ELSEVIER FINANCE

corporate bonds and structured financial products

Moorad Choudhry

Foreword by Professor Christine Oughton
Birkbeck, University of London

fil fixed income markets library

Corporate Bonds and Structured Financial Products

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Moorad Choudhry lives in Surrey, England.

Corporate Bonds and Structured Financial Products

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To Derek Taylor, a market expert and a true gent . . .

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Foreword

The fixed income markets have always been centres of innovation and creativity. This much is apparent from even a cursory glance at developments in recent and not-so-recent history. However, it is only in the last twenty years or so that such innovation has really been required, as markets changed significantly and capital started to move freely. The bond market has been the vital conduit through which capital has been raised; continuing product development in the markets has made a significant, and irreplaceable, contribution to global economic progress. The range of products available is vast and growing, as the needs of both providers and users of capital continually alters in response to changing conditions. This economic dynamic means that market participants observe a state of constant learning, as they must if they are to remain effective in their work. Consider, for instance, the new instruments and techniques that we have had to become familiar with in just the last few years: new instruments for hedging credit risk, new techniques for raising capital through synthetic securitisation of the most esoteric 'reference' assets, and new models for fitting the term structure of interest rates – there is much for market participants to keep in touch with. Inevitably practitioners are required to become specialists, as each segment of the debt markets demands increasingly complex approaches in addressing its problems and requirements.

Of course, users of capital are not limited to existing products for raising finance or hedging market risk exposure. They can ask an investment bank to design an instrument to meet their individual requirements, and target it at specific groups of customers. For example, it is arguable whether the growth of the 'credit-card banks' in the United States (such as MBNA) could have occurred so rapidly without the securitisation mechanism that enabled them to raise lower-cost funding. Witness also the introduction of exotic structured credit products, such as the synthetic collateralised debt obligation (CDO), which uses credit derivatives in its construction and followed rapidly on the development of more conventional CDO structures. The so-called 'CSO' was designed to meet regulatory capital and credit risk management requirements, as opposed to funding requirements. The increasing depth and complexity of the markets requires participants to be completely up-to-date on the latest analytical and valuation techniques if they are not to risk being left behind. It is clear that we operate in an environment in which there exists a long-term interest in the application of ever more sophisticated valuation and analytical techniques. The level of mathematical sophistication in use in financial markets today is phenomenal, not to mention very specialised.

That is why this book, from one of the leading researchers and writers on fixed income today, is such a welcome publication. I should of course say 'books', as we have a series here that forms part of a handsome Library. The antecedents of the author promise that these books will make a high-quality contribution to the field. But it is the books' clarity of approach and focus that I am most excited about. The books are welcome because they are part of the continuing need to remain, as Alan Greenspan would have said, ahead of the curve. They contain insights into practical techniques and applications used in the fixed income markets today, with a hint at what one might expect in the future. They also indicate the scope and significance of these techniques in the world of finance. Readers will notice that the text is fairly technical at many points. This reflects the level of mathematical sophistication one encounters in the markets.

If the author will indulge me, I would like to highlight those parts of the books I was particularly interested in.

The treatment of yield curve analysis in *Advanced Fixed Income Analysis* is first rate. For instance, I liked the comprehensive description of the 'variable roughness penalty' approach to cubic spline estimation of the term structure (Chapter 6). The author rightly points out that most market practitioners can have their analytical needs met by the simpler techniques of yield curve fitting, and only exotic option traders, who wish to model the volatility surface, really need to resort to multi-factor term structure models. That is why the practical demonstration of the cubic spline technique is so welcome in this book. Portfolio managers using this technique will get a good understanding of recent movements in the yield curve as well as good interpretive information for the future. Elsewhere we have a comprehensive treatment of the main single-factor and multi-factor yield curve models in use, with useful comment on the efficacies of using both. The practical implications of using the different interest-rate models are well handled and Chapters 4 and 5 will be of value to practitioners. There is also accessible coverage of the Heath–Jarrow–Morton interest-rate model, described and explained here in its single-factor and multi-factor forms. The author cleverly draws out the link between academic research and market applications by showing how financial institutions are able to continue meeting their clients' ever more complex requirements by incorporating insights from research into their product development.

I am very enthusiastic about the book *Corporate Bonds and Structured Financial Products*. The author captures all the key capital raising instruments. I was fascinated to learn about the synthetic asset-backed CP structure or 'conduit'. Distinct from conventional AB-CP programmes, I was very interested to read about this. Of course, one might (in hindsight!) easily have predicted its development, mirroring as it did the practice seen in the bonds and note market when credit derivatives were allied with traditional securitisation techniques to produce the synthetic CDO. The author presents a new look at established and new products, and both venerable and brand-new techniques. As such the book should be practical interest to fund managers and traders, as well as corporate treasurers.

It is a privilege to be asked to write this foreword. By drawing on both his practical experience of financial markets and research for his PhD at Birkbeck, University of London, Moorad Choudhry successfully combines insights from theory and practice to make a genuinely worthwhile contribution to the financial economics literature. I do hope that this exciting and interesting new Library spurs readers on to their own research and investigation; if they follow the application and dedication evident in this work, they will not be going far wrong.

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Birkbeck, University of London
March 2004

About the Author

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JP Morgan Chase ITS 1st XI
September 2002

Preface

This book is about the corporate bond markets. Although a large number of bonds issued by corporate entities are conventional or 'plain vanilla' bonds, meaning they have a fixed coupon and a fixed term to maturity, there is also a very large and significant market in structured bonds, or structured financial products, which is an all-encompassing term for securitised bonds, hybrid securities, credit-linked securities and so on. We describe the various forms of bond instrument that are encountered in the markets, always remembering that they are very dynamic and new instruments are being introduced all the time. As part of our description we discuss the yield curve, the main information tool of market participants.

Corporate borrowers wishing to finance long-term investment can raise capital in various ways. The main methods are:

- continued re-investment of the profits generated by a company's current operations;
- selling shares in the company, known as equity capital, equity securities or *equity*, which confirm on buyers a share in ownership of the company. The shareholders as owners have the right to vote at general meetings of the company, as well as the right to share in the company's profits by receiving dividends;
- borrowing money from a bank, via a bank loan. This can be a short-term loan such as an overdraft, or a longer term loan over two, three, five, years or even longer. Bank loans can be at either a fixed or more usually, variable rate of interest;
- borrowing money by issuing debt securities, in the form of *bonds* that subsequently trade in the debt capital market.

The first method may not generate sufficient funds, especially if a company is seeking to expand by growth or acquisition of other companies. In any case a proportion of annual after-tax profits will need to be paid out as dividends to shareholders. Selling further shares is not always popular amongst existing shareholders as it dilutes the extent of their ownership; there are also a host of other factors to consider including if there is any appetite in the market for that company's shares. A bank loan is often inflexible, and the interest rate charged by the bank may be comparatively high for all but the highest quality companies. We say comparatively, because there is often a cheaper way for corporates to borrow money: by tapping the bond markets. An issue of bonds will fix the rate of interest payable by the company for a long-term period, and the chief characteristic of bonds – that they are *tradeable* – makes investors more willing to lend a company funds.

Bond markets play a vital and essential role in raising finance for both governments and corporations. In 2002 the market in dollar-denominated bonds alone was worth over $13 trillion, which gives some idea of its importance. The basic bond instrument, which is a loan of funds by the buyer to the issuer of the bond, in return for regular interest payments up to the termination date of the loan, is still the most commonly issued instrument in the debt markets. Nowadays there is a large variety of bond instruments, issued by a variety of institutions. An almost exclusively corporate instrument, the international bond or Eurobond, is a large and diverse market. In 2002 the size of the Eurobond market was over $2 trillion. This book is intended to be an introduction to the extremely diverse and complex world of the corporate debt markets.

Intended audience

This book is aimed at anyone with an interest in the corporate bond markets. The material is deliberately made very accessible; more experienced practitioners may wish also to refer to the companion book in the Fixed Income Markets Library, *Advanced Fixed Income Analysis*.

The book is primarily aimed at people who work in the markets, including front office, middle office and back office banking and fund management staff who are involved to any extent in fixed interest markets. This includes traders, salespersons, arbitrageurs, money markets dealers, fund managers, stockbrokers and research analysts. Others including corporate and local authority treasurers, risk management personnel and operations staff will also find the contents useful, as will professionals who work in structured finance and other market sectors, such as accountants, lawyers and corporate financiers. For students wishing to enter a career in the financial services industry this book has been written to provide sufficient knowledge and understanding to be useful in their first job and beyond, thus enabling anyone to hit the ground running. It is also hoped that the book remains useful as a reference handbook.

Comments on the text are welcome and should be sent to the author care of Butterworth-Heinemann.

Organisation of the book

This book is organised into twenty-three chapters. The corporate debt markets are extremely diverse, and it is often in corporate markets that the latest and most exciting innovations are found. Some of the instruments used in the corporate markets demand their own particular type of analysis; to this end we review the pricing and analytics of callable bonds, asset-backed bonds and convertibles, among others. There is also a chapter on credit analysis. The latest development in corporate markets, the synthetic structured credit product, is considered in Chapter 22.

Further material on the fixed income markets generally can be obtained from the dedicated website at

www.YieldCurve.com

Moorad Choudhry
Surrey, England
August 2003

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No thanks to anybody.

--- Felt, *Gold Mine Trash*
Cherry Red Records 1987

Memories of years gone by,
Dashed hopes of a dream that died…
Spirit pulled us through.

--- Redskins, *Lean On Me!*
CNT Records 1983

Part I

Fixed Income Securities

We begin by describing the main instruments that go to make up the bond markets. So in Part I we explain the structure of bonds, and the variety of instruments available. This includes bond pricing and yield, and an initial look at the yield curve. Chapter 2 on the yield curve is a fairly long one and looks not only at the different types of yield curve that may be encountered, but also the issue of spot and forward interest rates, and how to interpret the shape of the yield curve. The remaining two chapters introduce non-vanilla bonds.

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1 A Primer on Bond Basics

Before we begin our look at specific instruments issued by corporate entities, we review the key features of conventional or plain vanilla bond instruments.

1.1 Description

We have said that a bond is a debt instrument, usually paying a fixed rate of interest over a fixed period of time. Therefore a bond is a collection of cash flows and this is illustrated at Figure 1.1. In our hypothetical example the bond is a six-year issue that pays fixed interest payments of C% of the *nominal* value on an annual basis. In the sixth year there is a final interest payment and the loan proceeds represented by the bond are also paid back, known as the maturity proceeds. The amount raised by the bond issuer is a function of the price of the bond at issue, which we have labelled here as the issue proceeds.

The upward facing arrow represents the cash flow paid and the downward facing arrows are the cash flows received by the bond investor. The cash flow diagram for a six-year bond that had a 5% fixed interest rate, known as a 5% *coupon*, would show interest payments of £5 per every £100 of bonds, with a final payment of £105 in the sixth year, representing the last coupon payment and the redemption payment. Again, the amount of funds raised per £100 of bonds depends on the price of the bond on the day it is first issued, and we will look further into this later. If our example bond paid its coupon on a semi-annual basis, the cash flows would be £2.50 every six months until the final redemption payment of £102.50.

Let us examine some of the key features of bonds.

1.1.1 *Type of issuer*

A primary distinguishing feature of a bond is its issuer. The nature of the issuer will affect the way the bond is viewed in the market. There are four issuers of bonds: sovereign governments and their agencies, local government authorities, supranational bodies such as the World Bank, and corporations. Within the corporate bond market there is a wide range of issuers, each with differing abilities to satisfy their contractual obligations to investors. The largest bond markets are those of sovereign borrowers, the government bond markets. The United Kingdom government issues *gilts*. In the United States government bonds are known as *Treasury Notes* and *Treasury Bonds*, or simply *Treasuries*.

1.1.2 *Term to maturity*

The *term to maturity* of a bond is the number of years after which the issuer will repay the obligation. During the term the issuer will also make periodic interest payments on the debt. The *maturity* of a bond refers to the date that the debt will cease to exist, at which time the issuer will redeem the bond by paying the principal. The practice in the market is often to refer simply to a bond's 'term' or 'maturity'. The provisions under which a bond is issued may allow either the issuer or investor to alter a bond's term to

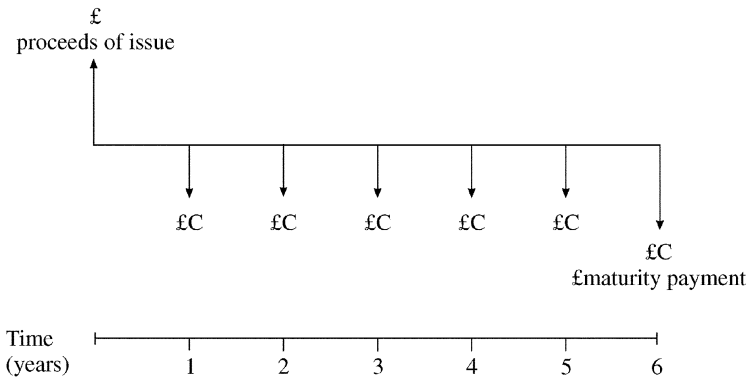

Figure 1.1: Cash flows associated with a six-year annual coupon bond.

maturity after a set notice period, and such bonds need to be analysed in a different way. The term to maturity is an important consideration in the make-up of a bond. It indicates the time period over which the bondholder can expect to receive the coupon payments and the number of years before the principal will be paid in full. The bond's *yield* also depends on the term to maturity. Finally, the price of a bond will fluctuate over its life as yields in the market change and as it approaches maturity. As we will discover later, the *volatility* of a bond's price is dependent on its maturity; assuming other factors constant, the longer a bond's maturity the greater the price volatility resulting from a change in market yields.

1.1.3 *Principal and coupon rate*

The *principal* of a bond is the amount that the issuer agrees to repay the bondholder on the maturity date. This amount is also referred to as the *redemption value, maturity value, par value* or *face amount*, or simply *par*. The *coupon rate* or *nominal rate* is the interest rate that the issuer agrees to pay each year. The annual amount of the interest payment made is called the *coupon*. The coupon rate multiplied by the principal of the bond provides the cash amount of the coupon. For example a bond with a 7% coupon rate and a principal of £1,000,000 will pay annual interest of £70,000. In the United Kingdom, United States and Japan the usual practice is for the issuer to pay the coupon in two semi-annual instalments. For bonds issued in European markets and the Eurobond market coupon payments are made annually. On rare occasions one will encounter bonds that pay interest on a quarterly basis. All bonds make periodic interest payments except for *zero-coupon bonds*. These bonds allow a holder to realise interest by being sold substantially below their principal value. The bonds are redeemed at par, with the interest amount then being the difference between the principal value and the price at which the bond was sold. We will explore zero-coupon bonds in greater detail later.

1.1.4 *Currency*

Bonds can be issued in virtually any currency. The largest volume of bonds in the global markets is denominated in US dollars; other major bond markets are denominated in euros, Japanese yen and sterling, and liquid markets also exist in Australian, New Zealand and

Canadian dollars, Swiss francs and other major currencies. The currency of issue may impact on a bond's attractiveness and liquidity which is why borrowers in developing countries often elect to issue in a currency other than their home currency, for example dollars, as this will make it easier to place the bond with investors. If a bond is aimed solely at a country's domestic investors it is more likely that the borrower will issue in the home currency.

1.2 Bond issuers

1.2.1 *Issuers and participants*

In most countries government expenditure exceeds the level of government income received through taxation. This shortfall is made up by government borrowing and bonds are issued to finance the government's debt. The core of any domestic capital market is usually the government bond market, which also forms the benchmark for all other borrowing.

In the United Kingdom, gilts are identified by their coupon rate and year of maturity; they are also given names such as *Treasury* or *Exchequer*. There is no significance attached to any particular name – all gilts are equivalent irrespective of their name. If a bond has a price of 106.77, this means £106.77 of par value. (Remember that par is the lump sum paid at maturity.) This price represents a *gross redemption yield* of 4.65%. If we pay £106.77 per £100 of stock today, we will receive £100 per £100 of stock on maturity. At first sight this appears to imply we will lose money, however we also receive coupon payments every six months.

Government agencies also issue bonds. Such bonds are virtually as secure as government bonds. In the United States agencies include the Federal National Mortgage Association. Local authorities issue bonds as part of financing for roads, schools, hospitals and other capital projects.

Corporate borrowers issue bonds both to raise finance for major projects and also to cover ongoing and operational expenses. Corporate finance is a mixture of debt and equity and a specific capital project will often be financed as a mixture of both.

1.2.2 *Capital market participants*

The debt capital markets exist because of the financing requirements of governments and corporates. The source of capital is varied, but the total supply of funds in a market is made up of personal or household savings, business savings and increases in the overall money supply. Growth in the money supply is a function of the overall state of the economy, and interested readers may wish to consult the reference list at the end of this chapter which includes several standard economic texts. Individuals save out of their current income for future consumption, while business savings represent retained earnings. The entire savings stock represents the capital available in a market. However, the requirements of savers and borrowers differ significantly, in that savers have a short-term investment horizon while borrowers prefer to take a longer-term view. The 'constitutional weakness' of what would otherwise be unintermediated financial markets led, from an early stage, to the development of financial intermediaries.

Financial intermediaries

In its simplest form a financial intermediary is a *broker* or *agent*. Today we would classify the broker as someone who acts on behalf of the borrower or lender, buying or selling a bond as instructed. However intermediaries originally acted between borrowers and lenders in placing funds as required. A broker would not simply on-lend funds that have been placed with it, but would accept deposits and make loans as required by its customers. This resulted in the first banks.

A *retail bank* deals mainly with the personal financial sector and small businesses, and in addition to loans and deposits also provides cash transmission services. A retail bank is required to maintain a minimum cash reserve, to meet potential withdrawals, but the remainder of its deposit base can be used to make loans. This does not mean that the total size of its loan book is restricted to what it has taken in deposits: loans can also be funded in the wholesale market.

An *investment bank* will deal with governments, corporates and institutional investors. Investment banks perform an agency role for their customers and are the primary vehicle through which a corporate will borrow funds in the bond markets. This is part of the bank's corporate finance function. It will also act as wholesaler in the bond markets, a function known as *market making*. The bond issuing function of an investment bank, by which the bank will issue bonds on behalf of a customer and pass the funds raised to this customer, is known as *origination*. Investment banks will also carry out a range of other functions for institutional customers, including export finance, corporate advisory and fund management. Other financial intermediaries will trade not on behalf of clients but for their own *book*. These include *arbitrageurs* and speculators. Usually such market participants form part of investment banks.

Investors

There is a large variety of players in the bond markets, each trading some or all of the different instruments available to suit their own purposes. We can group the main types of investors according to the time horizon of their investment activity.

Short-term institutional investors

These include banks and building societies, money market fund managers, central banks and the treasury desks of some types of corporates. Such bodies are driven by short-term investment views, often subject to close guidelines, and will be driven by the total return available on their investments. Banks will have an additional requirement to maintain *liquidity*, often in fulfilment of regulatory authority rules, by holding a proportion of their assets in the form of easily-tradeable short-term instruments.

Long-term institutional investors

Typically these types of investors include pension funds and life assurance companies. Their investment horizon is long-term, reflecting the nature of their liabilities. Often they will seek to match these liabilities by holding long-dated bonds.

Mixed horizon institutional investors

This is possibly the largest category of investors and will include general insurance companies and most corporate bodies. Like banks and financial sector companies, they are also very active in the primary market, issuing bonds to finance their operations.

Market professionals

This category includes the banks and specialist financial intermediaries mentioned above, firms that one would not automatically classify as 'investors' although they will also have an investment objective. Their time horizon will range from one day to the very long-term. They include the proprietary trading desks of investment banks, as well as bond market makers in securities houses and banks who are providing a service to their customers. Proprietary traders will actively position themselves in the market in order to gain trading profit, for example in response to their view on where they think interest rate levels are headed. These participants will trade direct with other market professionals and investors, or via brokers. Market makers or *traders* (also called *dealers* in the United States) are wholesalers in the bond markets; they make two-way prices in selected bonds. Firms will not necessarily be active market makers in all types of bonds; smaller firms often specialise in certain sectors. In a two-way quote the *bid price* is the price at which the market maker will buy stock, so it is the price the investor will receive when selling stock. The *offer price* or *ask price* is the price at which investors can buy stock from the market maker. As one might expect the bid price is always higher than the offer price, and it is this *spread* that represents the theoretical profit to the market maker. The bid-offer spread set by the market maker is determined by several factors, including supply and demand, and liquidity considerations for that particular stock, the trader's view on market direction and *volatility*, as well as that of the stock itself and the presence of any market intelligence. A large bid-offer spread reflects low liquidity in the stock, as well as low demand.

Markets

Markets are that part of the financial system where capital market transactions, including the buying and selling of securities, takes place. A market can describe a traditional stock exchange, a physical trading floor where securities trading occurs. Many financial instruments are traded over the telephone or electronically over computer links; these markets are known as *over-the-counter* (OTC) markets. A distinction is made between financial instruments of up to one year's maturity and instruments of over one year's maturity. Short-term instruments make up the *money market* while all other instruments are deemed to be part of the *capital market*. There is also a distinction made between the *primary market* and the *secondary market*. A new issue of bonds made by an investment bank on behalf of its client is made in the primary market. Such an issue can be a *public* offer, in which anyone can apply to buy the bonds, or a *private* offer where the customers of the investment bank are offered the stock. The secondary market is the market in which existing bonds and shares are subsequently traded.

1.3 World bond markets

The origin of the spectacular increase in the size of global financial markets was the rise in oil prices in the early 1970s. Higher oil prices stimulated the development of a sophisticated international banking system, as they resulted in large capital inflows to developed country banks from the oil-producing countries. A significant proportion of these capital flows were placed in *Eurodollar* deposits in major banks. The growing trade deficit and level of public borrowing in the United States also contributed. The last twenty years has seen tremendous growth in capital markets' volumes and trading. As capital controls were eased and exchange

rates moved from fixed to floating, domestic capital markets became internationalised. Growth was assisted by the rapid advance in information technology and the widespread use of financial engineering techniques. Today we would think nothing of dealing in virtually any liquid currency bond in financial centres around the world, often at the touch of a button. Global bond issues, underwritten by the subsidiaries of the same banks, are commonplace. The ease with which transactions can be undertaken has also contributed to a very competitive market in liquid currency assets. The world bond market has increased in size more than fifteen times in the last thirty years. As at the end of 2002 outstanding volume stood at over $21 trillion.

The market in US Treasury securities is the largest bond market in the world. Like the government bond markets in the UK, Germany, France and other developed economies, it is also very liquid and transparent. Table 1.1 lists the major government bond markets in the world; the US market makes up nearly half of the total. The Japanese market is second in size, followed by the German market. A large part of the government bond market is concentrated therefore in just a few countries. Government bonds are traded on major exchanges as well as over-the-counter. Generally OTC refers to trades that are not carried out on an exchange but directly between the counterparties. Bonds are also listed on exchanges, for example the NYSE had over 600 government issues listed on it at the end of 1998, with a total par value of $2.6 billion.

The corporate bond market varies in liquidity, depending on the currency and type of issuer of any particular bond. Outstanding volume as at the end of 2001 was over $7.5 trillion. Corporate bonds are also traded on exchanges and OTC. One of the most liquid corporate bond types is the *Eurobond*, which is an international bond issued and traded across national boundaries.

Companies finance their operations in a number of ways, from equity to short-term debt such as bank overdrafts. It is often advantageous for companies to fix longer-term finance, which is why bonds are so popular. Bonds are also attractive as a means of raising finance because the interest payable on them to investors is tax deductible for the company. Dividends on equity are not tax deductible. A corporate needs to get a reasonable mix of debt versus equity in its funding however, as a high level of interest payments will be difficult to service in times of recession or general market downturn. For this reason the market views unfavourably companies that have a high level of debt.

Country	**Nominal value ($ billion)**	**Percentage (rounded)**
United States	5,490	48.5
Japan	2,980	26.3
Germany	1,236	10.9
France	513	4.5
Canada	335	3.0
United Kingdom	331	2.9
Netherlands	253	2.2
Australia	82	0.7
Denmark	72	0.6
Switzerland	37	0.3
Total	11,329	100

Table 1.1: Major government bond markets, December 2002. Source: IFC 2003.

1.4 Non-conventional bonds

The definition of bonds given earlier in this chapter referred to conventional or *plain vanilla* bonds. There are many variations on vanilla bonds and we can introduce a few of them here.

Floating rate notes

The bond market is often referred to as the *fixed income* market, or the *fixed interest* market in the UK. Floating rate notes (FRNs) do not have a fixed coupon at all but instead link their interest payments to an external reference, such as the three-month bank lending rate. Bank interest rates will fluctuate constantly during the life of the bond and so an FRN's cash flows are not known with certainty. Usually FRNs pay a fixed margin or *spread* over the specified reference rate; occasionally the spread is not fixed and such a bond is known as a *variable rate note*. Because FRNs pay coupons based on the three-month or six-month bank rate they trade essentially as money market instruments.

Index-linked bonds

An index-linked bond has its coupon and redemption payment, or possibly just either one of these, linked to a specified index. When governments issue index-linked bonds the cash flows are linked to a price index such as consumer or commodity prices. Corporates have issued index-linked bonds that are connected to inflation or a stock market index.

Zero-coupon bonds

Certain bonds do not make any coupon payments at all and these are known as *zero-coupon bonds*. A zero-coupon bond or *strip* only has cash flow, the redemption payment, on maturity. If we assume that the maturity payment is say, £100 per cent or *par* the issue price will be at a discount to par. Such bonds are also known therefore as *discounted* bonds. The difference between the price paid on issue and the redemption payment is the interest realised by the bondholder. As we will discover when we look at strips this has certain advantages for investors, the main one being that there are no coupon payments to be invested during the bond's life. Both governments and corporates issue zero-coupon bonds. Conventional coupon-bearing bonds can be *stripped* into a series of individual cash flows, which would then trade as separate zero-coupon bonds. This is a common practice in government bond markets such as Treasuries or gilts where the borrowing authority does not actually issue strips, and they have to be created via the stripping process.

Securitised bonds

There is a large market in bonds whose interest and principal liability payments are backed by an underlying cash flow from another asset. By securitising the asset, a borrower can provide an element of cash flow backing to investors. For instance, a mortgage bank can use the cash inflows it receives on its mortgage book as asset backing for an issue of bonds. Such an issue would be known as a mortgage-backed security (MBS). Because residential mortgages rarely run to their full term, but are usually paid off earlier by homeowners, the notes that are backed by mortgages are also prepaid ahead of their legal final maturity. This feature means that MBS securities are not bullet bonds like vanilla securities, but are instead known as *amortising* bonds. Other asset classes that can be securitised include credit card balances, car loans, equipment lease receivables, nursing home receipts, museum or leisure park receipts, and so on.

Bonds with embedded options

Some bonds include a provision in their offer particulars that gives either the bondholder and/or the issuer an option to enforce early redemption of the bond. The most common type of option embedded in a bond is a *call feature*. A call provision grants the issuer the right to redeem all or part of the debt before the specified maturity date. An issuing company may wish to include such a feature as it allows it to replace an old bond issue with a lower coupon rate issue if interest rates in the market have declined. As a call feature allows the issuer to change the maturity date of a bond it is considered harmful to the bondholder's interests; therefore the market price of the bond at any time will reflect this. A call option is included in all asset-backed securities based on mortgages, for obvious reasons (asset-backed bonds are considered in a later chapter). A bond issue may also include a provision that allows the investor to change the maturity of the bond. This is known as a *put feature* and gives the bondholder the right to sell the bond back to the issuer at par on specified dates. The advantage to the bondholder is that if interest rates rise after the issue date, thus depressing the bond's value, the investor can realise par value by *putting* the bond back to the issuer. A *convertible* bond is an issue giving the bondholder the right to exchange the bond for a specified amount of shares (equity) in the issuing company. This feature allows the investor to take advantage of favourable movements in the price of the issuer's shares. The presence of embedded options in a bond makes valuation more complex compared to plain vanilla bonds.

1.5 Pricing a conventional bond

The principles of pricing in the bond market are exactly the same as those in other financial markets, which states that the price of any financial instrument is equal to the net present value today of all the future cash flows from the instrument. A bond price is expressed as per 100 nominal of the bond, or 'per cent'. So for example if the all-in price of a US dollar denominated bond is quoted as '98.00', this means that for every $100 nominal of the bond a buyer would pay $98. The interest rate or discount rate used as part of the present value (price) calculation is key to everything, as it reflects where the bond is trading in the market and how it is perceived by the market. All the determining factors that identify the bond – those discussed in this chapter and including the type of issuer, the maturity, the coupon and the currency – influence the interest rate at which a bond's cash flows are discounted, which will be roughly similar to the rate used for comparable bonds.

Since the price of a bond is equal to the present value of its cash flows, first we need to know the bond's cash flows before then determining the appropriate interest rate at which to discount the cash flows. We can then compute the price of the bond.

1.5.1 *Bond cash flows*

A vanilla bond's cash flows are the interest payments or coupons that are paid during the life of the bond, together with the final redemption payment. It is possible to determine the cash flows with certainty only for conventional bonds of a fixed maturity. So for example, we do not know with certainty what the cash flows are for bonds that have embedded options and can be redeemed early. The coupon payments for conventional bonds are made annually, semi-annually or quarterly. Some bonds pay monthly interest.