paid by companies over the risk free rate.

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3 Instruments

3.1 Learning outcomes

After studying this text the learner should:

1. Understand the characteristics of the different types of bonds found in the international bond markets and be able to distinguish between them.

3.2 Introduction

There are five bond issuer groups and there are subcategories that apply to government as shown in Figure 1.

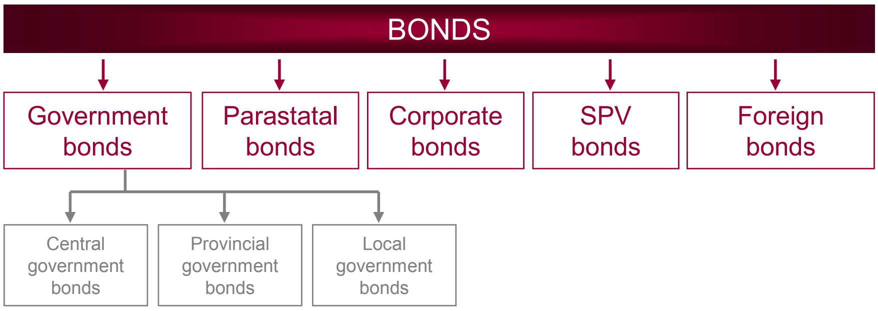


Figure 1: classification of bonds

These borrowers issue one or more of the many types of bonds that have been created to satisfy the needs of the issuers and the investors. The varieties of bonds found in international bond markets are[15]:

- Plain vanilla bonds.
- Bearer bonds versus registered bonds.
- Perpetual bonds versus fixed-term bonds.
- Floating rate bonds versus fixed-rate bonds.
- Inflation-linked bonds.
- Zero coupon bonds versus coupon bonds.
- Call bonds.
- STRIPS.
- Convertible bonds.
- Exchangeable bonds.
- Bonds with share warrants attached.
- General obligation bonds.
- Revenue bonds.
- Serial bonds.
- Catastrophe bonds.

- Asset-backed bonds.
- Senior, subordinated, junior and mezzanine bonds.
- Junk bonds.
- Guaranteed bonds.
- Pay-in-kind bonds.
- Split coupon bonds.
- Extendable bonds.
- Foreign bonds.
- Eurobonds.
- Global bonds.
- Retail bonds.

3.3 Bond instruments

3.3.1 Plain vanilla bonds

The plain vanilla bond was covered in an earlier section. A reminder: it is a fixed-term, fixed-rate and registered bond. An example is presented in Box 1 and its cash flows are presented in Figure 2.

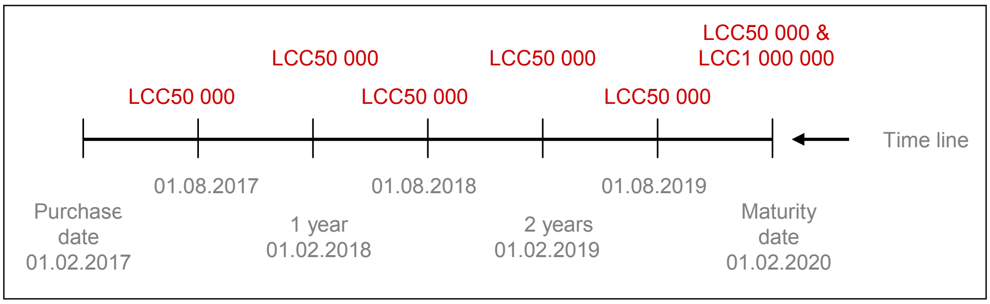


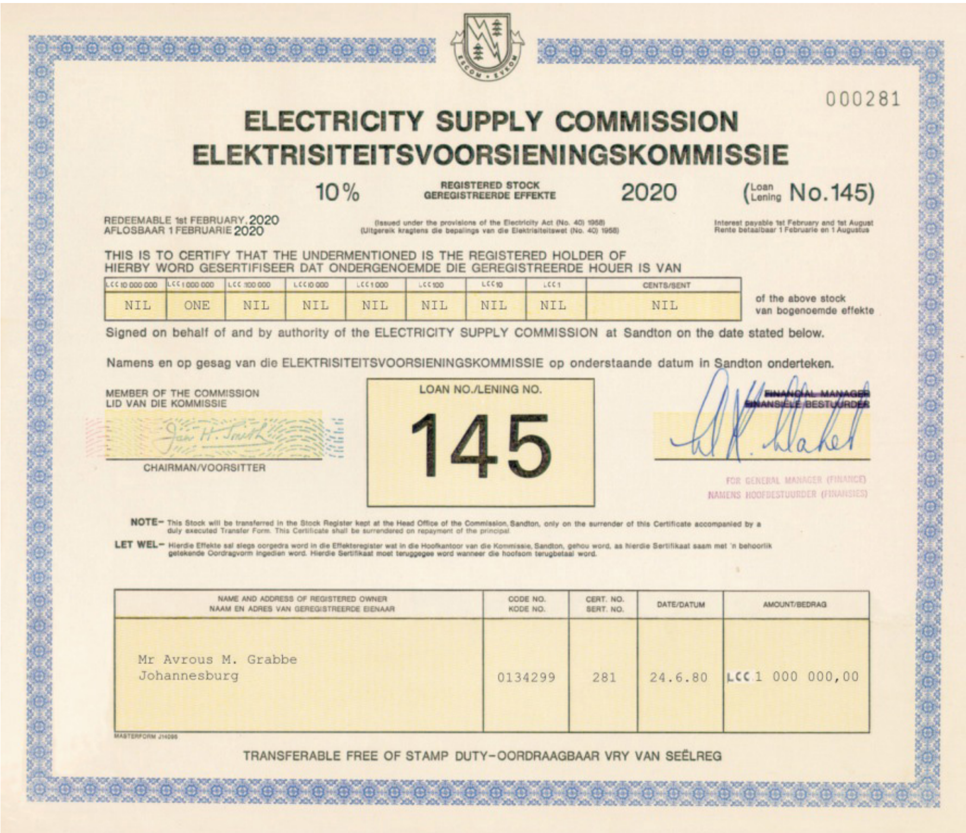
Figure 2: example of cash flows of plain vanilla bond: 10% coupon, interest payable six-monthly in arrears, due 1 February 2020

Assuming this bond is purchased on 1 February 2017 its cash flows are:

- LCC50 000 every 6 months until maturity including on the maturity date (0.10 × LCC1 000 000 / 2).
- LCC1 000 000 (the nominal / face value of the bond).

These characteristics of the bond do not change during the life of the bond. All that changes is the market rate on the bond, which brings about a change in the price of the bond.

BOX 1: EXAMPLE OF PLAIN VANILLA BOND



000281

ELECTRICITY SUPPLY COMMISSION
ELEKTRISITEITSVOORSIENINGSKOMMISSIE

10% REGISTERED STOCK GEREGISTREERDE EFFEKTE 2020 (Loan Lening No.145)

REDEEMABLE 1st FEBRUARY, 2020
AFLOSBAAR 1 FEBRUARIE 2020

(Issued under the provisions of the Electricity Act (No. 40) 1958)
(Uitgereik kragtens die bepalings van die Elektrisiteitswet (No. 40) 1958)

Interest payable 1st February and 1st August
Rente betaalbaar 1 Februarie en 1 Augustus

THIS IS TO CERTIFY THAT THE UNDERMENTIONED IS THE REGISTERED HOLDER OF
HIERBY WORD GESERTIFISEER DAT ONDERGENOEMDE DIE GEREGISTREERDE HOUER IS VAN

LCC10 000 000	LCC1 000 000	LCC100 000	LCC10 000	LCC1 000	LCC100	LCC10	LCC1	CENTS/SENT
NIL	ONE	NIL	NIL	NIL	NIL	NIL	NIL	NIL

of the above stock
van bogenoemde effekte

Signed on behalf of and by authority of the ELECTRICITY SUPPLY COMMISSION at Sandton on the date stated below.

Namens en op gesag van die ELEKTRISITEITSVOORSIENINGSKOMMISSIE op onderstaande datum in Sandton onderteken.

MEMBER OF THE COMMISSION
LID VAN DIE KOMMISSIE

CHAIRMAN/VOORSITTER

LOAN NO./LENING NO.
145

~~FINANCIAL MANAGER~~
~~FINANSIËLE BESTUURDER~~

FOR GENERAL MANAGER (FINANCE)
NAMENS HOOFDESTUURDER (FINANSIES)

NOTE– This Stock will be transferred in the Stock Register kept at the Head Office of the Commission, Sandton, only on the surrender of this Certificate accompanied by a duly executed Transfer Form. This Certificate shall be surrendered on repayment of the principal.

LET WEL– Hierdie Effekte sal slegs oorgedra word in die Effekteregister wat in die Hoofkantoor van die Kommissie, Sandton, gehou word, as hierdie Sertifikaat saam met 'n behoorlik getekende Oordragvorm ingedien word. Hierdie Sertifikaat moet teruggegee word wanneer die hoofsom terugbetaal word.

NAME AND ADDRESS OF REGISTERED OWNER / NAAM EN ADRES VAN GEREGISTREERDE EIENAAR	CODE NO. / KODE NO.	CERT. NO. / SERT. NO.	DATE/DATUM	AMOUNT/BEDRAG
Mr Avrous M. Grabbe Johannesburg	0134299	281	24.6.80	LCC 1 000 000,00

TRANSFERABLE FREE OF STAMP DUTY–OORDRAAGBAAR VRY VAN SEËLREG

Source: Eskom

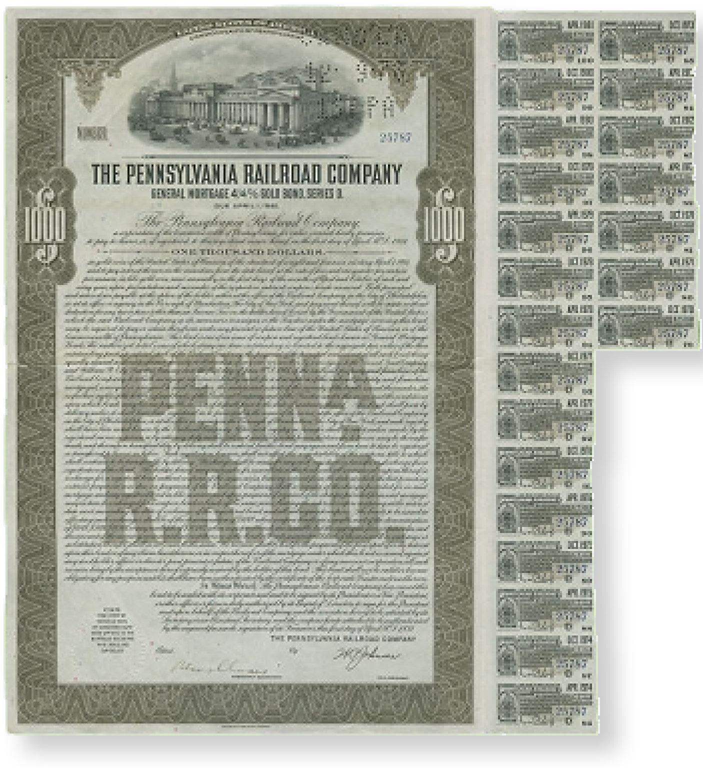
3.3.2 Bearer bonds versus registered bonds

Bearer bonds contrast to *registered bonds.* The plain vanilla bond in the example is a registered bond meaning that the name of the investor is printed on the certificate and that a register of owners is maintained. The register has two purposes: proof of ownership (together with the certificate) and the payment of interest to the registered owner.

Originally only the issuer maintained the register of owners. Later certain banks offered the service of maintenance of the register and change of registration of ownership; these services were utilised by most issuers. Later on these service providers became known as Transfer Secretaries.

With the advent of *immobilisation* and *dematerialisation* and the existence of a Central Scrip Depository (CSD), these Transfer Secretaries are now known as CSDPs (CSD Participants)[16]. With immobilisation, bonds are immobilised in the scrip depository and an electronic register is maintained by the CSDP and the CSD and these evidence ownership. The CSDP sends confirmation of ownership to investors on a regular basis. With total dematerialisation, the same situation prevails but no scrip is deposited in the CSD.[17]

BOX 2: EXAMPLE OF BEARER BOND WITH COUPONS



Source: http://riskencyclopedia.com/articles/book_entry_registered_bearer_bonds/

Transfer of ownership of registered bonds is accomplished by the completion of a *Securities Transfer Form* (CTF – also called *transfer deed*). This CTF is usually prescribed in terms of the statute that regulates companies / corporations.

In the case of *bearer bonds*, none of the above applies, i.e. the name of the issuer is not placed on the bond, and neither is a register kept. Proof of ownership is the physical bond itself.

The bond term *coupon* emanates from the bearer bonds issued in the distant past. Attached to the certificates were perforated coupons on which the amount of interest was printed. On interest dates these coupons were detached and presented to the issuer to honour. An example is provided in Box 2[18] (note the coupons on the right of the certificate).

Transfer of ownership of bearer bonds took / takes place by exchange of the certificate for funds. It will be apparent that a higher measure of risk attaches to bearer bonds, which is why they are no longer issued in the developed markets.

3.3.3 Perpetual bonds versus fixed-term bonds

Perpetual bonds are also knows as perpetuities, consols, treasury annuities and undated treasuries. They have an English genesis and they contrast to *fixed-term bonds*. A perpetual bond is a bond that has no maturity date. The rate (coupon) payable on the bond may be floating or fixed, and the rate is paid in perpetuity. An example of a fixed-rate perpetual bond is depicted in Figure 3.

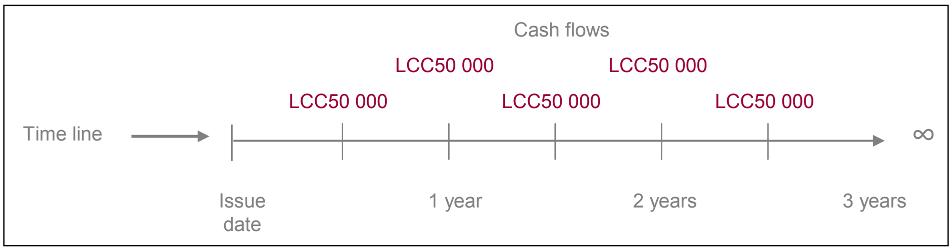


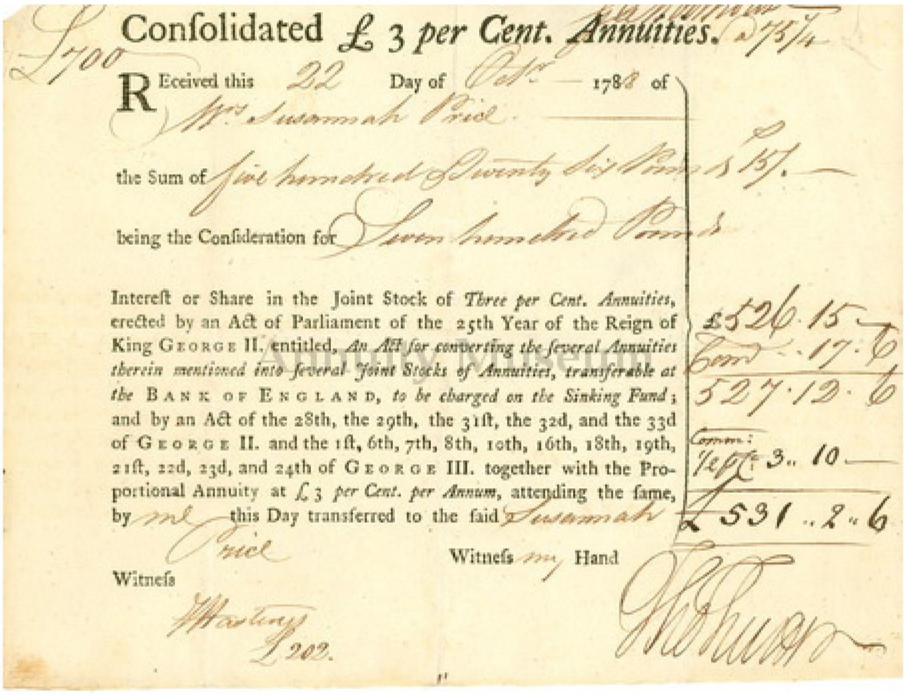
Figure 3: example of a perpetual bond (nominal value = LCC1 000 000; coupon = 10% pa)

In this example the perpetual bond has a nominal value of LCC1 million and an interest rate (coupon) of 10% per annum, payable 6-monthly in arrears. The nominal value is the amount payable for the bond *at issue* and this amount is not repayable. The LCC50 000 coupon (LCC1 000 000 × 0.10 / 2) is paid every 6 months from issue date *ad infinitum* (i.e. forever).

It will be evident that investors will only invest in these bonds if they are issued by an institution that has the ultimate creditworthiness. Only certain governments can claim this status. These bonds obviously still exist, but they are not issued any longer.

An example of a UK perpetual bond (annuity) is presented in Box 3.19

BOX 2: EXAMPLE OF PERPETUAL BOND (ANNUITY)


£700 Confolidated £ 3 per Cent. Annuities. a 75¼

REceived this 22 Day of Oct. 1783 of Mrs. Susannah Price

the Sum of five hundred & twenty six Pounds 15/. —

being the Confideration for Seven hundred Pounds

Intereft or Share in the Joint Stock of *Three per Cent. Annuities*, erected by an Act of Parliament of the 25th Year of the Reign of King GEORGE II. entitled, *An Act for converting the feveral Annuities therein mentioned into feveral Joint Stocks of Annuities, transferable at the* BANK OF ENGLAND, *to be charged on the Sinking Fund*; and by an Act of the 28th, the 29th, the 31ft, the 32d, and the 33d of GEORGE II. and the 1ft, 6th, 7th, 8th, 10th, 16th, 18th, 19th, 21ft, 22d, 23d, and 24th of GEORGE III. together with the Proportional Annuity at £3 *per Cent. per Annum*, attending the fame, by me this Day transferred to the faid Susannah Price

Witnefs my Hand

Witnefs

£526.15 —
Com. .17.6
527.12.6
Comm: 3..10 —
£531..2..6

Source: http://financelongrun.blogspot.com/2013/02/perpetual-bonds.html

3.3.4 Floating rate bonds versus fixed-rate bonds

A *floating rate bond* (also called "floating rate note" – FRN) contrasts with a *fixed-rate bond*. This bond usually has the same features as a plain vanilla bond except that it does not have a fixed coupon, i.e. the rate payable on the bond is not fixed. Instead, the rate payable is linked to some benchmark rate. The benchmark rate can be any rate that "floats", i.e. changes frequently with market conditions, but it is a rate that is quoted regularly and is reliable in terms of reflecting market conditions accurately. Examples of benchmark rates are:

- *Prime rate*. This is the rate charged by banks on overdraft facilities to prime clients, and they are usually the same. They are usually quoted by the banks on a permanent basis.
- *Interbank lending rates.* In most countries a neutral organisation (such as an exchange) gathers in a variety of rates at which a number of the large banks will lend to one another for various periods, for example overnight, 30 days, 60 days, 91 days, 182 days and so on. Here we call them *IBAR* (interbank agreed rates). The neutral organisation usually calculates and publishes daily arithmetical averages for each rate after lopping of the highest and the lowest.
- *3-month BA rate* (i.e. the rate on 3-month bankers' acceptances). This rate occupied a high profile position in many countries in the past, but the instrument is no longer as widely traded.
- *91-day treasury bill tender rate*. Most central banks, on behalf of their governments, conduct weekly treasury bill tenders for various terms. In most countries these rates are published weekly and have high credibility in the market.

An example of a floating rate bond is (see Figure 4):

Nominal value:	LCC1 000 000
Term:	3 years
Interest frequency:	6-monthly
Floating rate:	100 basis points (bp) above most recent 91-day weekly treasury bill tender rate pa on interest dates (TB rate).

Because the floating rate is a per annum rate, the 6-monthly rate is:

(TB rate + 100bp) / 2.

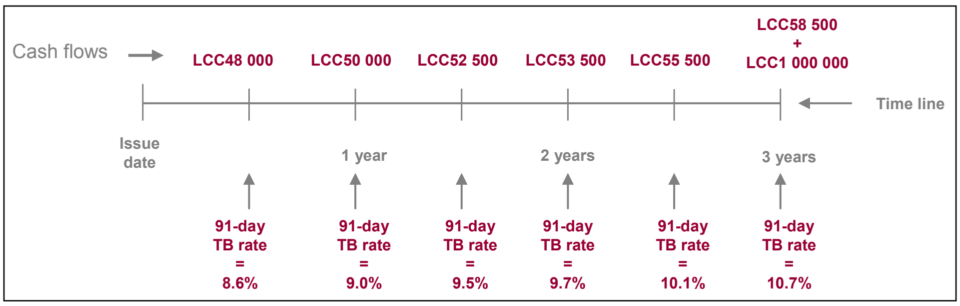


Figure 4: example of a floating rate bond

For example, the first interest amount payable is:

LCC1 000 000 × [(0.086 + 0.01) / 2]
= LCC1 000 000 × 0.048
= LCC48 000.

Floating rate bonds are also referred to as *reset bonds* in some countries.

3.3.5 Inflation-linked bonds

Inflation-linked bonds are also called *index bonds*. Their return is usually linked to the CPI (consumer price index) and as such is a variation of floating rate bonds. The differences are that the benchmark is not an interest rate but the inflation rate, and the principal value is adjusted for the differential between the CPI rate and the benchmark rate.

There is no generic CPI bond. The type is found in many countries (which are usually issued by government and parastatals – public enterprises) can be described as follows: the coupon rate is determined in an open market auction and remains fixed throughout the life of the bond. Adjustments are made to the bond's capital value to compensate for inflation.

An example is required. If the coupon on the bond is 6.0% pa and the investment is LCC1 million, the interest paid per annum is LCC60 000. If inflation in the next year is 4.0% pa, the capital value of the bond is adjusted to LCC1 040 000 (LCC1 000 000 × 1.04). The coupon rate of 6.0% pa remains unchanged but is payable on the higher capital value; it is therefore LCC62 400 (LCC1 040 000 × 0.06). This means that both capital and income are adjusted upwards by the CPI inflation rate.

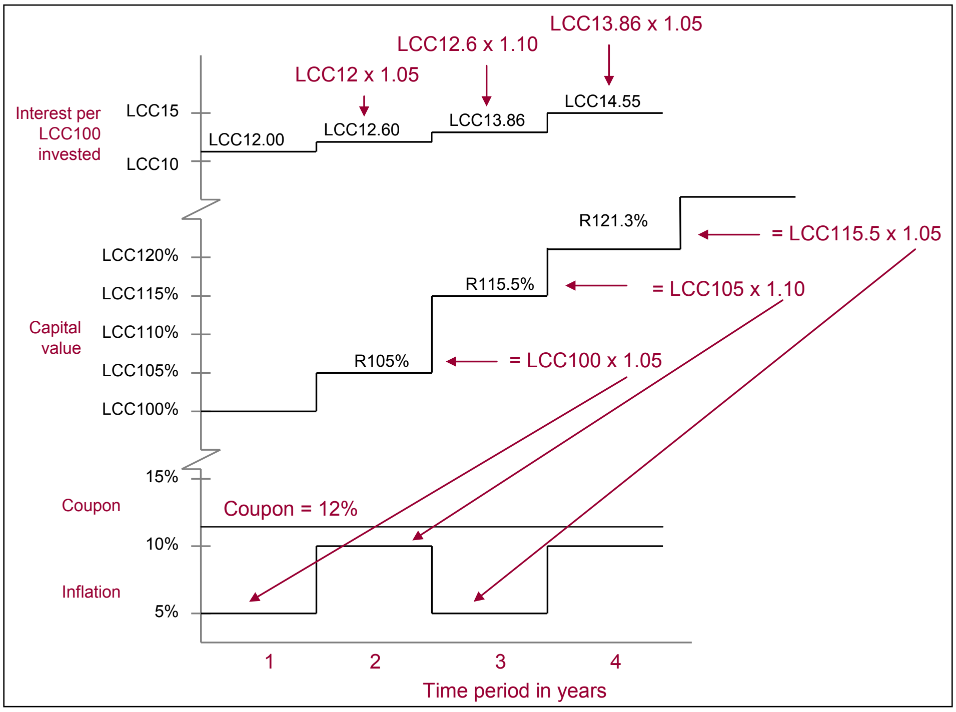


Figure 5: example of inflation-linked bond

Another example is presented in Figure 5 (inflation fluctuates between 5% and 10%; coupon = 12%).

Inflation-linked bonds are appropriate for investors who need to match inflation-linked liabilities.

3.3.6 Zero coupon bonds versus coupon bonds

A *zero coupon bond*, as the name indicates, is a bond that does not have any coupon payments. An example follows (see Figure 6):

Nominal value:	LCC1 000 000
Term:	3 years
Interest payable:	None (except that the "discount" is payable)
Interest dates:	None (except that the discount amount is payable on maturity date).

The *zero coupon bond* contrasts with the *coupon bond*, and is the most straightforward of all bonds. The face of the certificate[20] has the name of the investor, the nominal (face) value and the maturity date. It is *issued at a discount rate*, which reflects the interest rate that the investor is prepared to pay, i.e. the market rate for 3-year money. The return to the investor is the difference between that nominal value and the price paid, i.e. the discount amount.

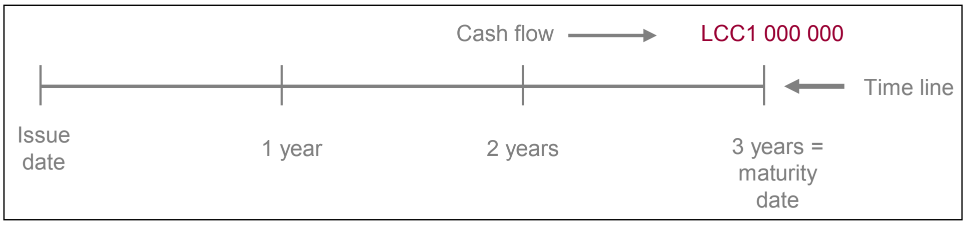


Figure 6: example of zero coupon bond

3.3.7 Call bonds

Call bonds are also termed *bonds with call provisions.* Call bonds are plain vanilla bonds that have a call provision attached, i.e. the *issuer has the option to repurchase the bond after a stipulated period* but before maturity, under certain conditions (usually price). Clearly, the issuer has the right but not the obligation to exercise this "option".

Usually in the case of call bonds a pre-determined cost to the issuer (advantage to the buyer) is included in the deal. For example, a 10% pa coupon callable bond issued at a price of 100% may be callable at a price of 110%, i.e. if the issuer calls the bond, the holder will be paid a price of 110%. Clearly, the issuer will only call the bond if the price rises to above 110%.

In the case of call bonds where the price is determined according to a tender, the bonds are called at par. This option for the issuer will ensure that the tender price will be lower than on equivalent term bonds that are not subject to calls.

There are three versions of call bonds:

1. Where the issuer has the option to call the entire issue.
2. Where the issuer has the option to call the issue in tranches.
3. Where the issuer has the option to call part of the issue.

A number of callable bonds are listed on the exchanges of the world. Although the callable feature allows the issuer to refinance at a lower rate, it places a limit on the capital gains to be made by the investor; hence callable bonds are not favoured by investors. Banks often issue callable bonds to qualify as Tier II capital in accordance with the regulations of the BASEL Accord.[21]

There are also a few bonds in issue that have put options attached, i.e. the holder has the right (but not the obligation) to sell the bond back to the issuer on or before a specified date under certain conditions.

3.3.8 Strips

STRIPS is the acronym for **S**eparate **T**rading of **R**egistered **I**nterest and **P**rincipal of **S**ecurities. These securities have existed in international bond markets for some years.

"Stripping" involves separating a plain vanilla bond into its constituent interest (coupon) payments (often called C-strips) and the principal payment (often called the P-strip), such that they exist separately.

The way bonds are stripped is straightforward: the plain vanilla bond is placed in a special purpose vehicle (SPV) and the SPV in turn issues the various "stripped" bonds (C-strips and the P-strip), with the bond providing collateral security. Bonds may also be stripped by the issuer itself: the bond (or part of the issue) is cancelled and a series of C-strips and P-strips are issued in place thereof.

It will be apparent that each cash flow (each coupon interest payment and the final principal amount) is a *zero coupon bond*. An example is presented (see also Figure 7 and Figure 8). The bond has the following features:

Nominal value:	LCC1 000 000
Issue date:	15 April 2008
Maturity date:	15 April 2011
Term:	3 years
Interest dates:	15 April and 15 October
Coupon rate:	8% pa.

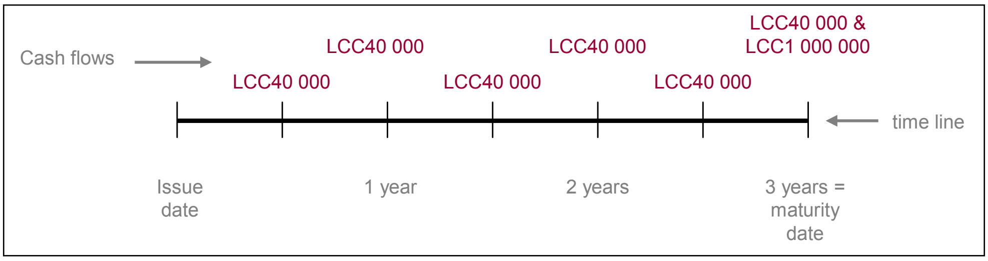


Figure 7: example of stripped bond

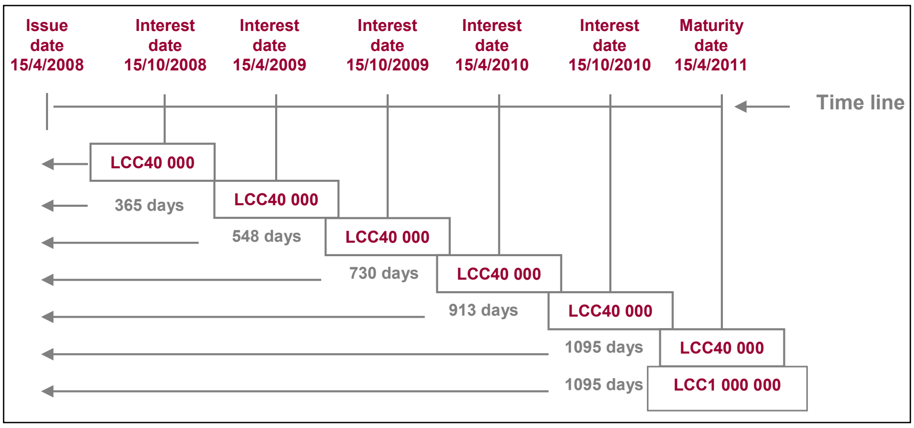


Figure 8: example of stripped bond

The *zero coupon bonds* derived from the "stripping" are as follows:

1 × LCC40 000 nominal value; term183 days
1 × LCC40 000 nominal value; term 365 days
1 × LCC40 000 nominal value; term 548 days
1 × LCC40 000 nominal value; term 730 days
1 × LCC40 000 nominal value; term 913 days
1 × LCC40 000 nominal value; term1095 days
1 × LCC1 000 000 nominal value; term1095 days.

3.3.9 Convertible bonds

Convertible bonds are bonds that are *convertible into ordinary (also known as common) shares* at a pre-specified price at the option of the investor; they may be handed over in return for equity in the issuer. Clearly the investor will only do so if it is profitable, i.e. if s/he is able to benefit from a rise in the share price [and more so than the rise in the bond price that he may be enjoying (which is the same as a decline in the bond rate)].

3.3.10 Exchangeable bonds

Exchangeable bonds are corporate bonds that are exchangeable for shares in a company other than the issuer of the bond. The *investor has an option to undertake the exchange*, but does not have an obligation to do so.

3.3.11 Bonds with share warrants attached

In some foreign markets issues are made of *bonds with share warrants attached*. The warrant is an option to purchase a pre-specified number of the shares of the company that issued the bonds at a pre-determined price.

These bonds thus differ from convertible and exchangeable bonds in that the bondholder retains the bonds upon exercise of the warrants. For example, in the case of convertible bonds the bonds are surrendered and cancelled upon conversion / exchange.

3.3.12 General obligation bonds[22]

The term *municipal bond* in the US refers to the bond issues of *any state* or any *entity created by a state* (cities, counties, school districts, water districts, etc.). There are three types of municipal bonds: general obligation bonds, revenue bonds and serial bonds. These are discussed separately (and not as categories of municipal bonds) in order to avoid confusion with domestic municipal bonds.

General obligation bonds are municipal bonds that are backed by "the full faith and credit" of the issuer. This means that the issuer will do all in its power to honour the debt. Because municipalities must continue to operate, a defaulting municipality may take many years to repay the interest and principal *after* due date.

3.3.13 Revenue bonds

A revenue bond is a US municipal bond that is issued to finance a *specific project* that is revenue generating, for example, a sewerage plant, a road, a tunnel. The revenues collected from the public for the use of the asset are used to pay the interest and principal. These bonds are more risky because the revenue may not be sufficient to cover the interest and principal and therefore they carry a relatively high rate. Investors (or the rating agencies on their behalf) would take a careful look at the ratio of expected revenue to interest commitment.

3.3.14 Serial bonds

A *serial bond* is a US municipal debt instrument. It is a series of bonds that are issued together, each with a different maturity. An example is the issue of US$100 million on a particular day for each of the periods 5 years, 10 years, 15 years and 20 years. They are all plain vanilla bonds and investors select which series are suitable for them, depending on their investment horizon. Pension funds usually prefer the longer bonds, short-term insurers the medium term bonds, while banks are more interested in the shorter bonds.

3.3.15 Catastrophe bonds

Catastrophe bonds are bond issues by risk takers such as insurance companies to offset some of their risk. For example[23], in 1997 Tokyo Marine & Fire Insurance issued a 10-year bond, the interest on which was tied to whether and to what extent Tokyo was damaged by an earthquake. The bondholders received interest (from the premiums collected by the insurer), which fluctuated at between 400-500 bp over LIBOR. The principal was lost if the earthquake occurred.

3.3.16 Asset-backed bonds

Asset-backed bonds are not a bond variety but are included here for the sake of comprehensiveness. Any of the bonds already mentioned or to be mentioned can be asset-backed, i.e. backed by certain assets. For example, central government securities in most countries are backed by the revenue and assets of the country.

Other examples of asset-backed bonds are the bonds issues of SPVs. As noted in a previous section, SPVs are the product of securitisations undertaken mainly by banks and companies themselves.

In the case of a mortgage securitsation the mortgages of individuals are pooled in a SPV and these are financed by the issue of two tiers of *mortgage-backed securities* (MBS): prime rated (AAA) bonds to the extent of about 90% and subordinated bonds for the balance of 10% (actually there are three tiers of MBS – see next section). All the bonds are *backed* by specific mortgages. This means that if the SPV fails, the holder of the bonds has a call on the underlying mortgage bonds.

A variation of the securitised mortgage-backed bond is the *non-securitised mortgage-backed bond*. An example is a power plant utility that issues bonds to finance the building of a plant. The plant is mortgaged (which means that it is pledged as collateral security for the bond).

3.3.17 Senior, subordinated, junior and mezzanine bonds

In securitisations, certain assets that have a cash flow are pooled and bonds (or short-term commercial paper) are issued to fund these assets. As seen above, *highly rated bonds*, called *senior bonds*, are issued up to a certain proportion of the assets pooled (usually 90%), and *subordinated bonds* for the rest (the balance of usually 10%). The split depends on the rating agencies' credit-enhancement demands.

The *subordinated bonds* are further split into so-called *mezzanine bonds* (to the extent of about 7%) and *junior bonds* for the balance (about 3%). The mezzanine bonds are usually rated BBB and the junior bonds are unrated (because they are usually taken up by the sponsor of the securitisation).

In the event of the failure of a portion of the underlying assets, the holders of the *junior bonds* are the first to take the loss. Next in line are the holders of the *mezzanine bonds* and last in line are the holders of the highly rated *senior bonds*. Thus the junior bonds are *subordinated* to the mezzanine bonds and the mezzanine bonds are *subordinated* to the highly rated *senior bonds*.

These bonds are usually of the plain vanilla variety, but some are floating rate bonds.

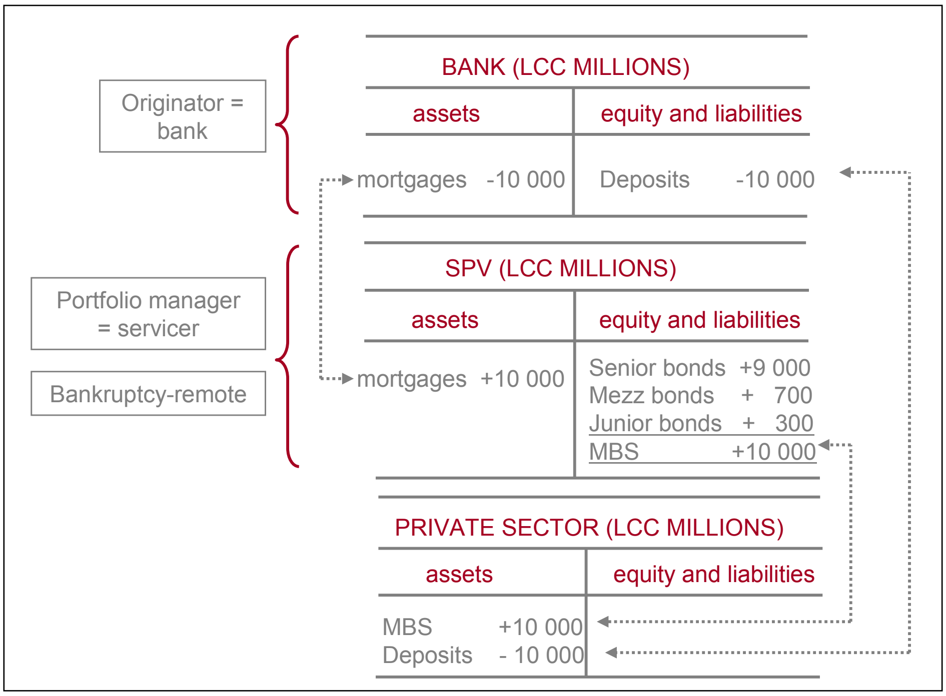


Figure 9: example of bank securitisation of mortgages

An example of a securitisation of mortgages by a bank is presented in Figure 9 for the sake of didactic elucidation. In this example it is assumed that all the mortgage backed securities (MBS) have been purchased by members of the financial private sector (pension funds, insurers and so on). In reality the junior (unrated) bonds are taken up by the originator / sponsor (usually a bank), while the mezzanine bonds are taken up by some risk-taker because the rate offered on them is high, reflecting the risk profile of these bonds.

3.3.18 Junk bonds

Junk bond is the term for bonds of companies that are not rated (because they cannot get a decent rating) or for bonds that are rated below investment grade, which is BBB – in the case of Standard & Poor's and Baa3 in the case of Moody's. Included thus in this category are the *junior bonds* of securitisations referred to above (the LCC300 million shown in Figure 9).

3.3.19 Guaranteed bonds

A *guaranteed bond* is a bond that is guaranteed by a party other than the issuer. One has to differentiate here between company bonds and parastatal (public enterprise) bonds. The companies with weak ratings or no credit ratings issue guaranteed bonds.

The company that issues the guarantee is usually an insurance company that has a high credit rating. It will be apparent that the investor in this case is not concerned about the financial standing of the issuer. Because the credit rating of the insurer is substituted for the rating of the issuer, the investor will look to the insurer for comfort. A weak company will only issue bonds with guarantees if the insurance premium is less than the interest premium the company would pay in the absence of the guarantee.

In many countries, the central government guarantees the bonds of the parastatals. These bonds trade at only small premiums to central government bonds, mainly because they are not as liquid as central government bonds.

3.3.20 Pay-in-kind bonds[24]

Pay-in-kind (PIK) bonds are bonds where the issuer has the option to pay the interest in the form of additional bonds. In some cases the issuer has the option to issue additional bonds in lieu of interest only during the first few years of the issue. Companies that may have cash flow difficulties in the first few years of a project usually issue this type of bond. These bonds usually carry a higher coupon (to compensate for the higher risk level).

3.3.21 Split coupon bonds

Split coupon bonds are similar to PIK bonds in that no interest is paid in the first few years (except that here the issuer has no option). The split coupon bond is a hybrid of the zero coupon bond and the fixed-rate bond. The bond is issued at a discount to face value (say 0.92) and the interest accrues until a specified time (say, when the value of the bond is 1.0). Thereafter, interest is paid at the coupon rate until maturity date.

Such bonds are issued in order that debt servicing is removed in a specified period. Such bonds have been issued to finance leveraged buyouts and recapitalisations and therefore carry a higher yield than equivalent term (uncomplicated) bonds.

3.3.22 Extendable bonds

Extendable bonds are bonds where the issuer has the option to extend the term of the bond beyond the (initial) maturity date for another fixed period or periods (the final maturity date). Because this bond has benefits for the issuer in the form of conserving cash at the initial maturity date, the rate is usually somewhat higher.

3.3.23 Foreign bonds

Foreign bonds are bonds issued by foreign entities (usually governments and parastatals) in local currency. They are foreign from the point of view of the local bond market. For example, a bond issued by a Swiss utility in Local Country (LC), denominated in LCC, is a foreign bond.

A number of countries at time issue bonds denominated in USD (US dollars) in the United States; these are foreign bonds (also called *Yankee* bonds) to US investors in them. Another example is a foreign country issue of bonds in Japan denominated in yen (JPY) (also called *Samurai* bonds). If a country issues bonds in the United Kingdom denominated in sterling / pounds (GBP), it is a foreign bond (in this case called *Bulldog* bonds). Foreign bonds are also called *traditional international bonds*.

Foreign bond issues are usually arranged by the investment banks of the country in which they are issued or investment banks that have an international presence with which the issuing government has a relationship. These bonds are issued in large denominations and are taken up mainly by the retirement funds, insurance companies and unit trusts.

3.3.24 Eurobonds

Eurobonds are bonds that are *issued in countries other than the country of the currency in which they are denominated*. For example, the Kenyan government could issue a USD-denominated bond in the UK.

Another example is a *Euro-LCC bond*, i.e. a bond that is denominated in LCC and is issued in another country. These bonds are normally created by institutions that have a better rating than the country's (i.e. Local Country's) sovereign rating; an example is a Euro-LCC bond issued by the World Bank and sold in the US.

It should be noted that the word *Euro* in Eurobond is a misnomer because a Eurobond does not have to be issued in Europe or the Euro-zone. This market first emerged in 1963, when USD-denominated bonds were issued in Europe in order to avoid onerous regulation and taxes; hence the term *Euro* in Eurobond. When the regulations were amended, the market had grown to such an extent that it continued to operate.

The Eurobond market generally is a retail market (i.e. the denominations are small – usually $5 000 and $10 000), with the bonds issued in bearer form, and it is driven by individuals, who wish to conceal their ownership of the bonds from their respective receivers of revenue, and other investors. Investment banks that have an international presence usually undertake the placing in the Eurobond market.

3.3.25 Global bonds

Global bonds are bonds that are issued and traded in two or more markets but are denominated in the currency of one of the markets. For example, if Local Country issues a global bond denominated in USD in both the US bond market (in which case it is a foreign bond and also called a *Yankee bond*), as well as the Eurobond market (in which case it is called a *Eurodollar bond*).

3.3.26 Retail bonds

A number of so-called *retail bonds* exist in a number of countries of the world. As the name suggests, they are *bonds*, i.e. have a long term to maturity, and the target market is the *retail* sector, as opposed to the wholesale sector. This means that the target market is the household sector, and that denominations are small. Retail bonds are issued by the government sector and the corporate sector.

3.3.27 Islamic bonds

Islamic finance is governed by Islamic rules and principles (Shariah) which, inter alia, prohibit the payment of interest (Riba). Shariah also forbids the investment in businesses that provide goods and services considered contrary to its principles (Haraam), and this includes gambling and alcoholic beverages. However, Islamic finance encourages trading and business, but through risk and profit sharing participation in permitted activities. The Shariah-compliant bonds are often referred to as Sukūk and they either:

- are backed by returns from real assets (ownership right to tangible assets, a pool of assets, or the assets of a specific project) and earn a variable rate of return that is tied to the performance of the asset, or
- offer returns that are unspecified before the investment is made but shared based on a pre-agreed ratio on actual earnings.[25]

3.4 Summary

There are many varieties of bonds in the bond markets of the world. The standard / most common bond is the plain vanilla bond (fixed-rate, fixed-term bond). The other popular bonds are zero coupon and inflation-linked bonds. There are many variations of these. The variety of bonds generally reflects the demands of the investors.

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4 Organisational structure

4.1 Learning outcomes

After studying this text the learner should / should be able to:

1. Appreciate the risks faced by market participants in an OTC market and how these risks are overcome by an exchange.
2. Describe the methods of issue, the various participants and the roles they play in the primary bond market.
3. Comprehend the basic structure of an exchange-driven market.
4. Be familiar with the importance of the secondary bond market, the participants and the role they play in the market, the organisation and structure and functions of the secondary bond market.

4.2 Introduction

As an introduction we present an outline of organisational structure of financial markets (see Figure 1). Markets are either spot markets or derivative markets and the difference between the two essentially is when the deal is settled. The spot market settles as soon as is practically possible whereas in derivatives deals the underlying instrument is settled (sold / bought) in the future at a price established at the outset. In the spot bond markets of the world the settlement date differs widely between 3 and 7 business days.

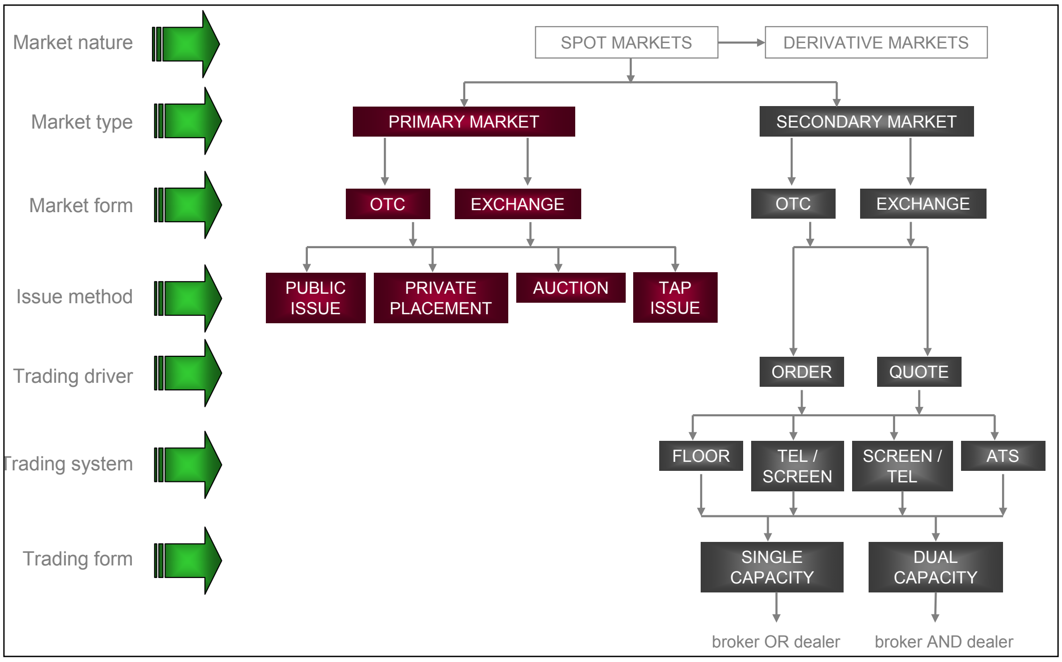

Figure1: organisational structure of spot financial markets

Like all marketable securities markets, the spot bond market has a *primary market* and a *secondary market*. The primary market is the market for the issue of new bonds while the secondary market is the market for the exchange of bonds that are already in issue. These markets are either *exchange-driven markets* (EDMs) or over-the counter (OTC) markets.

In this section we discuss the elements of the organisational structure of the bond market and make reference where applicable to the differences between OTC and exchange-driven markets. The following are the sections:

- Risks in, and shortcomings of, OTC markets.
- Advantages of exchange-driven markets.
- Primary market.
- Secondary market.

4.3 Risks in, and shortcomings of, OTC markets

In OTC markets two main risks exist that can be subsumed under the heading of *counterparty risk*:

- *Settlement risk*. This is the risk of the deal not being settled promptly by the counterparty or of the counterparty reneging on the deal as a result of a price change. This risk includes the risk of the intermediary to the deal (the broker-dealer) accepting the funds from the buyer and not paying the seller.
- *Tainted scrip risk*, i.e. the risk of non-valid securities certificates being introduced into the market by sellers.

OTC markets also suffer from shortcomings such as:

- Securities being physically delivered before payment can be effected in the form of a cheque (which may also need to be bank guaranteed), which then has to be deposited. There are numerous problems in this regard such as securities being stolen from the delivery vehicle, or late delivery (settlement risk).
- Lack of information on market liquidity.
- Lack of a price discovery mechanism.
- Little or no surveillance of the broker-dealers[26] in the market. One or more of them may be trading for own account without the knowledge of the client (buyer or seller of the securities). Or one or more of them may also be capitalised too low for the type of business they conduct (which could lead to fraud).

These risks and shortcomings are eliminated or lessened by a formalised exchange.

4.4 Advantages of exchange-driven markets

The purpose of a financial exchange is to facilitate trading in the securities for which it was created, and this it does by establishing a secure environment for the participants in the market, i.e. the issuers, investors, speculators and members / authorised users (the broker-dealers). By *secure environment* is meant that the trading and settlement of deals are achieved in an efficient and risk-free manner. In fact, an exchange can be seen as an institution that *risk manages the process of dealing, clearing and settlement on behalf on the participants*, saving them the expensive process of specific risk management.

Essentially, the advantages of exchange-driven markets are:

- Elimination or lessening of the risk of trading.
- Efficiency of trading.

The counterparty risks referred to earlier are eliminated or lessened:

- Settlement risk.
  - Deals are settled efficiently by the exchange (applies especially in a dematerialised environment) through a deal booking system.
  - The broker-dealers are members of the exchange and are therefore under surveillance; in the unlikely event of a member defaulting or defrauding a client the guarantee fund of the exchange covers investor losses.
  - Member broker-dealers will know their clients and settlement problems are unlikely.
- Tainted scrip risk is lessened (and eliminated in an immobilised or dematerialised market).

The elimination or lessening of risk by the exchange goes hand-in-hand with efficiency of trading (security when dealing with a member, efficient deal capture system, clearing and settlement by the central scrip depository, and so on).

The elimination or lessening of risk and the efficiency of trading may be subsumed under the heading of "a secure and efficient dealing environment". Such an environment attracts more participants, local and foreign, which leads to higher turnover, i.e. higher liquidity, and ultimately to efficient price discovery, and possibly to lower transactions costs.

A further word on price discovery is perhaps required. Price discovery (the determination of market prices) is not efficient in many OTC markets, and this is because liquidity is low, and low liquidity is the result of the existence of the risks and other factors referred to earlier. Efficient price discovery is largely a function of liquidity (many role-players and number of deals), and it means that information about the relevant market is priced into the market at all times.

4.5 Primary market

4.5.1 Introduction

The primary bond market may be defined as the conventions, facilities and legal prescriptions that exist for the issue of new bonds. It is also the market in which the issuer receives funds.

It is notable that bond (or multiple-asset) exchanges not only facilitate trading in bonds, but also facilitate the issue of new bonds (the primary market). In many bond markets where exchanges exist the issuers are not required by law to list their bonds; however, it is likely that issuers will, and the reason for this is that demand is positively affected by a listing. The rigorous process a new issue has to endure provides investors with a great measure of comfort. This of course does not mean that the investors do not undertake their own credit assessments; it merely means that a listing is a positive factor, and not listing is a negative factor.

4.5.2 Methods of issue

There are a number of ways in which primary issues are made:

- Public issue.
- Private placement.
- Tap issue.
- Auction.

Before discussing each of these methods of issue, there are a number of requirements that are common to all the methods (with the exception of issues via market making) that need mentioning. In an exchange-driven market they are:

- For each new issue that is listed, the issuer is obliged to appoint a *sponsoring member*, who is a member of the exchange. The sponsoring member may also be the *arranger*, which means that the member undertakes to draw up most of the documentation required.
- A *dealer* to the issue is also appointed. This is usually the sponsoring member, but does not have to be. The dealer undertakes to do all *dealing* on behalf of the issuer.
- In addition, the issuer appoints an attorney, or a firm of attorneys, as *legal advisors*.
- A *transfer secretary* is appointed to handle all transfers of bonds.
- A firm of auditors is appointed as *auditors to the issue*.
- There may also be an *underwriter to the issue*. This undertaking by the underwriter (which is done for a fee), gives comfort to potential investors, i.e. that a financial institution that is fully acquainted with the bond market and the issuer is prepared to take up all bonds not taken up by the public.
- A *placing document* or *prospectus*, setting out the details of the issue and the issuer, is drawn up prior to the issue. All the parties mentioned above are involved in this document.

In OTC bond markets, a placing document is required and some of the other requirements are also obligatory.

It is also important to note that in some exchange-driven markets the facility of listing a *bond (or note) programme*, as against listing specific instruments initially, exists. This provides the issuer with the opportunity to issue bonds when it is appropriate to do so (i.e. when it requires the funds or when the market is conducive for issues), without having to go through the laborious (and expensive) listing procedure each time.

Each of the four main methods of issue is covered briefly below.

4.5.3 Public issue

A public issue is one where the general public (the main ones being the so-called institutions [the retirement funds, insurers and the bond funds (via their fund managers)] is invited to subscribe for a specific amount of bonds. The placing document, which sets out the details of the issue, is advertised in the press.

The public completes the subscription form, the most pertinent aspect of which is the amount subscribed for. In the event of an over-subscription, a partial allocation is made to subscribers. A public issue is usually made at a specified price.

4.5.4 Private placement

A private placement is where the issuer and/or its appointed sponsoring member makes contact with the institutions, describe the details of the issue in a formal presentation, and invites them to take up a portion of the amount on issue. This process is sometimes also referred to as *bookbuilding*.

4.5.5 Tap issue

The tap issue method of issuing bonds is generally undertaken by issuers that are smaller than government that make a market in their own bonds in order to increase the marketability of their bonds (usually the parastatals). They make it known to the institutions that they are open for business and from then on quote bid and offer rates / prices simultaneously at all times for all their bond issues. In the process of making the market, they are net sellers of their own bonds. This is referred to "tapping" out their bonds.

Some of the larger companies also make use of this method of issue but outsource this function to banks that specialise in this activity.

4.5.6 Auction

The auction method of issuing bonds generally is the preferred method of issuing bonds, particularly by government. Bonds are either auctioned directly to investors or indirectly via market makers / primary dealers to investors.

In most markets government bonds are issued by the central bank on behalf of government, i.e. the central bank acts as the agent of government. In some markets the central bank invites the institutions and the banks, etc to tender directly. However, in most markets the central bank appoints certain of the banks (which are market makers) as *primary dealers* (this may be seen as a subset of market making).

When tenders (auctions) are announced the amount is specified and the primary dealers are obliged to tender for a specified minimum amount of bonds. In addition the primary dealers are required (in some of the markets) to make a market in these (or certain of these) bonds by quoting firm bid / offer rates based on the size of the deal (usually the institution asking for the quote does not have to disclose whether it is a buyer or seller).

Generally, parastatal enterprises and companies that participate in the bond market as issuers also appoint a certain number of market makers (usually a smaller number than in the case of government) to make a market in their bonds. The companies usually do not ask the market makers for bids but issue to them at fixed prices.

4.5.7 Economic function of primary market

The primary bond market plays a significant role in the financial system. It permits government, parastatals and the private sector to *acquire long-term funds for investment in projects of a long-term nature,* which are usually ventures that add to the infrastructure and production capacity of the economy.

The primary market also assists the secondary market in times of low turnover. All markets go through periods of turbulence and subdued trading, both scenarios leading to rates being inefficient (or extremely volatile). A primary issue during these times may set the norm rate for secondary market trading. This is because the large institutions will have established the primary issue rate.

4.6 Secondary market

4.6.1 Introduction

This section covers the following topics relating to the secondary market:

- Definition.
- Significance of the secondary bond market.
- Basic structure of an exchange.
- Participants in the secondary market.
- Order-driven and quote-driven secondary markets.
- Commissions.
- Clearing and settlement.
- Trading.

4.6.2 Definition

The *secondary bond market* may be defined formally as the conventions, facilities and legal prescriptions that exist for the exchange of bonds in issue. The issuer does not receive funds in this market – this happens only in the primary market. It is the market that enables holders of previously issued securities to acquire funds by disposing of their holdings and enables investors to invest funds by purchase existing or new securities.

4.6.3 Significance of the secondary bond market

The secondary securities market plays a significant role in the financial system. In the case of the secondary bond market, the following advantages may be mentioned:

- Efficient price discovery (if there are many participants and turnover is high).
- An active secondary bond market facilities primary market issues, i.e. improves the capacity of issuers to place newly created bonds. Investors having the assurance that they will be able to dispose of bonds if they so desire brings this about.
- An active secondary bond market reduces the cost of funding for the issuer because investors place a premium on marketability.
- An active secondary market provides the benchmark for the determination of rates to be offered on new issues.
- An active secondary bond market registers changing market conditions rapidly, indicating the receptiveness of the market for new primary bond issues.
- An active secondary bond market enables investors to rapidly adjust their portfolios in terms of size, risk, return, liquidity, maturity, duration, etc.
- An active market enables the central bank to buy and sell securities in order to influence liquidity in the financial markets (open-market operations). Although the central bank usually operates in the money market, at times it does so in the market for short-term bonds.

Before proceeding with the details of the participants of the bond market, it will be useful to present an attempt at illustrating the broad structure of the secondary bond market and its participants.

4.6.4 Basic structure of an exchange

In a nutshell, an exchange offers a secure and efficient dealing environment for the products for which it was created: bonds (and other debt securities) issued by government, parastatal enterprises, the corporate sector, SPVs and the foreign sector. Usually the main products of bond exchanges are the bonds of central government.

Clients of the exchange are any person or institution that needs to buy or to sell bonds. They are obliged to do so with the broker-dealers who are members of the exchange under a relevant statute. The broker-dealers are authorised by the exchange and become so if they comply with the provisions of the contained in its Rulebook, which includes a minimum level of education pertaining to the market, capital adequacy, and so on. The exchange will have measures in place to ensure surveillance of its members.

When a deal is struck between the client and the member, the deal is entered into a bond capture system (BCS). The BCS performs validation of trades and matches them (i.e. clearing) and routes them to a settlement system which is usually a Central Securities Depository (CSD). The system also reports on the status of trades to the members.

The bonds traded on the exchange are contained in a "list" of securities that the exchange maintains, hence the term "listed securities", and the issuers are obliged to comply with the listing requirements of the exchange. These requirements include the issue of a placing document (prospectus), strict financial disclosure requirements, etc.

In addition to its all-important trading function, the exchange usually provides a range of data services:[27]

- From the trade capture system: daily publishing of trading statistics and mark-to-market details.
- From its price discovery system: live trading bids, offers, yields and volumes, giving a real-time picture of the bond market.
- General: total return indices, historical data and customised reports.

4.6.5 Participants in the secondary market

4.6.5.1 Introduction

The participants in the secondary bond market are:

- Members of the exchange.
- Market makers: banks.
- Market makers: issuers.
- Investors.
- Speculators.

4.6.5.2 Members of the exchange

In exchange-driven markets the members of the exchange are the broker-dealers that are authorised "users" of the exchange in terms of the statute that governs the exchange and the Rules of the exchange established in terms of the statute.

It is important to distinguish between the interdealer brokers (that exist in many countries) and the "ordinary" members. The "ordinary" members deal with all market participants, whereas the interdealer brokers perform a self-imposed specialised function: they trade exclusively between other members of the exchange, particularly the market makers (and their subset the primary dealers)[28].

These brokers advertise prices and volumes of actual deals on an electronic price dissemination medium. Internationally there are two types of interdealer broker: "matched principal" and "name-give-up". The *name-give-up* brokers marry the requirements of two principals in a deal who are disclosed to one another before the deal is confirmed, to ensure that the two parties are able to deal with one another. Settlement takes place between the two principals and not between each principal and the interdealer broker. The brokers charge a small fixed (and disclosed) brokerage.

The *matched principal* interdealer brokers are distinguished by higher levels of capital, giving comfort to the principals in terms of settlement with them. The majority of interdealer brokers are of the matched principal variety.

4.6.5.3 Market makers: banks

In the previous section we distinguished between "ordinary" members and interdealer brokers, and we dealt with the latter. The "ordinary" members may be split between banking members and non-bank members (also known as "securities trading houses" – STHs). The STHs are the smaller-capitalised member firms that provide a securities broking service to the smaller investors.

The banking members of most exchanges may be split between the market making banks and those that are not. The banks that do not participate in market making activities are the smaller ones and they operate very much like the STHs.

The term *market maker* refers to any body / organisation that quotes buying (bid) and selling (offer) rates (*prices* in some countries) on bonds simultaneously and at all times when requested to do so by buyers and sellers. It will be evident that market risk is a central element of market making, ensuring that well-capitalised entities take on this role: the larger banks.

However, the term does not only apply to the banks; it applies also to certain issuers who are members of the exchange for this reason (see next section).

A subset of the bank market makers is the *primary dealers*. They are a group of the larger capitalised domestic and international banks that are appointed by the central bank, on behalf of government, to assist in the marketing of central government bonds. As part of their sole access to the newly issued bonds of government, they are obliged to quote firm buying and selling rates on certain bonds (the more marketable ones) at all times and they must be prepared to deal in a stipulated minimum amount.

It is notable that certain bond issuers (corporate and parastatal enterprises) also appoint bank market makers to market their paper (primary market) and to make a market in the secondary market for this paper.

4.6.5.4 Market makers: issuers

Another important participant in the secondary market is the issuer in some cases. Certain issuers have set up dealing desks to make markets in their own issues of bonds. Their motivation for doing so is to enhance the marketability / liquidity of their bonds. Enhanced marketability means that new issues are issued at lower rates than otherwise would have been the case.

4.6.5.5 Investors

The other participants in the secondary market are of course the investors, domestic and foreign. The domestic investors are comprised of the household and corporate investors (the cash surplus ones) and the "institutions". The main actors in the latter group are the following:

- Retirement funds
- Insurance companies
- Unit trusts, particularly the bond funds
  Banks.

The motivation of the investors in the secondary market is to change the size and/or nature of their portfolios in response to changing market conditions.

4.6.5.6 Speculators

The term *speculator* refers to any entity that attempts to make opportunistic profits from changes in bond prices in the short term. It is particularly the banks, certain STHs, certain entities of the household and corporate sectors, and certain foreign entities that make a business of trying to profit from short-term movements in the bond market.

4.6.6 Order-driven and quote-driven secondary markets

The phrases *order-driven* and *quote-driven* secondary markets are pertinent to all markets: they are one or the other or a hybrid. Many a bond market can be described as a dual market in that is it both order-driven and quote-driven.

The interdealer brokers trade solely on an order-driven basis, i.e. they react only to orders that they receive from the other members of the exchange. The other non-market maker members of the exchange generally also trade on an order-driven basis to the extent that they deal with clients. This means that in their dealings with investors they react to orders and try and fill these orders.

A seen earlier, the market makers, on the other hand, trade solely on a quote-driven basis.

4.6.7 Commissions

In the case of market makers, commissions are not payable, because they take positions in bonds at risk to their capital base. At the central bank auctions, and in their function as the market makers, they bid at prices that they believe are a reasonable reflection of market conditions at that time. However, this is not always the case and rates can "turn against them" at times. This means that at time they hold certain bonds at a loss. For this reason, commissions are not applicable to them.

In the case of other members of the exchange, and in broking deals, commissions are disclosed to clients. These brokers are also obliged to inform clients when a deal involves bonds that are held by them in portfolio and that a "turn" (i.e. difference in price / yield) is being taken rather than a commission.

4.6.8 Clearing and settlement

Bond deals through exchanges are usually conducted on a netted and T+3 (or longer) rolling settlement system. The institutions involved in clearing and settlement are:

- A clearing house.
- A central securities depository.
- A settlement agent system.

4.6.9 Trading

There are four types of trading "systems":

- Floor trading (open outcry).
- Telephone-screen trading.
- Screen-telephone trading.
- Automated trading [on an automated trading system (ATS)].

Floor trading. The floor trading method (also called open-outcry trading) involves the matching of orders from clients in a physical place. Members shout out orders and look for opposite orders which are matched if the prices are the same. Bond markets have been known to make use of this system, but it is rare.

There are variations of open outcry; one example is the call-over system adopted by the Malawi Stock Exchange which works well in a small market.

Telephone-screen trading. Generally, some *market makers* place indication rates on information vendor (IV) screens (e.g.. Reuters Monitor Service), and deals are negotiated and consummated on the telephone. Some market makers do not advertise prices on screen and only quote prices to clients on the telephone. As noted, this is a quote-driven market, i.e. the market makers quote buying and selling rates.

Screen-telephone trading. The *interdealer brokers* make use of this method; they quote firm rates on IV screens, and the telephone is used by members of the exchange to "take" (buy) or "give" (sell), i.e. to confirm the transaction with the interdealer broker. They also advertise prices via their squawk boxes. As indicated, the interdealer brokers only deal with other members and not with the investors.

Automated trading system (ATS). The ATS system of trading applies to order markets, where orders are matched on a price-time priority basis. As noted, bond markets are generally quote-driven markets.

4.7 Summary

Like all financial markets, bond markets are either OTC or exchange-driven markets (EDMs). Many of the disadvantages of OTC markets are addressed by EDMs. There are a number of methods of issue in the primary bond market with the auction method being the preferred one in the government bond market and others' too.

The secondary market plays a significant role in the economy, not the least of which are price discovery, portfolio opportunities for holders of bonds and assisting the primary market in terms or rates to be offered on new issues. Most bond markets are quote-driven markets.

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5 Mathematics

5.1 Learning outcomes

After studying this text the learner should / should be able to:

- Know, understand and be able to calculate future value from present value and vice versa.
- Understand how the annuity formula applies to bonds.
- Know, understand and be able to calculate the price (value) of a bond with a fixed coupon rate and a fixed term to maturity.
- Understand the concepts of cum interest and ex interest.
- Know, understand and be able to apply the standard price formula for bonds with 6 months or longer to maturity and for bonds with less than 6 months to maturity.
- Know, understand and be able to apply the following formulae: perpetual bonds, bonds with a variable rate, CPI bonds, zero coupon bonds and strips.

5.2 Introduction

The basic tenet of the time value of money concept is that a LCC received today is worth more than a LCC received at some stage in the future, i.e. money has a *future value* (FV) and a *present value* (PV). FV is present value plus interest, and PV is future value discounted by a relevant rate.

Another basic principle of the concept is that interest is compounded, i.e. interest that is earned is reinvested, and an essential assumption here is that interest earned is reinvested at the rate earned on the principal amount.

The PV / FV concept is the foundation of virtually all the mathematics of the financial markets. "Virtually" is used because it does not play a role in certain derivatives. The aim of this chapter is to elucidate the mathematics of the bond market. The following is covered:

- Present value / future value.
- Annuities.
- Plain vanilla bonds.
- Perpetual bonds.
- Bonds with a variable rate.
- CPI bonds.
- Zero coupon bonds.
- STRIPS.

5.3 Present value / future value

The FV of an investment is calculated in terms of the following formula:

$$FV = PV\,(1 + ir/cp)^{y.cp}$$

where

ir = interest rate pa expressed as a fraction of 1
y = number of years
cp = number of compounding periods pa (number of times interest is paid)

Example:
PV = LCC1 000 000
ir = 0.15
y = 3
cp = 2 (i.e. six-monthly)

$$\begin{aligned} FV &= \text{LCC1 000 000}\,(1 + 0.15/2)^{3x2} \\ &= \text{LCC1 000 000}\,(1.075)^{6} \\ &= \text{LCC1 000 000}\,(1.54330153) \\ &= \text{LCC1 543 301.53.} \end{aligned}$$

This means that an investment made now of LCC1 000 000 at 15% pa, compounded six-monthly, for 3 years will be worth LCC1 543 301.53 then.

The PV formula is derived from the future value formula:

PV = FV / (1 + ir/cp)$^{y.cp}$

Example: FV = LCC1 000 000
ir = 0.12
y = 3
cp = 2 (i.e. six-monthly)

PV = LCC1 000 000 / (1 + 0.12/2)$^{3.2}$
= LCC1 000 000 / (1.06)^{6}
= LCC1 000 000 / 1.41851911
= LCC704 960.54.

This answers the question: what amount must be invested now (PV) at 12% per annum compounded semi-annually to end up at LCC1million in 3 years' time?

The next step in elucidating bond market mathematics is the PV / FV concept inherent in the annuity calculation.

5.4 Annuities

The coupon payments of a fixed-rate bond are identical to the cash flows of an annuity; therefore an understanding of the principles of annuities is required.

An annuity is an investment now (PV) that comprises regular *payments* of the same amount over a stipulated period in the future. This is called a *fixed annuity*. The *life annuity* does of course exist (where the period of payments is not certain), but this we will leave to actuarial science.

The PV of a *stream of fixed payments* (PMT) in the future (various FVs of the same amount) is determined according to the following formula:

PV = [PMT / (1 + ir/cp)$^{y.cp}$] + [PMT / (1 + ir/cp)$^{y.cp}$] …

It follows that the PV of a 3-year annuity with *annual* payments is calculated according to:

$$\text{PV} = [\text{PMT} / (1 + \text{ir})^1] + [\text{PMT} / (1 + \text{ir})^2] + [\text{PMT} / (1 + \text{ir})^3].$$

Example 1: PMT = LCC200 000
ir = 9% pa
y = 3
cp = 1 (remember cp = compounding periods pa)

$$\begin{aligned}\text{PV} &= [\text{LCC200 000} / (1.09)^1] + [\text{LCC200 000} / (1.09)^2] + [\text{LCC200 000} / (1.09)^3] \\ &= (\text{LCC200 000} / 1.09) + (\text{LCC200 000} / 1.1881) + (\text{LCC200 000} / 1.2950) \\ &= \text{LCC183 486.24} + \text{LCC168 336.00} + \text{LCC154 440.15} \\ &= \text{LCC506 262.39}.\end{aligned}$$

The PV of a 2-year annuity with semi-annual payments is calculated according to:

$$\text{PV} = [\text{PMT} / (1 + \text{ir}/2)^{.5\times2}] + [\text{PMT} / (1 + \text{ir}/2)^{1\times2}] + [\text{PMT} / (1 + \text{ir}/2)^{1.5\times2}] + [\text{PMT} / (1 + \text{ir}/2)^{12\times2}].$$

Example 2: PMT = LCC100 000
ir = 9% pa
y = 2
cp = 2

$$\begin{aligned}
PV &= (\text{LCC100 000} / (1.09/2)^{.5\times 2}) + (\text{LCC100 000} / (1.09/2)^{1\times 2}) + \\
&\quad (\text{LCC100 000} / (1.09)^{1.5\times 2}) + (\text{LCC100 000} / (1.09/2)^{2\times 2}) \\
&= (\text{LCC100 000} / (1.045)^{1}) + (\text{LCC100 000} / (1.045)^{2}) + \\
&\quad (\text{LCC100 000} / (1.045)^{3}) + (\text{LCC100 000} / (1.045)^{4}) \\
&= (\text{LCC100 000} / 1.045) + (\text{LCC100 000} / 1.092025) + \\
&\quad (\text{LCC100 000} / 1.141166) + (\text{LCC100 000} / 1.192519) \\
&= \text{LCC95 693.78} + \text{LCC91 573.00} + \text{LCC87 629.67} + \text{LCC83 856.11} \\
&= \text{LCC358 752.56}.
\end{aligned}$$

It will be apparent that the PV is the value now of the fixed annuity payments in the future, i.e. the PV is derived from the future payments (FV) and the interest rate applicable for the period. This means that a person has to pay (in the case of the last example) LCC358 752.56 now in order to receive payments of LCC100 000 every six months for two years. It will also be clear that what was done above was to *discount* each payment by the spot rate of interest for the period and then to add them.

The principle applied here is applicable to plain vanilla long-term bonds. A plain vanilla bond is nothing else than a finite series of fixed payments made in the future and repayment of the face value of the bond on redemption date.

5.5 Plain vanilla bond

5.5.1 Introduction

The plain vanilla bond is the most common one – it pays a fixed rate of interest at regular intervals and the nominal / face value at maturity / redemption. The intervals may be quarterly, six-monthly or annually in arrears, but the six-monthly one is the most universal. These bonds may be issued at one of three prices:

- 100% (=1.0)[29].
- Lower than 100% (< 1.0).
- Higher than 100% (> 1.0).

If issued at 100%, i.e. at par value, the coupon is the "rate" earned by the holder. If issued at a discount to par value, the "rate" earned is higher than the coupon. Clearly then, if a bond is issued at a premium, the "rate" earned is lower that the coupon.

To illustrate the principle, let us use a ridiculous example: assume that a LCC1 million (nominal value) bond has 365 days to run and one coupon payable at the expiry of the bond of 12% pa. Clearly, if this bond is issued at a price of 100%, the investor will earn 12% pa. If, however, the bond is issued at a discount price of, say, 98.3%, the investor will pay LCC983 000 (LCC1 000 000 × 0.983). However, s/he will earn the coupon of 12%, i.e. LCC120 000 (LCC1 000 000 × 0.12). Thus, his/her return is actually 12.21% pa (LCC120 000 / LCC983 000 × 100).

If the bond is issued at a premium of 105.2%, the investor will pay LCC1 052 000 (LCC1 000 000 × 1.052), but will earn LCC120 000 at the end of the period. The return is then 11.41% (LCC120 000 / LCC1 052 000 × 100).

As noted, these are ridiculous examples because bonds are longer in term and coupons are usually paid six-monthly. This makes them more complicated in terms of their mathematics. It will also have been noted above that use of the word *rate* in connection with discount and premium was placed in inverted commas. The reason is that in the bond market one cannot talk of the "rate" earned. It is more complex: in this respect market participants talk of the *yield to maturity* or the *yield to redemption*. We will use the former.

3.5.2 Yield to maturity

The yield to maturity (ytm) is a measure of the *rate of return* on a bond that has a number of coupons paid over a number of years and a face value payable at maturity. It may also be described as the rate that buyers are prepared to pay now (present value LCC) for a stream of regular payments and a lump sum at the end of the period for which the bond is issued. It is an *average rate* earned per annum over the period.

Formally described, the ytm is the *discount rate that equates the future coupon payments and principal amount of a bond with the market price*. Another way of stating this is: the *price* is merely the *discounted value of the income stream (ie the coupon payments and redemption amount), discounted at the market yield (ytm).*

A basic example will illuminate:

Settlement date:	30/9/2005
Maturity date:	30/9/2008
Coupon rate:	9% pa
Face value:	LCC1 000 000
Interest date:	30/9
ytm	8% pa (payable annually in arrears).

The cash flows and their discounted values (using the ytm) are as shown in Table 1.

Date	Coupon Payment	Face value	Compounding periods (cp)	Present value $C / (1 + ytm)^{cp}$
30/9/2006	LCC90 000	-	1	LCC83 333.33
30/9/2007	LCC90 000	-	2	LCC77 160.49
30/9/2008	LCC90 000	-	3	LCC71 444.90
30/9/2008	-	LCC1 000 000	3	LCC793 832.24
Total	**LCC270 000**	**LCC1 000 000**		**LCC1 025 770.96**
C = coupon. cp = compounding periods.				

Table 1: Cash flows and discounted values

The value now of the bond is LCC1 025 770.96, and the price of the bond is 1.02577096 or 102.577096%. It will be apparent that the price is derived from the following formula for bonds:

$$\text{Price (PV)} = [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [1 / (1 + ytm)^3]$$

where:

cr	= coupon rate pa (expressed as a fraction of 1)
ytm	= yield to maturity (expressed as a fraction of 1).

Using the same numbers as above (coupon rate = 9% pa, ytm = 8% pa):

Price (PV) = (0.09 / 1.08) + (0.09 / 1.166400) + (0.09 / 1.259712) + (1 / 1.259712)
= 0.08333333 + 0.07716049 + 0.0714449 + 0.79383224
= 1.02577096.

It will be apparent that the coupon rate (0.09) for the periods and the face value (1) that takes place at maturity (all FVs) are discounted at the ytm to PV. Because the coupon rate is higher than the ytm, the price is *higher than 1* (a premium to par). Where the coupon rate is equal to the ytm (assume 9% pa) the price is *equal to 1* (par):

Price (PV) = (0.09 / 1.09) + (0.09 / 1.1881) + (0.09 / 1.295029) + (1 / 1.295029)
= 0.082569 + 0.075751 + 0.069497 + 0.772183
= 1.000000.

As noted, when the coupon rate is lower than the ytm (assume coupon rate = 9% pa, ytm = 11% pa), the price is *lower than 1* (i.e. at a discount to par):

Price (PV) = (0.09 / 1.11) + (0.09 / 1.232100) + (0.09 / 1.367631) + (1 / 1.367631)
= 0.081081 + 0.073046 + 0.065807 + 0.731191
= 0.951125.

The *inverse relationship* between ytm and price will also be clear. This is because the ytm is the *denominator* in the formula. Thus, if the ytm falls, the price of the bond rises. It follows that if the ytm increases the price falls. Another way of seeing this phenomenon is the logic of: as the ytm rises the future cash flows are worth less when discounted to present value, pulling down the price.

In reality bonds are slightly more complicated but the principle remains the same. The majority (by far) of bonds issued in the bond market have coupons that are payable six-monthly in arrears, and they are issued and traded for periods that are broken, i.e. issues and secondary market settlement dates are between interest payment dates.

In the case where interest payments are made six-monthly in arrears (ignoring settlement between interest payment dates), the coupon rate is halved and the compounding periods are doubled (assume a three-year bond):

$$\text{Price (PV)} = [(cr/2) / (1 + ytm/2)^1] + [(cr/2) / (1 + ytm/2)^2] + [(cr/2) / (1 + ytm/2)^3] + [(cr/2) / (1 + ytm/2)^4] + [(cr/2) / (1 + ytm/2)^5] + [(cr/2) / (1 + ytm/2)^6) + [1 / (1 + ytm/2)^6].$$

The aforementioned bond formula is usually written as:

$$\text{Price} = \sum_{t=1}^{n} [cr / (1 + ytm)^t] + [1 / (1 + ytm)^n]$$

where

cr = coupon rate (cr / 2 if six-monthly)
ytm = yield to maturity (ytm / 2 if six-monthly)
n = number of periods (years × 2 if six-monthly).

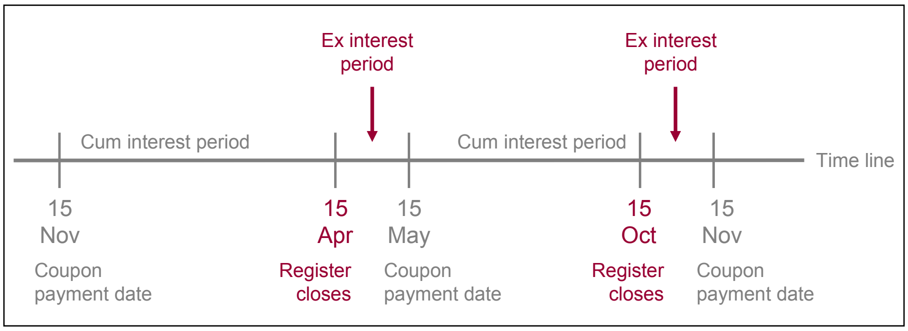

Figure 1: cum and ex interest

Another concept that needs grasping before proceeding to the more elaborate bond formula is that of *cum interest* and *ex interest*. This arises out of the fact that bond registers close for a period prior to the interest payment dates (we assume one month[30]). The date on which the register closes is known as the *last day to register*. Prior to this date, the bond is said to be *cum interest* and from the last day to register until the date of the interest payment it is said to be *ex interest* (see Figure 1).

If a bond is sold in the *cum interest* period the ownership change is recorded in the register and the new investor receives the full half coupon. S/he has to compensate the previous holder for the interest accrued to him/her during the relevant period. This interest factor is added to the clean price in order to arrive at the all-in price (also called *dirty price*). For example, if the coupon is 10% pa, and the bond was sold on 16 July, the price the new investor pays is increased by 0.016986 (62/365 × 0.10).[31]

If a deal is settled on say 16 October, the bond remains registered in the name of the "old" holder until the interest payment date of 15 November. The new holder must be compensated for the interest not received that accrues to him/her, i.e. interest from 16 October to 15 November. The applicable interest factor, 0.008493 ($31/365 \times 0.10$), is deducted from the clean price in order to arrive at the all-in price (dirty price).

Thus, as can be seen in Figure 2 (assumption: no market rate change over the period), in ex interest periods the dirty price is below the clean price (= buyer pays lower price / gets higher rate – because seller gets the full coupon), whereas in cum interest periods the dirty price is above the clean price (= buyer pays higher price / earns lower rate – because s/her gets the full coupon).

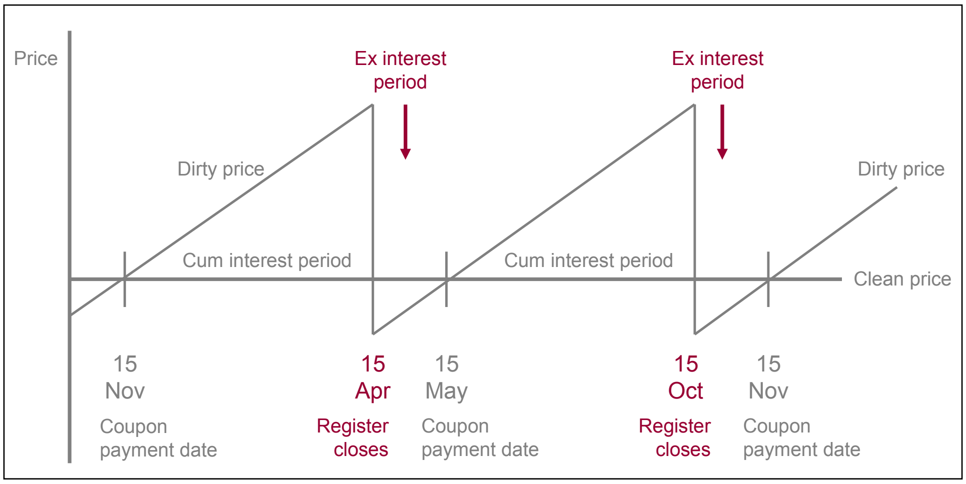

Figure 2: cum and ex interest

5.5.3 Standard pricing formula

The standard pricing formula for plain vanilla bonds (with more than 6 months to maturity) takes into account all the possibilities referred to above. It is:

$$\text{All-in price} = V_i^{d1/d2}\,[1/2\,c\,(a_n^{\,i} + e) + 100V_i^{\,n}]$$

where

- d1 = number of days from settlement date to next interest date
- d2 = number of days from last to next interest date or from settlement date to next interest date if settlement falls on an interest date
- i = yield at which bond trades (percentage)
- V_i = 1 / (1 + i / 200) = present value of 1 payable in 6 months' time
- c = coupon (percentage)
- n = number of full six month periods from next interest date to redemption date
- $a_n^{\,i}$ = $(1 - V_i^{\,n}) / (i / 200)$ = present value of an annuity of 1 per six months, payable in arrears
- e = 1 if the stock is cum interest and 0 if ex interest

Accrued interest = [(d2 – d1) / 365] × c (if cum interest)
Accrued interest = – (d1 / 365 × c) (if ex interest)
Clean price = all-in price – accrued interest.

The following example may be useful:

Coupon (payable half-yearly)	= 12% pa
Coupon payment dates	= 15 March and 15 September
Redemption (maturity) date	= 15 September 2009
Yield to maturity	= 13.5% pa
Settlement date	= 20 July 2005
Nominal value	= LCC1 000 000.

In this example the all-in price is 99.4450610, and the consideration (amount paid) would be LCC994 450.61. It will be evident that this bond is *cum interest.* The following will be useful:

d1	= 20 July 2005 – 15 September 2005	= 57 days
d2	= 15 March 2005 – 15 September 2005	= 184 days
n	= 8	
d1/d2	= 0.30978261	
V_i	= 0.93676815	
V_i^n	= 0.59300306	
$V_i^{d1/d2}$	= 0.97996852	
$a_n^{\ i}$	= 6.02958430	

All-in price $= V_i^{d1/d2} \times [1/2c \times (a_n^{\ i} + e) + (100 \text{ x } V_i^n)]$

$= 0.97996852 \times [6.0 \times (6.02958430 + 1) + 59.300306]$

$= 0.97996852 \times 101.4778118$

$= 99.4450610.$

If, however, the bond was purchased on 20 August 2005, the all-in price would be 94.60061322 and the consideration LCC946 006.13. It will be evident that this bond is *ex interest*. The following will be useful:

d1	= 20 August 2005 – 15 September 2005	= 26 days
d2	= 15 March 2005 – 15 September 2005	= 184 days
n	= 8	
d1/d2	= 0.14130435	
V_i	= 0.93676815	
V_i^n	= 0.59300306	
$V_i^{d1/d2}$	= 0.99081254	
$a_n^{\ i}$	= 6.02958430	

All-in price $= V_i^{d1/d2} \times [1/2c \times (a_n^{\ i} + e) + (100 \times V_i^n)]$

$= 0.99081254 \times [6.0 \times (6.02956430 + 0) + 59.300306]$

$= 0.99081254 \times 95.4778118$

$= 94.60061322.$

In a number of countries it is also a convention to calculate and present clients with the accrued interest and the so-called *clean price* (mainly for purposes of exchange control and to calculate the so-called *running yield*). As noted above, the *clean price* is determined by deducting the accrued interest from the all-in price.

In the above example the accrued interest price is equal to:

Accrued interest price = (184 – 57) / 365 × c
= 4.17534.

Clean price = All-in price – accrued interest price
= 99.44506 – 4.17534
= 95.26972.

In the case of an *ex-interest bond*, the accrued interest is negative and in the example above (with settlement 20 August) the calculations are as follows:

Accrued interest price = – (d1 / 365 × c)
= – (26 / 365 × 12.0)
= – 0.85479.

Clean price = All-in price – accrued interest
= 94.60061 – (-0.85479)
= 94.60061 + R0.85479
= 95.45540.

5.5.4 Bonds with less than six months to maturity

In the case of bonds with less than six months to maturity, there are only two features to consider in pricing. They are:

- Number of days to maturity.
- The last coupon payment.

In this case the concept of clean price clearly does not arise because the price is termed the *all-in price*. The price of these short-term bonds is determined in terms of the following formula:

All-in price (PV)[32] = (1 + cr / 2) / [1 + (t / 365 × ir)]

where

cr = annual coupon rate
t = number of days from settlement date to maturity date
ir = interest rate (or ytm).

If the bond in the above example (a reminder: maturity date 15 September 2009; coupon 12%) were purchased on 21 July 2009 at 11.0% pa, its price would be as follows:

All-in price = (1 + 0.12 / 2) / (1 + (56 / 365 × 0.11))
= 1.04240757.

The consideration in this example would be as follows:

Consideration = nominal value × price
= LCC1 000 000 × 1.0424076
= LCC1 042 407.60.

However, if the bond has *less than one month to redemption* (i.e. is *ex interest*), the formula changes to the following:

All-in price (PV) = 1 / [1 + (t / 365 × ir)].

This is because the new purchaser does not receive the coupon and must be compensated for the loss of interest. Again using the above example, if the bond is purchased on 21 August 2009 at 11% pa, the all-in price would be as follows:

All-in price (PV) $= 1 / [1 + (25 / 365 \times 0.11)]$
$= 0.99252209.$

It will be apparent that the purchaser will receive LCC1 000 000 on 15 September (i.e. the nominal amount and no coupon payment). For this s/he pays a consideration of LCC992 522.09. S/he thus receives income of LCC1 000 000 less LCC992 522.09, or LCC7 477.90, for the 25-day period. His/her return (11.0% pa) can be recalculated as follows:

Return = (amount earned / price paid) × 365/25
= LCC7 477.90 / LCC992 522.09 × 365/25
= 0.1099999
= 11.0% pa.

5.6 Perpetual bonds

A perpetual bond is one that has no maturity date and therefore no repayment of the principal amount, and it pays a fixed annual (or more frequent) coupon rate. The price of such a bond is determined as follows:

$$\text{Price (PV)} = [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + \dots \textit{(infinity)}$$

Because infinity is involved here, this formula simplifies to the following:

$$\text{Price (PV)} = cr / ytm.$$

It should be clear that when cr = ytm, the price is 1.0 or 100%. For example, if the coupon rate is 10% and the ytm is 10%, the price is 10 / 10 = 1.0. If the market rate moves up to 20%, the price is 10 / 20 = 0.5 or 50%. If the rate moves down to 5%, the price is 10 / 5 = 2.0 or 200%.

The principle at work here is that when the market rate for the perpetual bond falls from 10% pa to 5% pa, the buyers are prepared to earn 5% pa in perpetuity. This means that they are *prepared to pay a price* for the security that will yield them 5% pa (= 200%) on a LCC1 million face value perpetual bond the annual income on which is LCC100 000 (10%). Thus, the buyers will be prepared to pay LCC2 000 000 for the bond (LCC100 000 / LCC2 000 000 × 100 = 5.0% pa).

It will have been noted that the inverse relationship between price and market rate is most easily understood in the case of a perpetual bond.

5.7 Bonds with a variable rate[33]

Bonds with a variable rate are also called floating rate bonds / floating rate notes (FRNs). They are issued for short- and long-term periods and pay a rate of interest (called a coupon) that is benchmarked on a well-publicised and available rate, for example IBAR[34] + 30 basis points (bp). This is an example called *simple margin* (or *spread for term*). Variations are adjusted simple margin, discount margin, etc.

It may be useful to start this discussion with an extreme example: that of a security that has a true-blue floating rate attached. The price of a security that has a coupon rate equal to, for example, 50 bp over the overnight IBAR rate (OIBAR), is always LCC100%. Thus if the OIBAR rate on day 1 is 7.0% pa, the rate on the bond = 7.5% pa, and its price is 1.0 or 100.00%. If the ROD rate falls to 6.5% pa on day 2, the price of the security remains at 100%. This is because there is no fixed rate that has a benefit for the holder. The rate fluctuates with what the market demands. Price risk is not present in this example.[35]

The above example is rare. Benchmark (also called *basis* and *reference*) rates used in respect of variable rate bonds are often ones that reset quarterly or six-monthly (for example 3-month IBAR yield + 30bp). It will be evident that the coupon rate is determined as follows:

Coupon rate = reference rate +/- quoted spread.

The spread is determined mainly by the borrower's credit rating (credit spread), term to maturity and the prevailing interest rate environment.

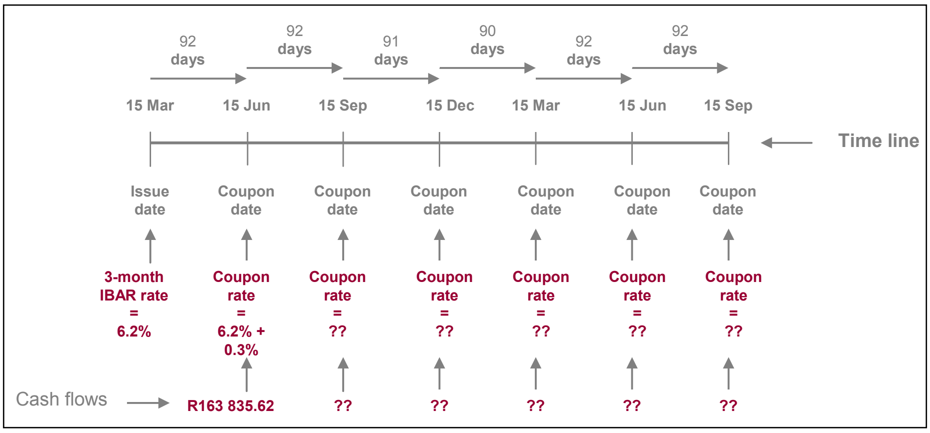

Figure 3: example of floating rate bond (LCC10 million, 3-month IBAR + 30bp)

In the case where coupons are payable quarterly, only the next coupon is certain; beyond this coupon payment the coupons are not known because the benchmark rates are not known (obviously) (see Figure 3).

These bonds [which are traded on price (all-in price) per LCC100 nominal] therefore do not – usually – trade at par (except at issue date and on rate reset dates).

The pricing (all-in price) of variable rate bonds is determined according to the following *inputs* (assumptions: quarterly reset dates; quarterly payments / payments are made on coupon dates):

- Initial spread (IS) – this is the margin at which the FRN is issued. For example, a FRN that bears interest at IBAR + 50bp has an IS of 50bp.
- Last interest reset rate (last rate on last coupon date).
- Number of days in the current interest period, i.e. number of days from the last coupon date to the next coupon date.
- Number of days from settlement date to next coupon date.
- Payment frequency of the bond (quarterly in the example).
- The values from a zero coupon yield curve[36] corresponding to the prospective coupon dates.
- Trading spread (the spread that would apply if the bond was issued on the day on valuation).

It will be evident that the pricing *methodology*, put simply, would be as follows:

- Generate a schedule of coupon payment dates (see example).
- Determine the zero coupon rate corresponding to each coupon date (from the zero coupon yield curve).
- Calculate the forward rate for each prospective coupon date (from the forward yield curve).
- Calculate the implied forward rates of the prospective coupons, i.e. predict the future coupons using the forward curve.
- Discount each coupon and principal back to present value, taking into account the market's perception of what the new trading spread should be.

In many cases, floating rate bonds have a cap, i.e. a maximum rate. If in this case rates are expected to move sideways or rise, the normal bond pricing formula applies.

5.8 CPI bonds

Bonds can also be issued at rates linked to an inflation rate. In this case, the floating (unknown) part of the interest can be paid to the holder or enhance the capital value of the bond.

An example is appropriate: a fixed coupon (for example, 5% pa) is paid six-monthly in arrears, and the capital value is enhanced by the rate of inflation. The following are the details:

$$\text{Capital value (CV) of the bond} = P \times IR_{date}$$

where

P = principal amount
IR_{date} = index ratio on relevant date.

The index ratio is calculated as follows:

$$IR_{date} = RCPI_{date} / RCPI_{idate}$$

where

$RCPI_{date}$ = reference CPI on date (usually interest-payment)
$RCPI_{idate}$ = reference CPI on issue date.

Coupons are thus paid on interest dates according to the formula:

Interest payment = (cr / 2) × CV

where

cr = coupon rate
CV = capital value.

In this example the coupon rate is 5% pa. Thus, on coupon dates the interest payable is 2.5% of the CV. If on an interest date the reference CPI is 119.9 and the reference CPI on issue date is 108.6, the index ratio is 1.10405 (119.9 / 108.6). Thus, the CV, assuming the principal amount is LCC10 000 000, is LCC11 040 500 (LCC10 000 000 × 1.10405). The coupon payable is thus LCC276 012.50 (0.025 × LCC11 040 500).

5.9 Zero coupon bonds

As noted above, zero coupon bonds are bonds that are discounted because they pay only the face value of the bond at the end of their life. The return earned by the holder is the difference between the amount paid, i.e. the discounted amount, and the face value of the bond.

A zero coupon bond is generally defined as follows[37]:

"A conventional bond is a debt instrument consisting of a series of periodic coupon payments plus the repayment of the principal on maturity. As the name suggests, a zero-coupon bond has no coupon payments. It has only a single payment consisting of the repayment of the principal at maturity. The zero-coupon bond is purchased by an investor at a discount to its face value and then redeemed for its face value at maturity. The return to the investor is the difference between the face value of the bond and its discounted purchase price."

The PV (price) of these bonds is calculated according to the normal bond pricing formula shown earlier. Thus, semi-annual compounding / discounting is assumed (in order to make them comparable to their plain vanilla counterparts). The valuation principle will be apparent from an example:

Face value	= future value (FV)	= LCC1 000 000
Term to maturity in years	= y	= 3 years
Compounding periods pa	= cp	= 2
ytm		= 9% pa

$$\begin{aligned} PV &= FV / [1 + (ytm / cp)]^{y.cp} \\ &= LCC1\ 000\ 000 / [1 + (0.09 / 2)]^{3\times2} \\ &= LCC1\ 000\ 000 / 1.045^{6} \\ &= LCC1\ 000\ 000 / 1.30226 \\ &= LCC767\ 895.81. \end{aligned}$$

We may test this calculation by calculating the FV from the PV, using the same variables:

$$\begin{aligned} FV &= PV \times [1 + (0.09 / 2)]^{6} \\ &= LCC767\ 895.81 \times 1.30226 \\ &= LCC1\ 000\ 000.00. \end{aligned}$$

It may be useful to present the valuation formulae in the case of (as these are used in some countries):

- Using number-of-days convention.
- Using annual compounding convention.

If the PV (price) of these bonds is calculated according to a day convention, the formula is:

$$PV = FV / (1 + ytm)^{d/365}$$

Example:

Face value (FV)		= LCC1 000 000
D	= number of days to maturity	= 430 days
ytm		= 9.35% pa

$$\begin{aligned} \text{PV (or price)} &= \text{LCC1 000 000} / (1 + 0.0935)^{430/365} \\ &= \text{LCC1 000 000} / (1 + 0.0935)^{1.17808219} \\ &= \text{LCC1 000 000} / 1.11104519 \\ &= \text{LCC900 053.40.} \end{aligned}$$

The buyer, using as givens the PV and the ytm, may verify this calculation as follows:

$$\begin{aligned} \text{FV} &= \text{PV } (1 + \text{ytm})^{d/365} \\ &= \text{PV } (1 + 1.0935)^{430/365} \\ &= \text{LCC900 053.40 } (1.0935)^{1.17808219} \\ &= \text{LCC900 053.40 } (1.11104519) \\ &= \text{LCC1 000 000.00.} \end{aligned}$$

In the case of unbroken years and *annual compounding* the calculation is:

Face value (FV)	= LCC1 000 000
y	= 3 years
ytm	= 12.0% pa

$$\begin{aligned} \text{PV} &= \text{FV} / (1 + \text{ytm})^3 \\ &= \text{LCC1 000 000} / (1.12)^3 \\ &= \text{LCC1 000 000} / 1.4049280 \\ &= \text{LCC711 780.25.} \end{aligned}$$

The test:

$$\begin{aligned} \text{FV} &= \text{PV } (1 + \text{ytm})^3 \\ &= \text{LCC711 780.25 } (1.12)^3 \\ &= \text{LCC711 780.25} \times 1.4049280 \\ &= \text{LCC1 000 000.00.} \end{aligned}$$

5.10 Strips

As noted in another section, STRIPS is the acronym for **S**eparate **T**rading of **R**egistered **I**nterest and **P**rincipal of **S**ecurities. A plain vanilla bond is stripped into C-strips and a P-strip. The amount and date of each interest payment (C-strips) and the final principal are known, and *each trades as a separate zero coupon bond* the mathematics of which was discussed above.

5.11 Summary

The basis underlying financial market mathematics is the time value of money, the PV / FV concept. The plain vanilla bond has the hallmarks of an annuity. A bond's value / price is determined by the discounting of all future cash flows to PV by the ytm. The latter is a "rate" created to cater for securities that have multiple future cash flows and can be described as an average rate for the period.

There are a number of variations to the plain vanilla bond, but the pricing principle remains the same.

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6 Tools

6.1 Learning outcomes

After studying this text the learner should / should be able to:

1. Know, understand and be able to apply other yield measures.
2. Know, understand and be able to apply bond market tools like duration, Macauley duration and modified duration.
3. Appreciate the concept of convexity.
4. Appreciate the concept of LCC per basis point.
5. Understand the meaning of the yield curve and how it is derived.
6. Know and understand the various uses of the yield curve.
7. Understand the par yield curve and the zero-coupon yield curve and their uses.
8. Know the different shapes of the yield curve, what it represents in terms of short-term and long-term interest rates and expectations with regard to short-term interests rates (monetary policy).

6.2 Introduction

There are a number of tools that practitioners in the bond market employ daily to assist in operations. There are four tools / categories of such tools:

- Other yield measures.
- Duration.
- LCC per basis point
- The yield curve.

6.3 Other yield measures

6.3.1 Introduction

There are a number of other yield measures used in the bond market:

- Coupon.
- Yield to par.
- Simple yield to maturity.
- Current yield.
- Running yield.
- Holding period yield.
- Yield to call.

6.3.2 Coupon

Coupon is a yield measure that is applicable when a bond is issued at a rate (ytm) that matches the coupon. This means that the bond is issued at "par". Par means that the bond is issued at a price of 1.0 or 100%. We saw earlier that, generally, bonds are issued at a premium or a discount which means that the ytm is not equivalent to the coupon. In some countries bonds are issued at par.

6.3.3 Par yield

Par yield (or "yield to par") is an expression or yield measure that is applicable when a bond is trading at an ytm equal to the coupon rate.

6.3.4 Simple yield to maturity

The simple yield to maturity[38] is a measure used in some countries. It ignores reinvestment of the coupon and the capital loss or gain is amortised equally over the unexpired term to maturity. It is:

$$\text{Simple ytm} = \{cr + [(RP - CP) / t]\} / CP$$

where

cr = coupon rate pa
RP = redemption price at maturity (always = 1.0)
CP = clean price (reminder: all-in price – interest price)
t = time (unexpired years to maturity).

Example:

cr = 11.0% pa
CP = 0.97456
t = 8

$$\begin{aligned}\text{Simple ytm} &= \{0.11 + [(1.0 - 0.97456) / 8]\} / 0.97456 \\ &= [0.11 + (0.02544 / 8)] / 0.97456 \\ &= 0.11318 / 0.97456 \\ &= 11.613\% \text{ pa.}\end{aligned}$$

6.3.5 Current yield

The so-called *current yield* is a *simple measure* of return earned in a year. The current yield (cy) is the ratio of the coupon rate (cr) to the all-in market price (MP):

$$cy = cr / MP$$

Example:

cr = 12% pa
MP = 0.954554
cy = 0.12 / 0.954554
= 0.1257
= 12.57% pa.

It will be apparent that this measure ignores:

- reinvestment of coupon (compounding)
- any capital gain or loss, i.e. the difference between the all-in price paid and the redemption price at maturity (1.0); in the example it is a capital gain (1.0–0.054554).

6.3.6 Running yield

Running yield (ry) (also called *flat yield*) is the same as the current yield, except that the denominator is the clean price CP:

ry = cr / CP.

6.3.7 Holding period yield

Holding period yield (hpy) mathematics is similar to the ytm mathematics. While the ytm is the *average expected return* over the life of the bond, hpy is the yield for the period that a bond is held when sold before maturity. Formally it is the yield that equates the market price (MP) of the bond with the cash flows [coupon rate (cr) and the sale price (SP)] between the time of purchase and sale (n = holding period):

$$MP = [cr / (1 + hpy)^1] + [cr / (1 + hpy)^2] \ldots [cr / (1 + hpy)^n] + [SP / (1 + hpy)^n].$$

All that remains is to solve for hpy. (Note that the assumptions here are that the bond is purchased on a coupon payment date and that the reinvestment rate of the coupons is equal to the coupon rate). In practice this is unlikely to be the case.

6.3.8 Yield to call[39]

Bonds with call options may never reach maturity; the issuer holds the option to retire them before maturity. The return measure *yield to call* (ytc) is regarded as a better measure of return than ytm in the case of call bonds. The calculation is the same as the ytm, but with two important differences:

- The anticipated call date is used as the maturity date (unlike non-call bonds, the call date can only be anticipated).
- The principal plus the call penalty (if applicable) is substituted for the principal.

An example is useful:

Face value (FV)	= LCC1 000 000
Term to maturity	= 10 years
Coupon	= 8.0% pa
Ytm now	= 9.0% pa
Price now	= LCC935 000
Anticipated call date	= 5 years
Anticipated penalty	= LCC50 000

$$ytc = LCC935\,000 = [LCC80\,000 / (1 + ytc)^1] \ldots [LCC80\,000 / (1 + ytc)^5] + [LCC1\,050\,000 / (1 + ytc)^5]$$

$$= 10.55\%.$$

6.4 Duration

6.4.1 Introduction

The concepts of duration and related measures are discussed under the following sections:

- Duration (price sensitivity).
- Modified duration.
- Convexity.
- LCC per basis point.

6.4.2 Duration

6.4.2.1 Introduction

Duration is an alternative approach to term to maturity. Because of the impact of the time to maturity and the coupon (etc.) on the price of bonds, an alternative index of maturity to calendar years was developed: *duration*. The basic idea was to create a *linear (= proportional) relationship between maturity and bond price volatility (or elasticity) irrespective of the level of the coupon rate*. In order to explain this we need again to go back to the basics.

The pricing of bonds was elucidated earlier with the assistance of an example. This is repeated here:

Settlement date:	30/9/2005
Maturity date:	30/9/2008
Coupon rate:	9% pa
Face value:	LCC1 000 000
Interest date:	30/9
ytm	8% pa.

In this example the cash flows occur as shown in Table 1.

Date	Coupon Payment	Face value	Compounding periods (cp)	Present value $C / (1 + ytm)^{cp}$
30/9/2006	LCC90 000	-	1	LCC83 333.33
30/9/2007	LCC90 000	-	2	LCC77 160.49
30/9/2008	LCC90 000	-	3	LCC71 444.90
30/9/2008	-	LCC1 000 000	3	LCC793 832.24
Total	**LCC270 000**	**LCC1 000 000**		**LCC1 025 770.96**
C = coupon. cp = compounding periods.				

Table 1: Cash flows and discounted values

The value of the bond is LCC1 025 770.96n and the price of the bond is 1.02577096 or 102.577096%. What was explicated in the table may be rewritten as (cr = coupon rate pa):

$$\text{Price} = [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [1 / (1 + ytm)^3].$$

This serves as an introduction to the characteristics of bonds which are explicated hereafter.

4.2.2 Impact of ytm change on price of bond

If the ytm on this bond (coupon = 9.0%) is increased to 11% pa (from 8.0%), the price is:

$$\begin{aligned} \text{Price} &= [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [1 / (1 + ytm)^3] \\ &= (0.09 / 1.11^1) + (0.09 / 1.11^2) + (0.09 / 1.11^3) + (1 / 1.11^3) \\ &= (0.09 / 1.11) + (0.09 / 1.2321) + (0.09 / 1.367631) + (1 / 1.367631) \\ &= 0.08108108 + 0.07304602 + 0.06580722 + 0.73119138 \\ &= 0.95112570 \\ &= 95.112570\%. \end{aligned}$$

Conclusion: if the rate rises, the price falls.

If the ytm on this bond (coupon = 9.0%) is decreased to 5% pa (from 8.0%), the price is:

$$\begin{aligned}
\text{Price} &= [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [1 / (1 + ytm)^3] \\
&= (0.09 / 1.05^1) + (0.09 / 1.05^2) + (0.09 / 1.05^3) + (1 / 1.05^3) \\
&= (0.09 / 1.05) + (0.09 / 1.1025) + (0.09 / 1.157625) + (1 / 1.157625) \\
&= 0.08571429 + 0.08163265 + 0.07774538 + 0.86383760 \\
&= 1.10892992. \\
&= 110.892992\%.
\end{aligned}$$

Conclusion: if the rate falls, the price rises.

This inverse relationship between ytm and price is portrayed in Figure 1.

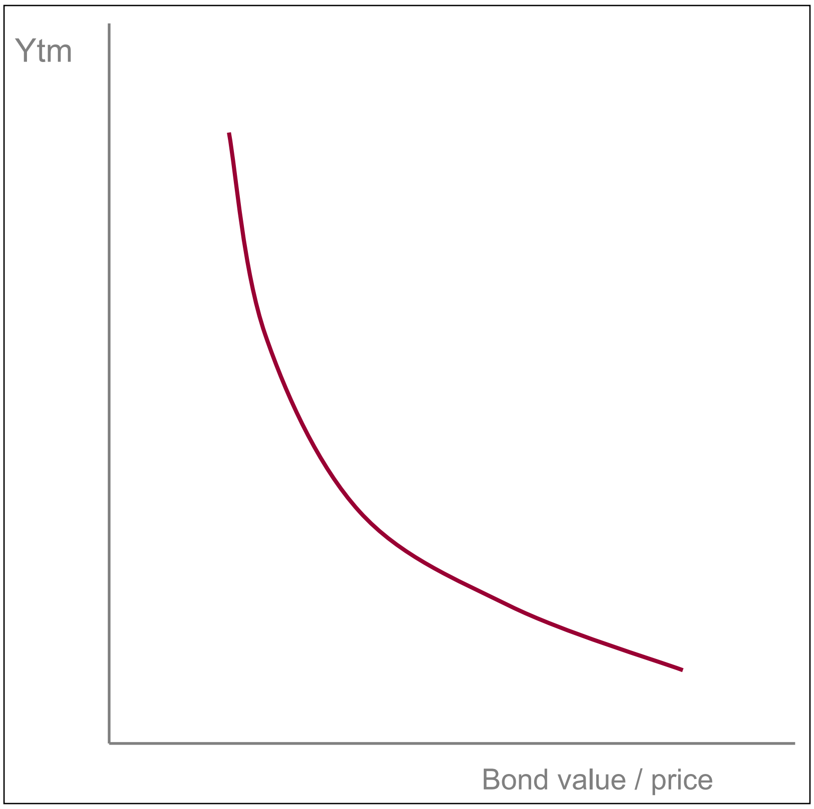


Figure 1: relationship between rate (ytm) and price (value)

In both cases the rate was changed by 300 bp. However, it will not be immediately apparent that the *price decline* in the case of the increased ytm was *smaller* than the *price increase* in the case of the lower ytm:

In the first case (ytm increase of 300bp): 1.02577096 – 0.95112570 = 0.07464526.

In the second case (ytm decrease of 300 bp): 1.10892992 – 1.02577096 = 0.08315896.

From these numbers one can also determine the *price elasticity* of the bond (i.e. the responsiveness of the bond's price to changes in ytm):

$$\text{Price elasticity} = (P_1 - P_0 / P_0) / (ytm_1 - ytm_0 / ytm_0)$$

where

P_1 = price at subsequent time
P_0 = price at initial time
ytm_1 = yield to maturity at subsequent time
ytm_0 = yield to maturity at initial time.

In the first case (ytm increase 8% to 11%):

$$\begin{aligned}\text{Price elasticity} &= (P_1 - P_0 / P_0) / (ytm_1 - ytm_0 / ytm_0)\\ &= (0.95112570 - 1.02577096 / 1.02577096) / (11\% - 8\% / 8\%)\\ &= (-0.07464526 / 1.02577096) / (3 / 8)\\ &= -0.07276991 / 0.375\\ &= -0.19405.\end{aligned}$$

In the second case (ytm decrease 8% to 5%):

$$\begin{aligned}\text{Price elasticity} &= (P_1 - P_0 / P_0) / (ytm_1 - ytm_0 / ytm_0)\\ &= (1.10892992 - 1.02577096 / 1.02577096) / (5\% - 8\% / 8\%)\\ &= (0.08315896 / 1.02577096) / (-3 / 8)\\ &= 0.08106972 / -0.375\\ &= -0.21619.\end{aligned}$$

For an upward movement in ytm from 8% to 11% the price elasticity for the bond is –0.19405, and a decline in ytm from 8% to 5% the price elasticity is –0.21619. Thus, the price elasticity is greater for the downward movement in interest rates than for an increase in interest rates.

Conclusion: ytm increases bring about proportionately smaller price changes than ytm decreases of the same magnitude.

6.4.2.3 Impact of term to maturity on bond price

If we use the same terms of the bond above (ytm = 8% pa; coupon = 9% pa), but increase the term from 3 to 4 years, the following is the price:

$$\begin{aligned}
\text{Price} &= [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [cr / (1 + ytm)^4] + \\
&\quad [1 / (1 + ytm)^4] \\
&= (0.09 / 1.08^1) + (0.09 / 1.08^2) + (0.09 / 1.08^3) + (0.09 / 1.08^4) + \\
&\quad (1 / 1.08^4) \\
&= (0.09 / 1.08) + (0.09 / 1.166400) + (0.09 / 1.259712) + \\
&\quad (0.09 / 1.360489) + (1 / 1.360489) \\
&= 0.08333333 + 0.07716049 + 0.0714449 + 0.06615268 + 0.73502983 \\
&= 1.03312123 \\
&= 103.312123\%.
\end{aligned}$$

If the ytm of this bond is increased to 11% pa (+300 bp – the same increase as in the case of an above example – for comparison purposes), its price will be:

$$\begin{aligned}\text{Price} &= [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [cr / (1 + ytm)^4] + \\ &\quad [1 / (1 + ytm)^4] \\ &= (0.09 / 1.11^1) + (0.09 / 1.11^2) + (0.09 / 1.11^3) + (0.09 / 1.11^4) + \\ &\quad (1 / (1.11)^4) \\ &= (0.09 / 1.11) + (0.09 / 1.2321) + (0.09 / 1.367631) + \\ &\quad (0.09 / 1.518070) + (1 / 1.518070) \\ &= 0.08108108 + 0.07304602 + 0.06580722 + 0.0592858 + 0.65873115 \\ &= 0.93795127 \\ &= 93.795127\%.\end{aligned}$$

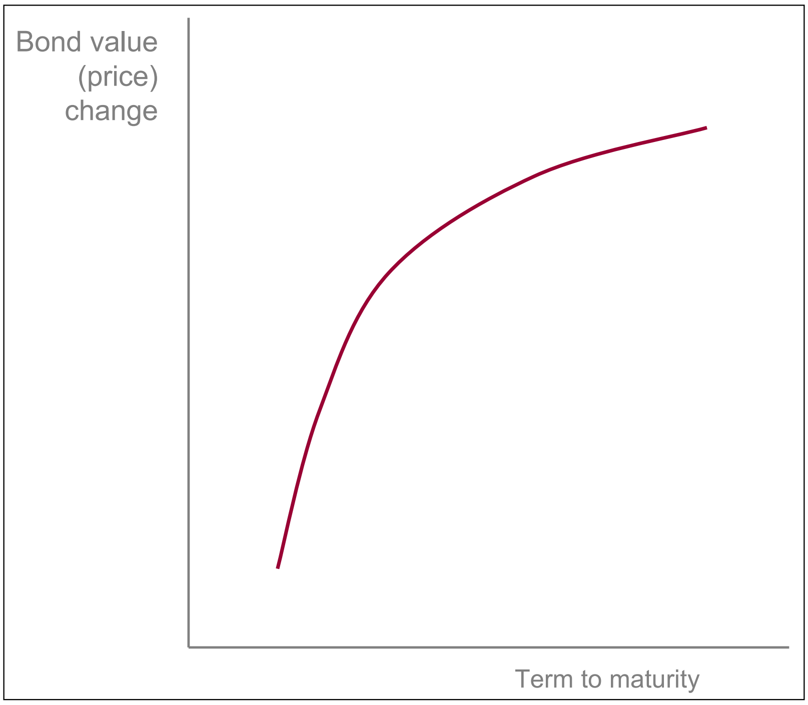


Figure 2: relationship between term to maturity and price change

The price change in the case of the 3-year bond with the coupon of 9%, but where the ytm increased by 300 bp (to 11%) was:

1.02577096 – 0.95112570 = 0.07464526 or 7.28% (or price elasticity of -0.1940).

In the case of the 4-year bond with the same characteristics, however, the price change was:

1.03312123 – 0.93795127 = 0.09516996 or 9.21% (or price elasticity of -0.2457).

Conclusion: the longer the bond the more price-sensitive it is to interest rate changes.

This relationship may be depicted as in Figure 2.

6.4.2.4 Impact of coupon rate on price of bond

Finally, we need to demonstrate that interest rate risk is inversely related to the coupon rate of the bond.

In the example of the bond above (i.e. 3-year, 9% coupon, and 8% ytm), the price was 1.02577096. When the ytm of the bond was increased to 11% pa, its price changed to 0.95112570. Thus, the change in the price was:

1.02577096 – 0.95112570 = 0.07464526 or 7.28% (or price elasticity of –0.199)

If we change to coupon to 20% and leave the other characteristics unchanged (i.e. term = 3 years and ytm = 8%), the price of this bond will be:

$$
\begin{aligned}
\text{Price} &= [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [1 / (1 + ytm)^3] \\
&= (0.20 / 1.08^1) + (0.20 / 1.08^2) + (0.20 / 1.08^3) + (1 / 1.08^3) \\
&= (0.20 / 1.08) + (0.20 / 1.16640) + (0.20 / 1.259712) + (1 / 1.259712) \\
&= 0.18518519 + 0.17146776 + 0.15876645 + 0.79383224 \\
&= 1.30925164 \\
&= 130.9251643\%.
\end{aligned}
$$

It the ytm on this bond (with a higher coupon) is lifted to 11% pa, the price changes to:

$$
\begin{aligned}
\text{Price} &= [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [1 / (1 + ytm)^3] \\
&= (0.20 / 1.11^1) + (0.20 / 1.11^2) + (0.20 / 1.11^3) + (1 / 1.11)^3) \\
&= (0.20 / 1.11) + (0.20 / 1.2321) + (0.20 / 1.367631) + (1 / 1.367631) \\
&= 0.18018018 + 0.16232449 + 0.14623828 + 0.73119138 \\
&= 1.21993433 \\
&= 121.993433\%.
\end{aligned}
$$

The price difference here is:

1.30925164 – 1.21993433 = 0.08931731 or 6.82% (or price elasticity of –0.1819).

Thus, compared with the 9% coupon bond, the 20% coupon bond exhibits a smaller price change when the ytm (rate) is increased to the same extent (i.e. 6.82% compared with 7.28%, or price elasticity of –0.1819 compared with –0.199).

Conclusion: interest rate risk increases inversely with coupon, ie the prices of higher coupon bonds are less sensitive to changes in interest rates than are the prices of lower coupon bonds. This may be depicted as in Figure 3.

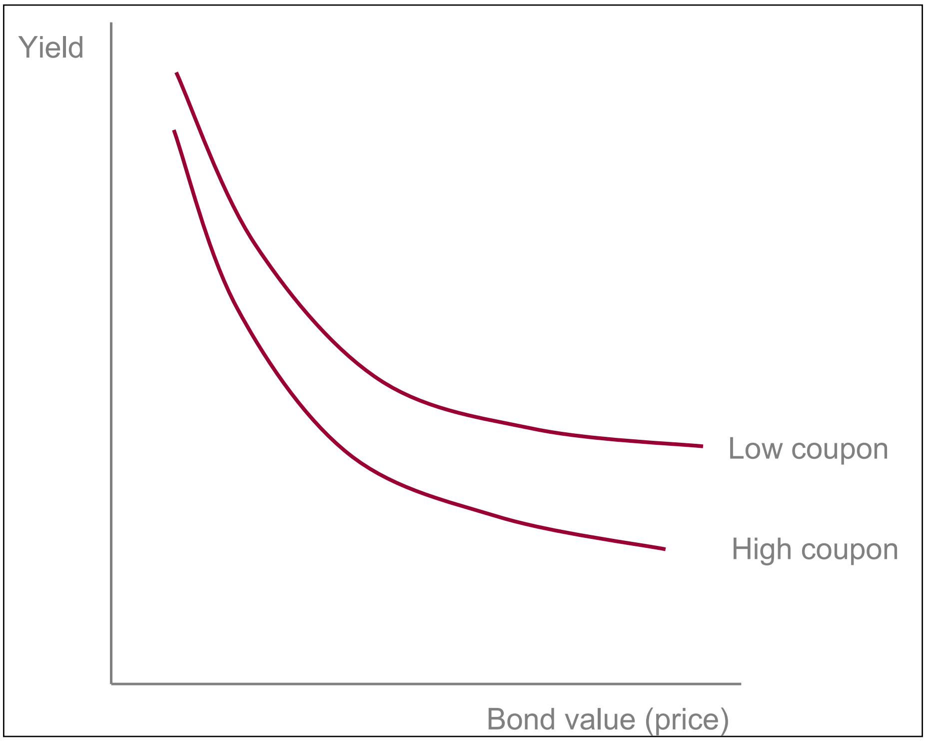


Figure 3: relationship between coupon and price

6.4.2.5 Macauley duration

We learned above that:

- Bond prices rise when rates (ytm) fall, and bond prices fall when rates increase.
- Ytm increases bring about proportionately smaller price changes than ytm decreases of the same magnitude.
- The maturity of a bond has an increasing effect on price sensitivity.
- Price risk increases inversely with coupon.

The above shows that, while maturity has a major impact on price (i.e. is a major determinant of interest rate risk), it is not the only determinant. Put another way, *maturity alone is not sufficient to measure interest rate risk*. Another maturity measure was required and the concept of *duration* was developed.

Duration was developed by Frederick Macaulay (see bibliography), and has been defined as the *effective maturity of a bond*, i.e. the *average maturity of a bond's promised cash flows* (i.e. coupons and principal). This maturity measure is a *gauge of interest rate sensitivity*.

Duration has also been described as a *method that converts a coupon bond (or any interest paying security) into its zero coupon equivalent*. By calculating the duration of all bonds in a portfolio, the bond portfolio manager is able to compare the interest rate sensitivity of all bonds held. The manager is essentially able to construct a *proportional (linear) relationship between maturity and price volatility*, irrespective of coupon rates. For example, if the portfolio manager doubles the duration of a bond portfolio s/he doubles the price elasticity of the portfolio.

Macaulay computed duration as the *weighted average of the times to each coupon or principal payment made by the bond*. Thus, duration is *the present value of interest and principal payments of a security weighted by the timing of those payments, divided by the present value of the security's stream of interest and principal payments*. The weight applied to each payment is the proportion of the total value of the bond accounted for by that payment, and the proportion is the present value of the payment divided by the bond price. An example is required (see Table 2).

Bond	Period to payment (years)	Payment amount (cash flow)	PV = payment discounted at 11% ytm	Weight* (PV as % of price)	Period to payment x weight = DURATION
LCC1 million 9% bond (annual interest)	1.0	90 000	81 081.08	0.086445	0.086445
	2.0	90 000	73 046.02	0.077878	0.155756
	3.0	90 000	65 807.22	0.070160	0.210480
	4.0	90 000	59 285.79	0.063208	0.252832
	4.0	1 000 000	658 730.97	0.701834	2.807336
			937 951.08	**1.000000**	**3.512849**
Zero coupon bond	1.0	-	-	-	-
	2.0	-	-	-	-
	3.0	-	-	-	-
	4.0	1 000 000	658 730.97	1.0	4.0

* weight = [CF / (1 + ytm)^{cp}] / bond price, where CF = cash flow; cp = compounding periods.

Table 2: Duration example

As may be seen, the zero coupon bond has a duration equal to its term to maturity. This of course makes sense because a zero coupon bond has one payment – at the end of the life of the bond.

Thus *all zero coupon bonds are comparable in terms of interest rate sensitivity*. For example, the price of the 4-year zero coupon bond at an 11% ytm is 0.65873097. If the maturity date is doubled to 8 years, the price is 0.43392696, i.e. a price change of 34.13% [(0.65873097 – 0.43392696) / 0.65873097]. If the maturity of the bond is increased by another 4 years to 12 years, the price changes to 0.28584082, i.e. a change of 34.13% [(0.43392696 – 0.28584082) / 0.43392696]. Thus, the relationship between maturity and price is *linear* (i.e. proportional)

Similarly, all *coupon-paying bonds*, irrespective of coupon, that have a duration of 4 are comparable in terms of interest rate sensitivity, i.e. the extent of the price change, given the same extent of ytm change.

From the above it will be evident that the duration formula in the example used in the box above may be written as:

$$D = (\{[CF_1 / (1 + ytm)^1] / BP\} \times 1) + (\{[CF_2 / (1 + ytm)^2] / BP\} \times 2) + (\{[CF_3 / (1 + ytm)^3] / BP\} \times 3) + (\{[CF_4 / (1 + ytm)^4] / BP\} \times 4)$$

where

D = duration
CF = cash flow for periods 1 to 4
BP = bond price $[CF_1 / (1 + ytm)^1] + [CF_2 / (1 + ytm)^2] + [CF_3 / (1 + ytm)^3] + [CF_4 / (1 + ytm)^4]$.

An even easier way to calculate duration is shown in Table 3 (using the same numbers in the box above).

Period to payment (years)	Payment amount (cash flow)	PV of cash flows – at 11% ytm	time period	PV of cash flows x period
1.0	90 000	81 081.08	1.0	81 081.08
2.0	90 000	73 046.02	2.0	146 092.04
3.0	90 000	65 807.22	3.0	197 421.66
4.0	90 000	59 285.79	4.0	237 143.16
4.0	1 000 000	658 730.97	4.0	2 634 923.88
		937 951.08		**3 296 661.82**

Table 3: Duration example: LCC1 million, 9% coupon, 4-year bond

The duration of the bond is:

LCC3 296 661.82 / LCC937 951.08
= 3.51 (which ties with the above figure).

Thus, duration may also be written as:

$$D \quad = (\text{sum } PV_{cf} \times t) / \text{sum } PV_{cf}$$

where

D = duration
PV_{cf} = present value of each cash flow
t = time period (period to the cash flow).

In words, duration is calculated as: the sum of the present value of each cash flow times the applicable time period, divided by the sum of the present value of each cash flow (i.e. the PV of the bond).

6.4.2.6 The uses of duration

The uses of duration are:

- Useful statistic to calculate the *effective average maturity* of a portfolio.
- Tool for the *immunisation of a portfolio from market rate risk* (e.g. to protect the return from a portfolio against changes in rates; select securities with duration that match investment horizon).
- Measure of *interest rate sensitivity* of portfolios.

Because duration is related in a linear fashion to price volatility, there exists a useful relationship between *changes in interest rates (ytm) and percentage changes in prices*. This may be written as follows:

$$\Delta P / P = -D \times (\Delta ytm / 1 + ytm)$$

where

P = price
ΔP = change in price
D = duration
ytm = yield to maturity.

Example:

D = 4
Δytm = 100 bp
ytm = 9%

$$\begin{aligned}\Delta P / P &= -D \times (\Delta ytm / 1 + ytm)\\ &= -4 \times (0.01 / 1.09)\\ &= -4 \times 0.0091743\\ &= -0.036697\\ &= -3.67\%.\end{aligned}$$

This means that if a bond has a duration of 4, then for every 100 basis point change in the yield, the price will change by 3.67%. This would be the same for any other bond with a duration of 4, irrespective of coupon, term to maturity and rate level. Thus, bond prices change in an inversely proportional way according to duration.

6.4.3 Modified duration

In practice many portfolio managers make use of duration in a slightly different form, i.e. that of *modified duration* (i.e. modified from the Macaulay duration). This is as follows:

$$D_m = D / (1 + ytm)$$

where

D_m = modified duration
D = Macaulay duration
ytm = yield to maturity.

Using the above example:

$$D_m = 4 / 1.09 = 3.66972.$$

The formula used earlier [$\Delta P / P = -D \times (\Delta ytm / 1 + ytm)$] now changes to the following (i.e. in the case of a 100 basis point change in the yield):

$$\Delta P / P = -D_m \times \Delta ytm = -3.66972 \times 1.0 = -3.67\%.$$

In the case of a 1 basis point change in the yield:

$$\Delta P / P = -D_m \times \Delta ytm = -3.66972 \times 0.01 = -0.0367\%.$$

This means that the percentage change in the price of a bond is *approximately* equal to the product of modified duration and the change in the yield of the bond. Thus, for each 100 basis point change in the yield of a bond with a modified duration of 3.67, the price will change by 3.67%. It follows that for each basis point change in the ytm of bonds with the same duration, the price will change by 0.0367%.

6.4.4 Convexity

The word "approximately" was used in italics above because duration correctly measures price sensitivity of bonds only for *small changes in interest rates*. With large changes in rates, duration becomes a less accurate measure of price changes. The reason for this is illustrated in Figure 4. *The true relationship between prices and yields is convex and not linear* (this can be proven empirically). Thus, with each large rate *increase* from the rate prevailing now (the intersection of the linear line and the curve) the duration model overestimates the *fall* in the price of the bond. Conversely, for large rate decreases, the duration model underestimates the increase in the price.

It will be clear that the duration model always underestimates the value (price) of the bond after large changes in interest rates (either positive or negative).

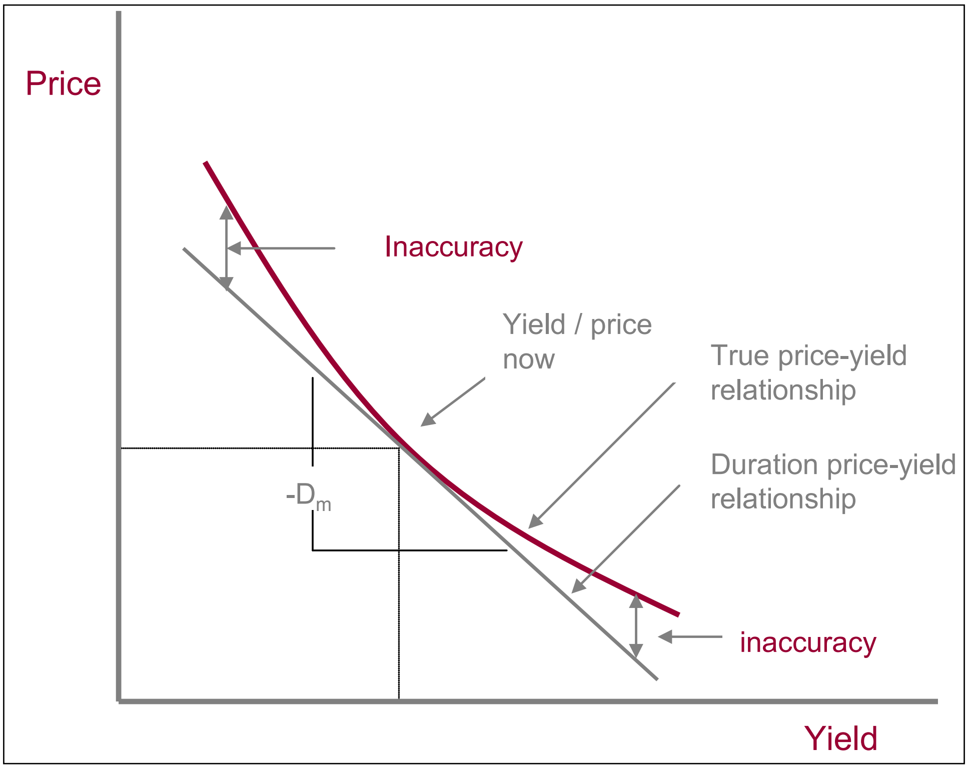


Figure 4: convexity

6.5 LCC per basis point

LCC per basis point (LCCbp) is simply the amount of LCC per basis point change in the rate on LCC1 million nominal value of the relevant bond, for example from 10.03% pa (ytm) to 10.02% pa (ytm).

This number is an important gauge for traders in the bond market in terms of assessing potential profits or losses. Thus, if the rate (ytm) on a R186 bond changes from 7.89% to 7.88% the LCC amount per LCC1 million nominal value of the bond (in this case a profit) may be LCC500. Clearly if the bond holding is LCC10 million, then the LCCbp = LCC5 000.

The LCCbp differs from bond to bond, and depends on coupon and term to maturity.

6.6 The yield curve (term structure of interest rates)

6.6.1 Introduction

This section has to do with the rates on bonds of various remaining terms to maturity at a point in time, i.e. the relationship between bond rates and terms to maturity, called the *term structure of interest rates* and the *yield curve*. We present a *positively-sloped* (or *normal*) yield curve in Figure 5.

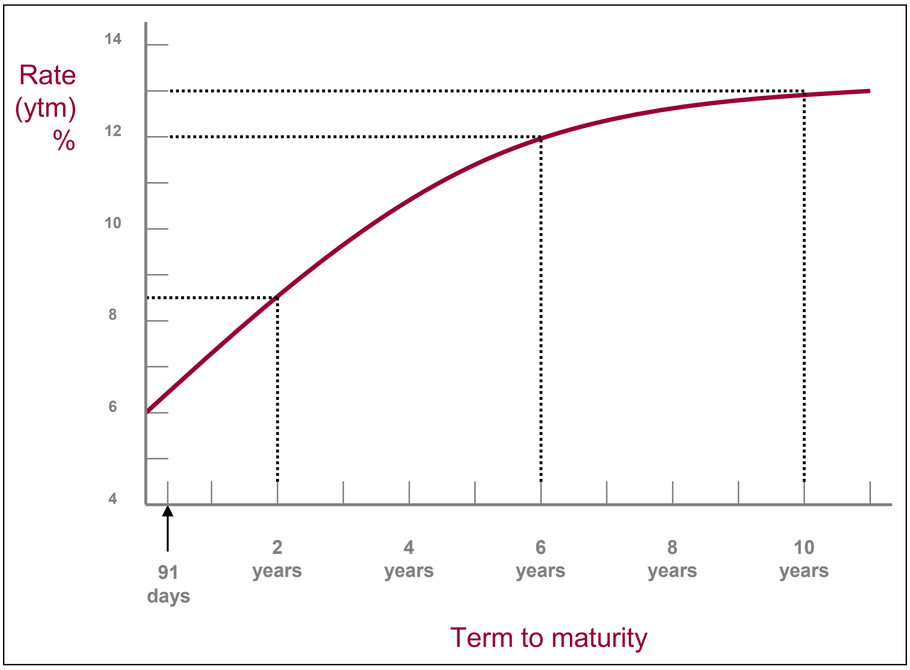


Figure 5: normal yield curve

Let us assume that this is a yield curve for government securities (treasury bill rate and bond rates[40]) at 4pm on 20 June 2009. The yield curve is telling us that the rates shown in Table 7.1 were recorded on that day (Note: they are read from the curve).

MATURITY OF SECURITY	RATE
91-days (treasury bill)	6.5%
1 year (government bond)	7.5%
2 years (government bond)	8.5%
3 years (government bond)	9.65%
4 years (government bond)	10.60%
5 years (government bond)	11.42%
6 years (government bond)	12.00%
7 years (government bond)	12.32%
8 years (government bond)	12.50%
9 years (government bond)	12.81%
10 years (government bond)	13.00%
11 years (government bond)	13.11%

Table 4: government security rates recorded on 20 June 2009

Where did this yield curve come from? It was constructed from the rates that prevailed on government securities of various maturities at 4pm on 20 June 2009. Figure 6 depicts this.

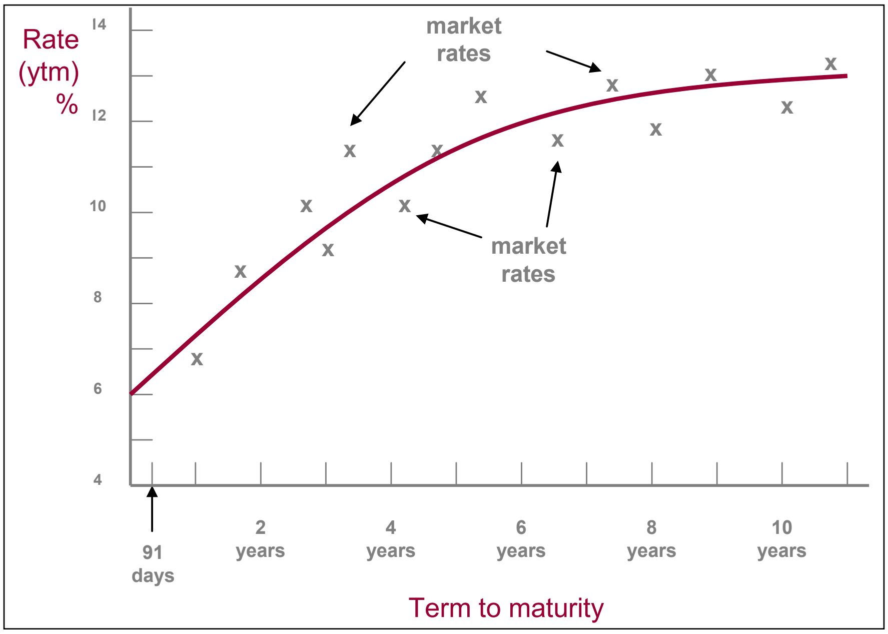


Figure 6: market rates and constructed yield curve

The market rates on government securities of different maturities are represented by the x's and the yield curve constructed and drawn with the use of sophisticated statistical techniques. Thus, it will be apparent that the yield curve is a *graphical representation of the relationship between rate and term to maturity of bonds.*

A yield curve is a useful tool:

- Rates for year intervals can be derived for analysis purposes. For example, rates can be derived from the curve for 1 year, 2 years, 3 years, etc. Thus, over a period of time a series of rates for various terms is available. Recording the rate on a *specific* 10-year bond is of no use because each month the bond has one month less to maturity (i.e. it is no longer a 10-year bond).
- Securities can be valued using the curve. The holder of a poorly traded bond is able to value the bond because the curve gives the "average" rate for all terms.
- The curve serves as a benchmark for both buyers of bonds and new issues of bonds.

It will be evident that in a sophisticated market the points (the x's) will not be as scattered as in the above example; they will be closer to the curve that is constructed from them.

It is to be noted that the above discussion was concerned with the *yield to maturity (ytm) yield curve*. It is the most familiar yield curve and is a representation of the relationship between yield to maturity and term to maturity of a group of homogenous securities (usually government).

6.6.2 Disadvantage of the ytm yield curve

There is a "problem" with the ytm yield curve. In the definition of ytm is the implicit assumption that coupon payments are reinvested at the ytm; this is rarely achieved (which can be called reinvestment risk). The only bond devoid of reinvestment risk is the zero coupon bond that has one payment at the end of its life.[41] For these reasons other yield curve types have been devised.

6.6.3 Par yield curve

As noted, the coupon rate has an effect on the price sensitivity of bonds. For this reason, various markets make use of a *par yield curve*. This is a yield curve of rates on bonds the prices of which are close to or at par (100% – at par ytm = coupon), which means that the effect of coupon on price is eliminated. This makes the various points on the yield curve comparable.

A caveat is required here. The par yield curve is more relevant in countries where bonds are traded on a clean price basis (accrued interest is taken into account after the deal is done). In South Africa dealing takes place on a yield basis; consequently, when ytm = coupon, the price is not necessarily 100%. The price equals 100% only on coupon dates.

6.6.4 Coupon yield curve

The coupon yield curve is a representation of ytm and term to maturity of a group of homogenous bonds that have the same coupon. Generally the high coupon bonds trade at higher rates than low coupon bonds (i.e. are valued lower), and this is so for two main reasons[42]:

- Reinvestment risk. It is likely that rates will fall during the life of all bonds; bonds with high coupons are prejudiced in relation to low coupon bonds because the coupons are invested at lower rates.
- Tax. High-rate taxpayers prefer low coupon bonds because capital gains are higher than in the case of high coupon bonds, capital gains tax is usually lower, and the tax on capital gains is deferred.

Yield curves of same coupon, homogenous (i.e. same credit quality) bonds are not constructed and compared by investors in order to gain from yield anomalies that may exist (this applies to zero / spot versus ytm curves). They are merely of academic interest: they (the differential) signify one of the major disadvantages of the ytm curve, and generally arise as a result of the mismatch in the demand and supply of bonds in the longer term maturity sector. Insurers, in order to match longer term liabilities, demand longer dated bonds and favour low coupon bonds for the abovementioned reasons. A consequence of this is (in many countries) the widening of the differential between low and high coupon bonds in the long end of the maturity scale.[43]

6.6.5 Yield curve of "on-the-run treasury issues"

In the US, financial market participants in this regard talk of the yield curve of "*on-the-run treasury issues*". This yield curve is constructed from the most recently issued treasury bonds, notes and bills (the notes and bonds are issued at a price of 100%). This yield curve is a proxy for a par yield curve.

6.6.6 Spot (zero-coupon) yield curve[44]

The ideal or "pure" yield curve is a *zero-coupon yield curve* (also called *spot yield curve*), i.e. a curve constructed from the rates on a series of central government zero coupon bonds and treasury bills. This means that the term of each maturity matches its duration and the rates are comparable. The problem is that in most markets zero coupon bonds are rare or non-existent; consequently, the curve has to be derived from coupon bond yields.

Spot yields satisfy the equation [assumptions: annual coupons; calculation takes place on a coupon payment date (therefore no accrued interest)]:

$$\begin{aligned} \text{AIP} &= \sum_{t=1}^{T} \left[\text{c} / (1 + \text{sy}_t)^t\right] + [\text{PVB} / (1 + \text{sy}_T)^T \\ &= \sum_{t=1}^{T} \text{c} \cdot \text{DF}_t + \text{PVB} \cdot \text{DF}_T \end{aligned}$$

where

AIP = all-in price of bond (dirty price)
c = coupon (annual and fixed)
sy_t = spot (zero coupon) yield with t years to maturity
PVB = par value of bond
DF_t = $1 / (1 + si_t)^t$ = corresponding discount factor.
Clearly, sy_1 = current 1-year spot yield; sy_2 = current 2-year spot yield; sy_3 …..

6.6.7 Shape of yield curve

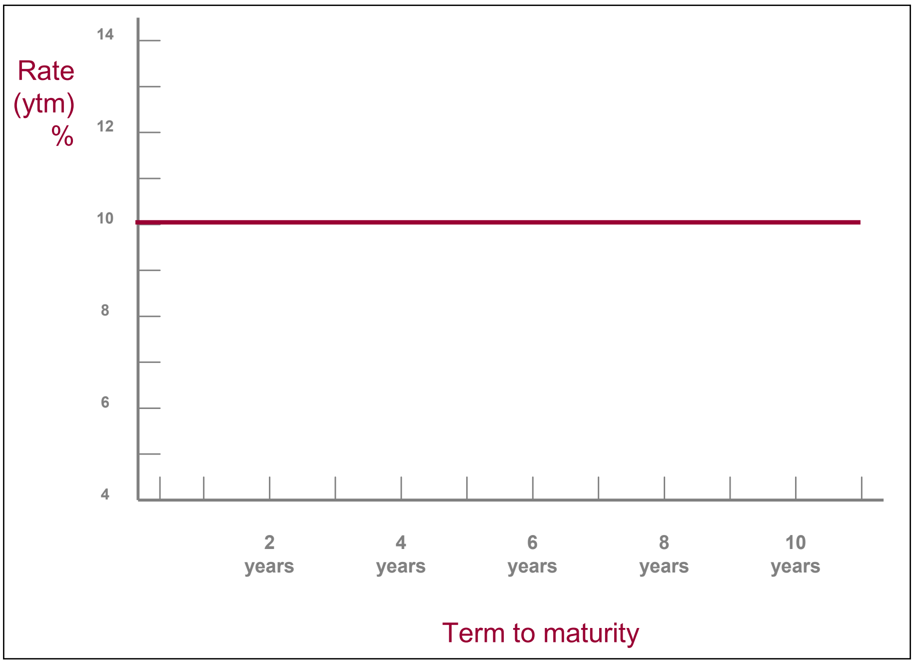


Figure 7: flat yield curve

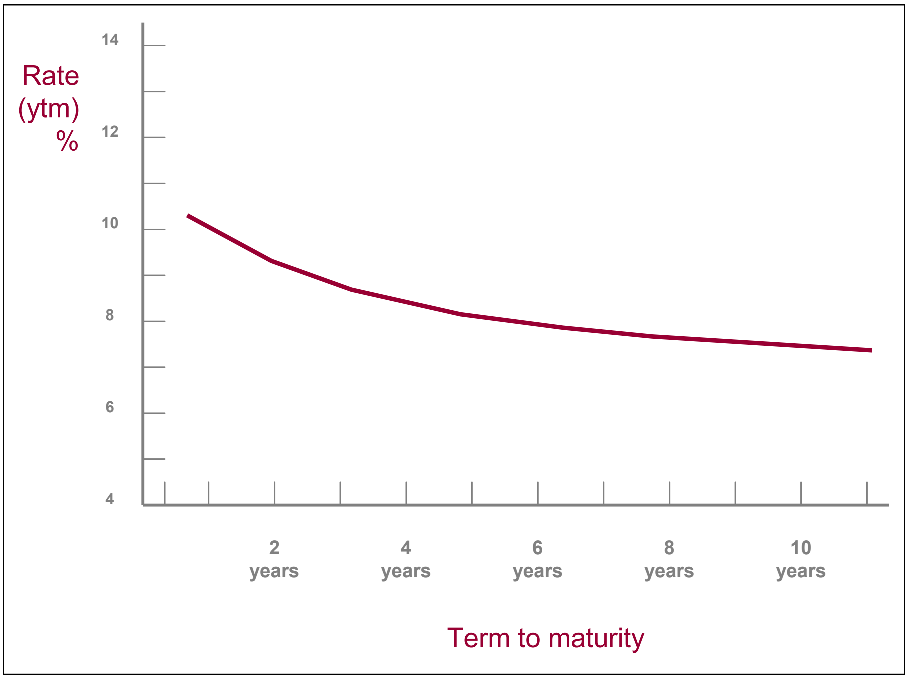


Figure 8: flat yield curve

Yield curves take on different shapes at different times. The normal curve is the one presented in the examples above, i.e. it is *positively sloped*, and it implies that the longer the bond the higher the return. Investors are rewarded for holding bonds of longer maturity. The other two basic shapes are the *flat yield curve* and the *inverted or negatively sloped yield curve*. The flat curve is portrayed in Figure 7.

The flat yield curve implies that there is no reward for the risk of a longer-term investment. Irrespective of term to maturity, all investors in government bonds earn a rate (ytm) of 9.4% pa in this example. This curve usually represents the stage between normal and inverse and vice versa.

The inverted or negatively sloped yield curve is illustrated in Figure 8. This curve tells us that investors are negatively compensated for holding long-term securities; they are "prejudiced" in relation to the holders of short-term securities – or so it appears. In reality, this yield curve normally comes about in periods of high rates when the monetary authorities are conducting a severe and tight monetary policy, driving up short-term rates. The long-term investors are content to accept short rates being higher than long rates because they *harbour strong expectations* that the shape of the yield curve is about to change to a normal shape and that the entire curve will shift downwards.

This means that the inverse yield curve is indicating that longer term investors are willing to accept lower rates now in exchange for large expected capital gains in the near future, i.e. the *income given up will be more than compensated for by the capital gain*.

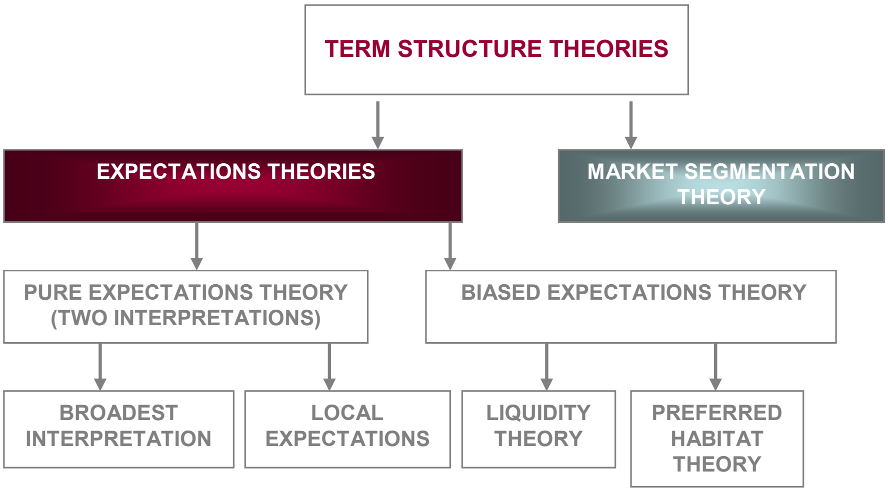
6.6.8 Theories of the term structure of interest rates

Two main theories have evolved to explain the yield curve, i.e. the expectations theory and the market segmentation theory. The former is categorised[45] into the pure expectations theory (of which there are two interpretations) and the biased expectations theory. There are two interpretations of the latter: the liquidity theory and the preferred habitat theory. Box 1 presents the term structure theories.

All these theories share a hypothesis about the behaviour of short-term forward rates and assume that the forward rates in current long-term bond rates are closely related to market participants' *expectations* about the future short-term rates.

The *pure expectations theory* postulates that the yield curve at any point in time (i.e. forward rates) reflects the market's expectations of future short-term rates. Thus, an investor with a 10-year investment horizon has a choice of buying a 10-year bond (and earn the current yield on his bond) or buying 10 successive 1-year bonds. The return on the two investments will be the same, i.e. long-term rates are geometric averages of current and expected future short-term rates.

In terms of this theory, a positively shaped yield curve indicates that short-term rates will rise over the investment term, and a flat curve indicates that short rates are to be stable over the investment horizon.



Box 1: term structure theories

As noted, there are basically *two broad interpretations* of this theory. The main criticism of this theory is that it does *not consider the risks* associated with investing in bonds.

The *liquidity theory* suggests that investors will hold longer term securities only if they are offered a long-term rate that is higher than the average of expected future rates by a risk premium that is *positively related* to the term to maturity (i.e. rises uniformly with maturity). Put another way: *the expected return from holding a series of short bonds is lower than the expected return from holding a long-bond over the same time period*. Thus, forward rates are not an unbiased estimate of the market's expectations of future rates because they embody a liquidity premium.

The *preferred habitat theory* buys the theory that the term structure of interest rates reflects the expectation of the future path of interest rates and the risk premium. However, it rejects the notion that the risk premium must rise uniformly with maturity. Thus, the risk premium can be positive or negative and can induce investors to move out of their preferred habitat, i.e. their preferred part of the curve. It will be evident that in terms of this theory the yield curve can be positively sloping, inverse or flat.

The *market segmentation theory* holds that investors have preferred maturities of bonds dictated by their liabilities. Thus, banks will hold short-term securities and pension funds / insurers long-term securities. They will not shift from one sector to another to take advantage of opportunities. The yield curve reflects supply and demand conditions in the various maturity sectors of the yield curve.

6.7 Summary

There are number of tools that have been developed by bond market participants over the past few decades: alternative yield measures, duration, LCC per basis point and the yield curve. The alternative yield measures offer quick guides to returns. Duration is an alternative measure to term to maturity and is useful in terms of price-sensitivity comparisons.

LCC per basis point enables dealers / speculators to gauge the risk and return parameters of positions. The yield curve is a representation of the relationship between rate and term to maturity at a point in time; it is an extremely useful tool in bond market analysis.

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7 Endnotes

1. A term used in economics for the non-financial economy.
2. There is one exception: the perpetual bond, which has no redemption date.
3. An example of an exchange-driven market is the South African bond market – the exchange is called Bond Exchange of South Africa (BESA).
4. As in the case of South Africa (the Bond Exchange of South Africa – BESA).
5. As well as certain other non-member banks that trade in bonds, local and international.
6. This particular bond has already expired, but has been resurrected and digitally "doctored" in order to extend its life (maturity). The coupon has also been changed. The currency (LCC = local country currency) is fictitious.
7. Note that most bonds are now immobilised / dematerialised.
8. This has changed in a number of countries, and will be discussed in full in a separate section.
9. This instrument has different meanings in different countries. In certain countries warrants are retail options, while in others they are options to take up further bonds.
10. This list is obtained from the Bond Exchange of South Africa (BESA) but the additions are logical inferences.
11. Note that there are other features of credit enhancement such as a liquidity requirement.
12. These unrated bonds are often taken up by he sponsor. The value of these bonds can be seen as the capital of the SPV entity.
13. These numbers apply to South Africa but will tend to be the same in many other countries.
14. Interest rate risk pertains to banks in the form of mismatches in the repricing dates of liabilities and assets.
15. Please note that there is much overlap in this list, i.e. each bond is not necessarily a separate bond. For example, a plain vanilla bond can be a registered bond or a bearer bond, a senior bond can also be a registered bond or a bearer bond, a retail bond can be a plain vanilla bond, and so on.
16. This name differs from country to country.
17. Note that these names differ from country to country.
18. Source: many sources on the internet.
19. Source: http://www.scripophily.net/fopean18.html
20. If it is not dematerialised.
21. This paragraph benefited from comments made by Mark Raffaelli; the author is grateful.
22. The details of the following three bonds are gleaned from McInish (2000: 208–209).
23. McInish (2000: 209–210).
24. For details on this and the following bond see Mayo (2003: 477).
25. This draws heavily on: IBRD, ECB and IMF, 2009.
26. Note that this is a generic term that covers any person or institution that is involved in the financial markets either as a broker (does not take positions) or a dealer (does take positions) or both (does broking and dealing – e.g. a bank)
27. Source: www.bondexchange.co.za
28. Although nothing legal prevents them from dealing with the investing institutions, there exists an understanding that the members will not deal with them if they do so.

29. LCC100% (i.e. per LCC100) or LCC1.0 (i.e. per unit of LCC1); from here on we leave off the currency.
30. Note that the period differs from country to country.
31. In practice (see below) the standard bond formula first calculates the all-in price. The interest factor is deducted in order to arrive at the clean price. In the case of an ex interest deal, the interest factor is added in order to arrive at the clean price. Many market participants, however, see the different prices as described above.
32. This is similar to the standard formula for interest add-on money market securities such as NCDs. The maturity value (or FV) is the sum of the nominal value plus the final half coupon payment.
33. http://www.bondexchange.co.za/besa/action/media/downloadFile?media_fileid=5381 is the BESA webpage from which this section benefited substantially. The relevant document is: Raffaelli, M, 2005. "BESA floating rate note (FRN) pricing specification". Johannesburg: Bond Exchange of South Africa.
34. A reminder: interbank agreed rate, the average rate at which the banks will lend to one another (gathered from a number of banks by an independent organisation).
35. Note that this is only true if and only if the credit spread (which is reflected in the margin) stays the same, the interest is paid daily, and the change in IBAR makes only one change per day which is reflected in the reset rate. This footnote is attributable to Mark Raffaelli, with appreciation.
36. Discussed in a separate section.
37. See www.treasury.gov.za (2003).
38. Steiner, R (1998, p. 97).
39. This section relies heavily on Mayo (2003: 506–507).
40. It makes sense to use homogenous securities such as government securities in yield curve construction because they are comparable in terms of the major risk, credit risk (zero in this case).
41. In this regard see: Blake (2000).
42. In this regard see: Blake (2000).
43. This section benefited much from discussions with Mr Mark Raffaelli.
44. This section relies heavily on Blake (2000).
45. See Fabozzi, 2000.