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HANDBOOK OF DEBT SECURITIES AND INTEREST RATE DERIVATIVES

Advance Praise

"With growing awareness about the need for active debt markets in India it is appropriate to say that this is the right book at the right time. The subject has been dealt in a fashion best suited particularly to most of the Indian bankers who are yet to unravel the complexities of plain vanilla debt as also the more complex derivative products. The book ushers in the newcomers first to the basic concepts of debt and gradually builds up the crescendo to increasingly complex topics. Bond mathematics which is at the core of the bond derivative markets has been dealt in a masterly way. This book should turn out to be the most dependable magnum opus on debt markets."

Dr. R H Patil
Chairman, High Level Expert Committee on Corporate Bonds and Securitization

"This book is a significant contribution to professional finance literature particularly in the Indian context and fully reflects Mr. Rajwade's vast experience and expertise in this area. It is a book that I am sure will become an important resource for academics, policy makers, regulators as well as students not just in India but for all those who are looking at the Indian markets with any level of seriousness. The deft manner in which both academic and practical aspects are dealt with is a point that needs special mention. I am sure that this book will become a must have for all connected with the Indian markets."

Prof. P. G. Apte
Director, Indian Institute of Management, Bangalore

"Lucid, analytical and comprehensive. Mr Rajwade takes the reader through the basic theory and all nuances of the Indian bonds and interest rate derivatives market with masterly skill. It is the first book of its kind and likely to remain the best for a long time."

Mr. Sudhir Joshi
Head of Treasury, HDFC Bank

The "Fabozzi" of Indian debt markets ... at once an essential text for beginners and a useful reference for professionals.

S. Vishwanathan
General Manager Treasury, State Bank of India

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Handbook of Debt Securities and Interest Rate Derivatives

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To

Harsh, Sanjeevani and Anushka;
Jyoti, Abhijit, Rohit and Ajinkya;
Sachin, Anjali and Aditya;

With my blessings and good wishes

Foreword

Mr A.V. Rajwade has done a yeoman service to the financial community as well as students and teachers of finance by writing this book on debt securities and bond markets. The book is comprehensive and deals with all aspects of bond markets, including possible trading strategies and management of risks. A striking feature of the book, and its treatment of various technical issues, is his emphasis on providing analytical details as well as mathematical calculation of values underlying different types of debt instruments and risk limitation strategies. These should be particularly useful to the students of finance.

The book also contains suggestions for broadening and deepening the securities market in India. These are particularly of interest to policy makers and regulators of financial markets. In India, bond markets are relatively narrower in respect to volumes as well as types of instruments available for trade and investment. Two important merits of the book from the policy-maker's point of view are: (a) it provides a careful analysis of differences between the characteristics of Indian markets and those prevailing in developed markets abroad and (b) it provides a detailed account of innovations in trading strategies because of electronic trading and availability of real-time information on yields and prices. The book also contains a number of suggestions for development of bond markets in India. The pros and cons of different types of regulatory safeguards to provide adequate investor protection, particularly at the retail level would need to be taken into account in considering various proposals for broadening the market.

In the chapter on "Management, Classification and Valuation" of debt securities portfolio, Mr Rajwade has made a valuable suggestion—the proposal to create a small research cell as part of the treasury by banks and other institutional investors. As suggested by him, this cell should be independent of dealers and manned by mathematicians/statisticians fully conversant with the debt (and derivatives) markets, with some grounding in macroeconomics.

The major responsibility of this cell should be to analyse the macroeconomic environment and its possible impact on the bond market, and to continuously review debt market strategy.

I hope this proposal will receive urgent consideration by all institutional investors, particularly large investors in bond markets.

New Delhi
January, 2007

BIMAL JALAN
Member of Parliament (Rajya Sabha)
Former Governor, Reserve Bank of India

Preface

The importance of fixed income portfolios and the need to manage them prudently and optimally, has grown rapidly in recent years. The subject is of interest to all financial intermediaries including commercial and cooperative banks, primary dealers, insurance companies, bond funds, etc. Liberalization of the interest rate regime and consequent volatility of interest rates have added to both the risks and rewards of fixed interest portfolios. Again, on the regulatory side, more stringent requirements for measuring market risk and capital charge have been prescribed.

The structure of the market has also undergone a dramatic change. On the one hand, secondary market volumes in fixed interest securities, particularly those issued by the central government, have grown. A flourishing and liquid over-the-counter market in interest rate swaps of various kinds has come into being. Interest rate futures have also been introduced.

This is the background in which this book has been written. To the best of my knowledge, there is no book on fixed income mathematics, published in India. Again, there is very little literature on topics like portfolio management; market risk measurement and setting of prudential limits on the risk; the regulatory capital charge on such portfolios; the measurement and importance of return on capital; etc. I hope that this void will be filled to some extent through this book, which incorporates long experience in consultancy and teaching the subject in different forums.

The book is divided in the following sections:

Section I : An overview

Chapter 1 : Debt Securities And Markets: An Overview

Chapter 2 : Money Market

Chapter 3 : Bond Market in India

Chapter 4 : The Primary Market in G-Secs

Chapter 5 : The Secondary Market

Chapter 6 : Interest Rate Derivatives

Chapter 7 : Market Practices and Data Sources

Section II : Fixed income mathematics

Chapter 8 : Valuation of Fixed Income Securities: Basic Concepts
Chapter 9 : Term Structure and Yield Curves
Chapter 10 : Bonds With Options
Chapter 11 : Securitisation
Chapter 12 : Interest Rate Derivatives: Pricing, Hedging, Valuation

Section III : Portfolio management

Chapter 13 : Measuring The Price Risk: Duration and Convexity
Chapter 14 : Measuring The Price Risk: VaR Approach
Chapter 15 : Debt Securities Portfolios: Management, Classification, Valuation
Chapter 16 : Price and Credit Risk Management: Capital Charge
Chapter 17 : Operational Risk
Chapter 16 : Issues in Accounting

I am grateful to Dr Bimal Jalan for writing the foreword. Shri S. Vishwanathan, General Manager, Treasury, and his colleagues in SBI, have taken the trouble to go through the manuscript and offer comments and suggestions. So has Dr Golak Nath of the Clearing Corporation of India Ltd., in particular about Chapter 14. I have also gained from conceptual discussions with professionals working in J. P. Morgan Chase and HDFC Bank. In particular, I am thankful to Sameer Karyatt of the latter bank for his comments and suggestions on valuation of derivatives. Valuable inputs have also been provided by my colleagues Haresh Desai, Rahul Ghosh and Aniruddha Godbole. My thanks to all of them.

I hope that the book will be found useful by all the participants in the money and bond markets, chartered accountants, as also by management schools and other institutions involved in teaching the subject.

Mumbai
May, 2007

A.V. Rajwade

Contents

Chapter 1

Debt Securities and Markets: An Overview

1.1 What are Debt Securities?

Debt securities are instruments, or promissory notes, executed by or on behalf of the issuer, who sells them to investors to raise funds. Debt securities have a **maturity date and a face value**, i.e., the amount the issuer/borrower promises to pay while redeeming the security on its maturity date. (To be sure, there have been a few issues of debt securities with no fixed maturity dates, also known as perpetual bonds—but these are exceptions.)

Two other features common to all debt securities should be noted. The first is that the investor requires **compensation, or return**, for lending money to the issuer by buying the securities. The desired return depends on various factors like:

- The credit risk, or the risk that the issuer may default in paying the contracted return and/or face value of the security on its maturity (higher the risk, higher the desired return);
- Inflation, present and future, which reduces the purchasing power of the investment (the investor generally expects a positive "real", i.e. inflation-adjusted, return);
- The time to maturity of the security: the longer the maturity, greater the uncertainties about the first two factors; and
- The demand for and supply of debt securities in the market from time to time.

The second feature common to almost all debt securities is that they are **transferable** by the holder to other investors.

Debt securities are referred to by various names like bills (short for bills of exchange), T-bills (short for bills issued by the Central government), notes (short for promissory notes), bonds, G-Secs (short for Government Securities when issuer is central or a state government), debentures issued by corporates, etc. G-Secs other than T-bills are also referred to as **dated securities**, often identified by the coupon (see paragraph 1.1.1 below) and the redemption or maturity date. While most debt securities are unsecured, corporate issues are often secured by tangible assets charged to the debenture-holders by way of security.

Some debt securities also have embedded options in favour of the issuer and/or the holder to insist on premature retirement, or conversion into the equity capital of the issuer, etc.

1.1.1 Return to the Investor

The return to the buyer of the security comes in two forms:

- In the form of **interest**, with the security document specifying the amount (in percent per annum of the face value) and periodicity of payments; and/or
- In the form of a **difference between the purchase price and face value** (or the sale price) of the security.

In practice, the total return can, and often does, come through a combination of both the above. In fact, as we would see later, sometimes the return of the second type can be **negative** also; this happens when the purchase price is more than the face value, or the sale price as the case may be.

The interest payable on a security is either at a **fixed rate** or at a **floating rate**. The latter term implies that the actual rate of interest payable on the security is refixed periodically, say every six months, based on the specified, transparent and acceptable benchmark market rate at the point of refixation.

The annual interest is often referred to as the **"coupon"**. The actual periodicity of interest payment is not necessarily annual—it can be, say, quarterly or half-yearly. The practice in the Indian G-Sec market is that interest is paid half yearly (say, 28th April and 28th October). There are also securities which pay no periodic interest and where the return comes only through the difference between the purchase price and the face value. Such securities are referred to as **zero coupon securities**, or deep discount bonds.

1.1.2 Primary and Secondary Markets

At the point of issue, debt securities are sold by the issuer in the **primary market**. The issue can be a public issue, through prospectus/offer document, to which any investor may subscribe; or by "private placement" to a relatively small number of institutional investors. Since the securities are transferable, the original investors can sell them to other investors in the **secondary market**, and so can the subsequent holders. Secondary market prices depend on the return desired by investors at the time of the transaction—which can, and does, differ, not only day-to-day but even intra-day, depending on market conditions. In many markets, secondary market transaction volumes in debt securities exceed those in equity markets. The trading volume in the interbank secondary market for government securities was an average of around Rs 3,200 crore per day in 2005-06.

1.1.3 The Issuers and the Investors

In 2005-06, the volume of issues of debt securities in India aggregated more than Rs 200,000 crore. The face value of government securities outstanding as on March 31, 2006, was as follows :

Central government Rs 11,36,000 crore

State governments Rs 2,33,000 crore

(Source: Rakshitra, April 2006, Clearing Corporation of India Ltd.)

The **issuers** of debt securities include Governments—both centre and states—state-owned enterprises, private corporates, banks, etc.

The **buyers** (investors) are banks, insurance companies and other financial institutions/intermediaries, provident funds, mutual funds, corporates, etc. Individuals also invest their savings in debt securities: obviously, they would do so only if they get higher returns than on bank deposits—the same reason for which the corporate sector invests surpluses in debt securities. Banks, insurance companies and financial intermediaries have an additional reason: laws/regulations require them to invest a portion of their funds in specified debt securities.

Commercial banks, for instance, are required to invest at least 25% of their demand and time liabilities, in specified debt securities, by way of the **statutory liquidity reserve** (SLR) debt securities eligible for inclusion in the SLR portfolio, often referred to as SLR securities, include T-bills, Central government dated securities, state development loans and other approved securities.

Just as savers will invest in debt securities to get higher returns than in, say, bank deposits, the corporate sector would issue debt securities to raise money either if the cost is lower than that of bank loans—or to supplement bank credit. This process of the borrower directly going to the saver, bypassing the banking system, is known as the process of **disintermediation**.

By far the largest proportion of debt securities consists of those issued by the Central government.

1.1.4 Credit Ratings

As stated above, credit risk is an important element in the pricing of debt securities. Only securities issued by the central government are considered as being (credit) risk-free. All other issuers are required to offer a higher return to attract investors. Corporate issues are required to be rated by independent credit rating agencies, before they can be sold to the public. In practice, the rating determines the extra return over Central government securities that other issuers will have to pay. The so-called investment grade ratings range from AAA to BBB. (Many institutional investors have internal policies, or regulatory prescriptions, which require them to invest only in investment grade paper.) Lower ratings, i.e. BB etc. signify non-investment grade, or higher credit risk securities, often referred to as "**junk bonds**". Rating agencies keep ratings under periodical review, and change them if so warranted. Thus, a security which was investment grade at the point of issue, can be down-graded later to junk status.

The established credit rating agencies in India are CRISIL, ICRA, CARE and FITCH. Internationally, the most reputed rating agencies are Standard & Poor's and Moody's, which are large investors respectively in the first two Indian rating companies.

1.2 Investment Portfolios: Some Statistics

1.2.1 Scheduled Banks

As on 31st March 2006, investment portfolios of scheduled commercial banks aggregated Rs 817,494 crore, out of a balance sheet total of Rs 2,639,131 crore, or 31%. The investments included Rs 130,180 crore of non-SLR, i.e. purely discretionary, investments. (*Source*: Report on Trend and Progress of Banking in India, 2004-05 and "Macroeconomic and Monetary Developments in 2005-06", both published by RBI.) A sizable proportion of non-SLR investments was in the form of bonds/debentures.

1.2.2 Insurance Companies

Insurance companies, both life and non-life, represent another segment of major investors in debt securities. The aggregate amount of investments of the insurance sector, in central and state government securities, as on 31.3.05, was as follows:

	(Rs crore)
Life	380,000
Non-life	25,000

(*Source: Insurance Regulatory Development Authority Journal*, November 2005)

1.2.3 Other Investors

An idea of the size of investment portfolios of some of the other investors can be had from the following table:

Table 1.1 Other Investors (Data as on 31.3.05)

(Rs crore)

Investor Category	Portfolio	Total Assets
Primary Dealers (PDs)	10,000	12,000
Financial Institutions (FIs)	114,000	143,000
NBFCs[1]	3,500	34,000

(Note that investment portfolios may include some non-debt securities as well)

[1]Non-banking finance companies.

Source: Report on Trend and Progress of Banking in India, 2004-05, RBI.

In recent years, mutual funds have also become large and active investors in debt securities.

1.3 Markets in Debt Instruments

1.3.1

Debt instruments are issued, purchased, sold and traded in **money and bond markets**. Recent years have also witnessed the growth in India of a market in interest rate **derivatives**, i.e. contracts whose value depends on the value of the underlying debt securities or instruments.

While we discuss the money, bond and derivatives markets in much greater detail in subsequent chapters, it is sufficient at this stage to have an overview of the basic features, which are summarized in the following table:

	Money Market	Bond Market
Maturity	Short, say up to 1 year	Long up to 30 years[1]
Tradable Instruments	1. Treasury bills up to 1 year maturity; 2. Certificates of deposits;	1. Zero coupon or deep discount bonds 2. Fixed interest bonds

	3. MIBOR[2] linked bonds; commercial paper; 4. Collateralised borrowing and lending obligations (CBLO).	3. Floating rate bonds 4. Capital indexed bonds
Non-tradable	1. Security repurchase agreements (repos); 2. Interbank call, notice and term money, and participation certificates.	
Market Participants (Traded instruments)	1. All financial intermediaries and corporates; 2. Provident funds.	1. All financial intermediaries and corporates; 2. Provident funds.
Market Participants (Non-traded instruments)	Interbank market limited to banks and primary dealers	
Prices (Tradable instruments)	At discount to face value (to reflect interest), except MIBOR linked bonds	At discount to face value in the case of zero coupon bonds. Generally, for coupon bonds, at premium or discount to face value reflecting difference between coupon and market rates.

[1]There have also been some issues of perpetual bonds
[2]MIBOR: Mumbai interbank offered rate, please see paragraph 7.3.3

The following data, taken from the Reserve Bank of India Annual Report 2005-06, would give an idea of the current level of activity in the money and bond markets.

Table 1.2 Call Money and Bond Market Turnovers

Month	Call money Average daily turnover (Rs crore)	Turnover in Govt. securities (Rs crore)+
1	2	3
2005-06		
April	17,213	90,040
May	15,269	1,17,969
June	20,134	2,04,197

July	20,046	1,14,634
August	16,158	4,239*
September	16,292	5,207*
October	17,164	2,815*
November	22,620	3,314*
December	21,149	2,948*
January	17,911	3,094*
February	13,497	2,584*
March	18,290	2,203*
2006-07		
April	16,909	3,685*
May	18,074	3,550*
June	17,425	2,458*
July	18,254	2,243*

+Outright turnover in central government dated securities (monthly)
*Outright turnover in central government dated securities (daily average) from August 2006

1.3.2 Derivatives

In recent years, a very active market in rupee interest rate derivatives has developed as part of the money market. While there are no interest rate options at present, there is an active and liquid market in over-the-counter forward rate agreements and interest rate swaps, as the data in the following table witness.

Table 1.3 Interest Rate Derivatives

(Rs crore)

Month	Forward Rate Agreements/Interest Rates Swaps (Notional principal)
1	2
2004-05	
April	5,76,808
May	6,11,595
June	6,04,669
July	5,90,118
August	6,40,113
September	8,53,195
October	9,25,175
November	9,50,151

December	9,75,135
January	10,14,442
February	9,46,293
March	10,62,242
2005-06	
April	10,76,513
May	10,72,684
June	10,93,367
July	12,18,072
August	13,15,084
September	13,17,829
October	13,42,335
November	14,75,384
December	13,92,606
January	13,16,351
February	13,37,720

Source: Macroeconomic and Monetary Developments in 2005-06, RBI

However, the RBI Annual Report 2005-06 gives somewhat different figures. To quote, "The outstanding notional principal amount in FRAs/IRS market rose from Rs 13,58,487 crore in April 2005 to Rs 21,94,637 crore in March 2006. Select foreign banks, private sector banks and Primary Dealers (PDs) are the major participants in this market."

Exchange traded interest derivatives have been introduced but the market is not active. The topic of derivatives is discussed in detail in subsequent chapters.

1.3.3 Regulators and Other Agencies

Besides its role as regulator and supervisor of the banking system, the Reserve Bank of India also uses the money and bond markets to convey interest rate signals and manage money supply. The **open market operations** (OMOs) of the Reserve Bank of India are aimed at managing the money supply. RBI purchases government securities in the secondary market to pump money in the system; contrarily, it sells securities from its own holdings to mop up excess liquidity.

Besides, the RBI also operates its **liquidity adjustment facilities** (LAFs) to manage short term liquidity in the money market and banking system through sale and repurchase of debt securities (repo and reverse repo transactions). Besides, the RBI also manages the issues of government securities in the primary market, in effect acting as the merchant banker. All these issues will be discussed in greater detail in later chapters.

Other regulatory bodies include SEBI (Securities Exchange Board of India), for exchange traded bonds and derivatives, and FIMMDA (Fixed Income, Money Market and Derivatives Association), a self-regulatory body of the participants. The Clearing Corporation of India Ltd. (CCIL) settles trades in the money and bond markets.

Box 1.1 FIMMDA's Mission Statement

FIMMDA represents Market Players and aids the development of the bond, money and derivatives markets. Dovetailed with this mission are specific objectives such as:

- *To function as the principal interface with the regulators on various issues that impact the functioning of these markets.*
- *To undertake developmental activities, such as, introduction of benchmark rates and new derivatives instruments, etc.*
- *To provide training and development support to dealers and support personnel at member institutions.*
- *To adopt/develop international standard practices and a code of conduct in the above fields of activity.*
- *To devise standardized best market practices.*
- *To function as an arbitrator for disputes, if any, between member institutions.*
- *To develop standardized sets of documentation.*
- *To assume any other relevant role facilitating smooth and orderly functioning of the said markets.*

FIMMDA seeks to achieve these objectives by establishing specific working groups. FIMMDA is represented in the Technical Advisory Committee (TAC) of the Reserve Bank of India on Government Securities and Money Market and also that on the Foreign Exchange Markets. The TAC provides FIMMDA an ideal platform to air market views to the central bank of the country. FIMMDA also conducts seminars, training programs and symposia to facilitate the achievement of its stated objectives.

(*Source:* www.fimmda.org)

1.4 Calculating the Returns

As we have seen in paragraph 1.1.1, the return on debt securities comes in two forms, interest (or coupon), and the difference between the price and the face value. In principle, debt securities of similar, or comparable, characteristics like credit rating and (balance) maturity, should fetch similar returns at a given point of time: but they can, and often do, have different coupons for various reasons. (For example, G-Secs maturing in 2010 have coupons ranging from 5.87% to 12.29%.) If the total return is to be similar, obviously their prices will have to be, and are, different, so that the difference in coupons is compensated by varying differences between price and face value. For example, other parameters being equal, a higher coupon security will have a higher price than a lower coupon one.

The total return from both the sources is measured by calculating **the yield to maturity** (YTM) of the security. This is also the internal rate of return (IRR) on the investment at its ruling, or market, price. This point is discussed in detail in Chapter 8. Please see the following table of prices and YTMs of G-Secs maturing in 2010, ruling on 20-Apr-06.

Table 1.4 Prices and Yields of Central Govt. Bonds Maturing in 2010

Coupon	Redemption Date	Coupon Rate	Coupon Frequency	Price	Yield
5.87	2-Jan-2010	5.87%	Half Yearly	96.85	6.84
12.29	29-Jan-2010	12.29%	Half Yearly	117.86	6.83
7.5	12-May-2010	7.5%	Half Yearly	102.00	6.92
7.55	14-May-2010	7.55%	Half Yearly	102.27	6.90
11.5	11-Jun-2010	11.5%	Half Yearly	116.26	6.91
12.25	2-Jul-2010	12.25%	Half Yearly	119.14	6.91
11.3	28-Jul-2010	11.3%	Half Yearly	115.92	6.93
8.75	13-Dec-2010	8.75%	Half Yearly	106.96	6.97

Note that the data evidence:

- prices of higher coupon securities are more than those of lower coupon securities; and
- the YTMs of all G-Secs maturing in the same year vary.

1.5 The Scheme of the Book

Chapters 2 to 7 (Section 1) give an overview of the money, bond and derivatives markets, and market practices. We then deal with valuation of debt securities, derivatives and related issues in Chapters 8 to 12 (Section 2). In Section 3, Chapters 13 to 15 consider issues in price risk measurement and management of portfolios. The three concluding chapters discuss management of market/price and credit risks (Chapter 16), operational risks (Chapter 17) and accounting (Chapter 18).

Chapter 2

Money Market

2.1 Money, Bond and Derivatives Markets

While we are devoting separate chapters to the three topics, it should be noted that the three **do not function in watertight compartments**. By definition, prices in the derivatives market are based on those in the underlying money, bond and, in the case of some derivative products, even the foreign currency markets. The money and bond markets not only interact, with interest rates in one market influencing those in the other, but the floating rate bond markets use benchmarks from the money market. The experience in most countries evidences that the central bank is able to control the short term rates in the money market far more effectively than the yields in the bond market.

This chapter discusses the money market and is divided in the following paragraphs.

2.2 The short term money market (overnight to say 3/6 months)

2.3 The longer end of the money market

2.4 Market Stabilisation Scheme

2.5 Market transactions and reporting requirements

A word of caution: the above distinction between short and medium term money markets is more for the convenience of exposition, and not rigid; so is the distinction between the money and bond markets, as far as prices and interest rates/yields are concerned.

2.2 The Short Term Money Market

A bank (and other financial intermediaries as well) is continuously exposed to inflows and outflows of funds, originating in its branches and other operating

Box 2.1 Evolution of Money Market in India

The evolution of the money market in India could be traced to the late 1980s when the Working Group on Money Market (Chairman: N. Vaghul) made a series of recommendations for developing various segments of the money market. The administered interest rate system in the money market was dismantled. A series of measures were undertaken to build the institutional infrastructure for the money market. The Discount and Finance House of India (DFHI) was established in 1988 to promote secondary market activity in money market instruments, followed by a system of primary dealers in 1996 as a mechanism for developing the gilt market. The segment for Certificates of Deposit came into being in 1989. The money market expanded further to cover segments for Commercial Paper (1990), Repos with Reserve Bank (1992), Market Repos, Forward Rate Agreements/Interest Rate Swaps (1999) and Collateralised Borrowing and Lending Obligation (CBLO) (2003). The development of the payment system infrastructure was strengthened with the formation of the Clearing Corporation of India Ltd. (CCIL) in April 2002, introduction of the Negotiated Dealing System (NDS) in February 2002 and the implementation of real time gross settlement (RTGS) system from April 2004.

The profile of the money market has also been changing in the recent period. There have been indications of a more balanced development of the money market. Participants have been increasingly switching from the uncollateralised call/notice money market to the collateralised segments, driven by standardisation of accounting practices, broad basing of eligibility criteria, the gradual phasing out of non-banks from the call market and lower Cash Reserve Ratio (CRR) requirements. In recent years, although the call money and the repo markets continued to be dominated by a few top lenders, they were not able to extract monopoly rents as call rates and market repo rates persistently ruled below the Reserve Bank's repo rate. While mutual funds have emerged as the largest supplier of funds in the repo and the CBLO markets, PDs are increasingly becoming the major borrowers in the call/notice money market.

The integration of various segments of the money market has improved after the introduction of the Liquidity Adjustment Facility (LAF). The correlation coefficient between interest rates of CDs, CPs, 91-day Treasury Bills and repo rate with the call money rate improved steadily from 0.32, 0.54, 0.61 and 0.36, respectively, during the period April 1993 to May 2000 to 0.93, 0.90, 0.95 and 0.87 during June 2000 to June 2004. Correlation coefficients turned out to be lower after netting out the repo rate reflecting the influence of the LAF in promoting money market integration. The integration of money market segments was further validated by confirmation of the existence of cointegrated relationships among money market rates. The degree of cointegration has strengthened in the recent period, i.e., June 2000 to June 2004.

Reference

1. Reserve Bank of India (1987), Report of the Working Group on the Money Market.

Source: Report on Trend and Progress of Banking in India 2003-04

units. These arise from withdrawal or accretion of deposits; disbursement or repayment of advances; transactions in the foreign exchange or securities markets, etc. Cumulatively, these result into shortages or surpluses in the banks' principal account with the Reserve Bank. The bank obviously wants to ensure that the account is adequately funded to honour all obligations. It simultaneously would like to avoid loss of interest earnings which an excessive balance in the account would entail. This situation leads to transactions in the shorter end of the money market described below.

The key player at the short end of the money market is the Reserve Bank, through the operation of its **Liquidity Adjustment Facility** (LAF). This is used to both mop up and supply short term liquidity from/to the banking system, at interest rates determined by the RBI from time to time as part of its conduct of monetary policy. LAF is operated through sale and repurchase of specified securities, or "repo" transactions, and "reverse repos", i.e. purchase and resale. Another interest rate used by RBI is the Bank Rate, which traditionally was the rate at which RBI offered refinance facilities to the banking system. However, export refinance is now given at the repo rate. Moreover, refinance is not really part of the money market as such.

The other elements of the short term market we would cover are the **call/notice money market** and the **collateralised borrowing and lending obligations** (CBLO) facility conducted by the Clearing Corporation of India Ltd.

2.2.1 Repo Transactions

Repos, short for repurchase agreements, are contracts for the sale and future repurchase of a financial asset, most often sovereign securities. On the termination date, the seller repurchases the asset at the price agreed at inception of the repo; the difference between the sale and repurchase prices represents interest for the use of the funds. As such, a repo is essentially a **short-term interest-bearing loan against collateral**. It has rapidly grown in importance as a money market instrument.

When a repo transaction is outstanding (i.e. between the sale and repurchase dates), the title to the underlying security passes to the lender; however, he does not take any price risk on the security since the repurchase price is agreed at the outset of the repo transaction. It should be noted that what is a repo transaction for the borrower, is a "**reverse repo**" transaction (i.e. purchase and resale) for the lender.

The methodology for calculating the forward price is illustrated below in a simplified form:

Trade day 15 July

Settlement day 17 July

28 day repo @4% p.a.

Maturity day 14 Aug (Interest calculation on 365 day year basis)

Collateral: Face value Rs 6 crore, Govt. of India 8.5% 2006, March 26

Current price of the security = 111.57083333%

Purchase price = 6,00,00,000 × (111.57083333/100)

= Rs 6,69,42,500

Under the repo transaction, on July 17, A pays Rs 6,69,42,500 and B delivers Rs 6,00,00,000 face value bonds.

They simultaneously enter into a forward contract for B to purchase back the security at a price to give the desired return of 4% p.a. to A. The repurchase consideration therefore needs to be

= Rs 6,71,47,912.60 ((i.e. 6,69,42,500 × 0.04 × 28/365) + 6,69,42,500)

giving a price of 111.91318767 per Rs 100

On 14th August, B pays this amount and receives the securities back. The illustrated transaction is a repo transaction for B (sale and repurchase) and reverse repo transaction (purchase and resale) for A.

As per market practice, the price of the security should not be expressed in more than eight decimals. (The calculations have been illustrated on the basis of the "full" price of the security. In practice, "clean" prices are used and the accrued interest accounted separately—see Chapter 8.)

Although the lender does not carry any price risk on the security, and has a right to sell it should the borrower/counterparty default on the second leg, he still has some residual credit risk on the borrower: the price of the security may fall because of an increase in market interest rates, and the sale may not realize the full amount due to the lender. The lender, therefore, may keep a safety margin ("**hair cut**") between the market value of the security and the amount for which it is purchased as part of the repo (i.e. the amount lent).

2.2.2 Liquidity Adjustment Facility

The RBI manages the liquidity in the market through the operation of LAF as part of its monetary policy and money supply targets. It undertakes reverse repo transactions **to mop up liquidity** and **repos to supply liquidity in the market**. (These are actually repo and reverse repo transactions respectively, as defined in paragraph 2.2.1, for RBI—but RBI uses the terminology as described, in accordance with international practice.) The two rates are obviously different, the reverse repo rate being lower than the repo rate. The LAF transactions are presently being conducted on overnight basis.

The procedure prescribed by RBI for operation of the LAF requires banks to submit bids for repo/reverse repo transactions at specified times twice a day. The bids are submitted electronically through the Negotiated Dealing System (NDS)—see Chapter 5. All scheduled banks and primary dealers having current and SGL (Securities General Ledger, in which holder-wise records of individual securities in dematerialized form are kept) accounts with RBI, are eligible to participate in the transactions with bids for a minimum amount of Rs 5 crore (or multiples thereof). The transactions are undertaken in SLR securities and/or treasury bills. A uniform margin of 5%, **in terms of the face value of the security**, is kept on accepted bids. Thus, RBI practice is different from market repos; the latter are based on market values and not face values of the securities. Data on LAF transactions are given in paragraph 2.4.

Box 2.2 Facets of Liquidity Management

The Liquidity Adjustment Facility (LAF), introduced in June 2000, allows the Reserve Bank to manage market liquidity on a daily basis and also transmit interest rate signals to the market. The LAF, initially recommended by the Committee on Banking Sector Reforms (Chairman: Shri M. Narasimham), was introduced in stages in consonance with the level of market development and technological advances in payment and settlement systems. The first challenge was to combine the various sources of liquidity available from the Reserve Bank into a single comprehensive window, with a common price. An Interim Liquidity Adjustment Facility (ILAF), introduced in April 1999 as a mechanism for liquidity management through a combination of repo operations, export credit refinance facilities and collateralised lending facilities supported by open market operations at set rates of interest, was upgraded into a full-fledged LAF. Most of the alternate provisions of primary liquidity have been gradually phased out and even though export credit refinance is still available, it is linked to the repo rate since March 2004. Accordingly, the LAF has now emerged as the principal operating instrument of monetary policy.

Analytically, the LAF experience with market stabilisation can be partitioned into multiple sets of roles (Jadhav, 2003). First, the LAF stabilises regular liquidity cycles, by allowing banks to tune their liquidity requirements to the averaging requirements over the reporting fortnight and smoothening liquidity positions between beginning-of-the-month drawdown of salary accounts to fund household spending and end-of-the-month post-sales bulge in business current accounts.

Second, it irons out seasonal fluctuations. It injects liquidity during quarterly advance tax outflows or at end-March, when banks avoid lending on call, which adds to their Capital to Risk-Weighted-Assets Ratio (CRAR) requirements. It mops up liquidity in April to counter the typically large ways and means advances drawn by the Government prior to the inception of its borrowing programme. Third, it modulates sudden liquidity shocks, by injecting liquidity on account of say, temporary mismatches arising out of timing differences between outflows on account of Government auctions and inflows on account of redemptions. Fourth, the LAF has emerged as an effective instrument for maintaining orderly conditions *in the financial markets in the face of sudden capital outflows to ward off the possibility of speculative attacks in the foreign exchange market. Fifth, by funding the Government through private placements and mopping up the liquidity by aggressive reverse repo operations at attractive rates, the LAF helps to minimise the impact of market volatility on the cost of public debt. Sixth, the LAF bore much of the burden of sterilisation in the face of sustained capital flows, especially since November 2000, by mopping up bank liquidity through reverse repos and at the same time, gradually reducing reverse repo rates to enable a softening of the interest rate structure. Finally, the Reserve Bank tailors monetary policy action through both quantum and rate channels of transmission. The LAF accords the Reserve Bank the operational flexibility to alter the liquidity in the system (by rejecting bids) as well as adjusting the structure of interest rates (through fixed rate operations) in response to evolving market circumstances.*

Source: Report on Currency and Finance 2003-04

2.2.3 Repo Market

In the Indian money market, repo transactions inter se the participants, i.e. without RBI being a party, are also quite common. Repos had been initially restricted only to banks and primary dealers. Mutual funds and other financial institutions were only allowed in the reverse repo, i.e. for lending. However, RBI has recently allowed non-bank entities also in the repo market.

The repo market in India has seen significant increase in volumes in recent years. The total volume for 2005–06 was Rs 16,94,500 crore. The average daily trading volume has seen an increase from Rs 5,335 crore in 2004–05, to Rs 5,803 crore in 2005–06.

While mutual funds, financial institutions and insurance companies are the major lenders, primary dealers and scheduled banks are the major borrowers in market repos. Again, most of the dated securities used in repos are those issued by the central government; repo transactions also take place in T-bills and, to a very limited extent, in state government securities. The market repo rate will generally operate within the LAF band.

2.2.4 Call/notice Money

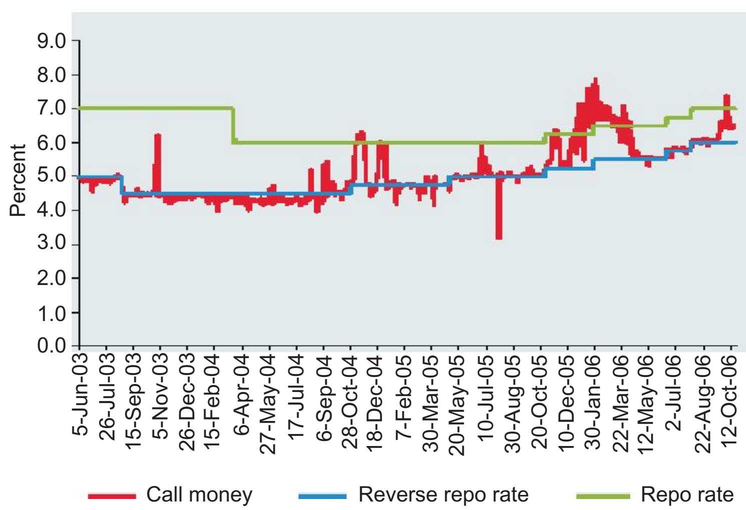
The call/notice money market is an important segment of the Indian money market. In this market, banks and primary dealers (PDs) borrow and lend funds to each other on unsecured basis. Non-bank participants have now been phased out of the market.

Call/notice money transactions are undertaken for management of liquidity for a very short period of time — mostly overnight. If the period is more than one day and up to 14 days it is called 'notice money'. Money lent for 15 days to 1 year is called term money. This market works on an unsecured basis. There are no brokers in the call money market and trading is done over the counter. Settlement is done between the participants through the current accounts maintained with the RBI.

The regulator has prescribed limits on the banks and primary dealers operations in the call/notice money market.

In general, the call money rate, referred to as the **overnight MIBOR** (Mumbai interbank offered rate), **will operate within the LAF band**—as otherwise it will be more economic for either the borrower or the lender to use LAF rather than operate in the call market. In normal market conditions, the call rate will rule higher than the market repo rate as call market is unsecured. However, when banks cannot use the RBI window for any reason—want of surplus securities for repo transactions, or RBI not accepting reverse repo bids for any reason—the call money rate can, and does, operate outside the LAF band. (See Chart 2.1.) Data on call money operations have appeared in Table 1.2

Chart 2.1 Call Rate and Reverse Repo Rate



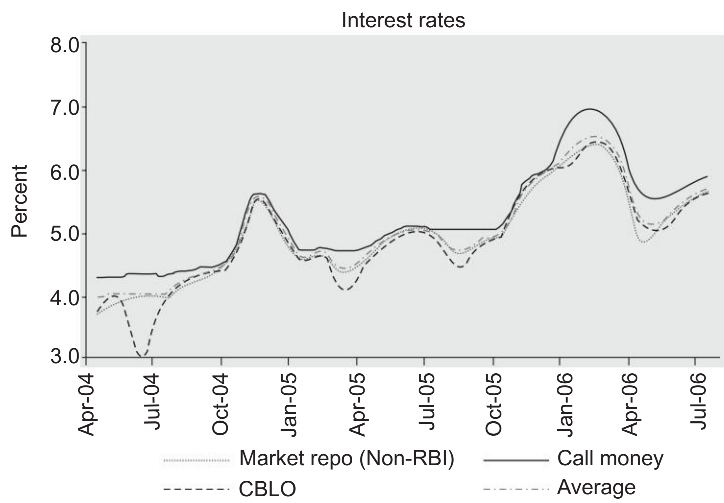
Source: Report on Trend and Progress of Banking in India 2005-06

2.2.5 CBLO

As an alternative to the call money market, CCIL has developed Collateralized Borrowing and Lending Obligation (CBLO), a money market instrument recognized by RBI. CBLO is an instrument issued at a discount and in electronic (i.e. dematerialized) book entry form, for initial maturities ranging from one day to one year. Dealings in CBLOs can be done through the Indian Financial Network (INFINET), the Negotiated Dealing System of RBI (NDS—see Chapter 5) or through the internet.

Participants are required to open Constituent SGL accounts with CCIL, for depositing securities offered as collateral for borrowing and lending of funds. (In turn, these are held in a separate SGL account of CCIL with RBI.) CCIL fixes borrowing limits for each participant based on the market value, and an appropriate margin, of the securities deposited with CCIL. By taking such collateral and based thereon, CCIL becomes the counterparty to every CBLO transaction. CBLOs can also be traded in the secondary market. CBLO rates are generally comparable to market repo rates, both being secured transactions. See Chart 2.2 below.

Chart 2.2 Money Markets—Interest Rates



Source: RBI Annual Report 2005-06

2.2.6 *Bills Rediscounting*

Banks often rediscount with another bank, bills of exchange already discounted by them to finance trade transactions: rediscounting enables the discounting bank to raise short term liquidity in the money market. Such bills are sometimes drawn on a bank, and/or under letters of credit. As the name itself shows, bill rediscounting transactions are on discount basis, i.e. the compensation to the discounter comes in the form of the difference between purchase price and face value. As far as the rediscounting bank is concerned, it is taking a credit risk on the discounter. The drawer/drawee/acceptor and earlier endorsers are also liable on all negotiable instruments.

2.2.7 Interbank Participation Scheme (IBPS)

IBPS is, in theory, aimed at providing short term liquidity. A bank can raise money by selling participation in an outstanding advance to another bank, on both (credit) risk sharing and non-risk sharing basis. Strictly speaking, this is not a money market instrument in the sense of its having liquidity or published prices. It is often used **to meet sectoral targets** for lending.

2.3 The Longer End of the Money Market

This includes the following instruments or market segments:

- Treasury bills;
- Commercial paper;
- Certificates of deposit; and
- Term interbank market.

2.3.1 Treasury Bills

Treasury bills are promissory notes of the central government and therefore qualify as being free of credit risks. These are issued to meet short term funding requirements of the government account with Reserve Bank. Some of the characteristics of the treasury bill market in India are as follows:

(a) For original maturities of 91, 182 and 364 days;

(b) At a discount to the face value;

The sale is by auction and there is also an active secondary market in T-bills. Any individual, corporate, bank, primary dealer or other entity is free to buy T-bills.

Data on T-bill issuance in 2004-05 are as follows:

	T-Bill issuance 2004-05 (Rs crore)	T-Bill issuance 2005-06 (Rs crore)
91-day Treasury Bills	1,00,592	1,03,424
182-day Treasury Bills*	–	26,828
364-day Treasury Bills	47,132	45,018

Source: RBI Annual Report 2005-06
* Issuance restarted in April 2005

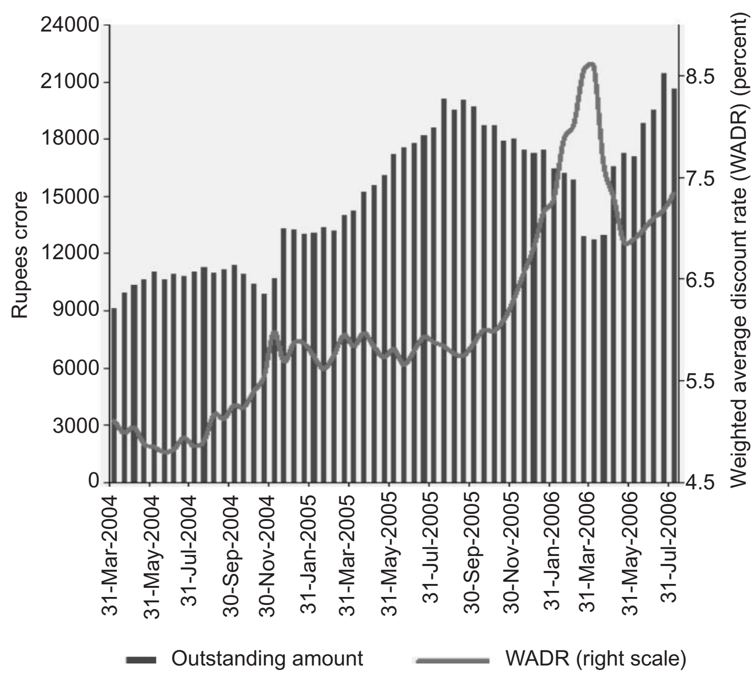
2.3.2 Commercial Paper or CP

CPs are **promissory notes issued by the corporate sector for** raising short term funds. These too are sold at a discount to face value. CP issues are often used by the corporate sector to lower the cost of funds.

Under RBI guidelines, maturity of the CP can range between a minimum of 7 days and a maximum of 1 year from the date of issue; CPs are required to be rated and the minimum rating for eligibility is P2. CPs can be issued on a stand alone basis, but banks and financial institutions provide standby facilities to back CP issues. CP issue can also be guaranteed by non-banking entities. Every issue has an Issuing and Paying Agent (IPA), which has to be a scheduled bank. While CPs can be issued by way of promissory notes, banks, financial institutions and PDs can invest in and hold CPs only in dematerialized form. Stamp duty is currently (mid-2005) payable on CP issues, depending on the maturity and who the initial buyer is.

CPs are also actively traded in the secondary market.

Chart 2.3 Commercial Paper



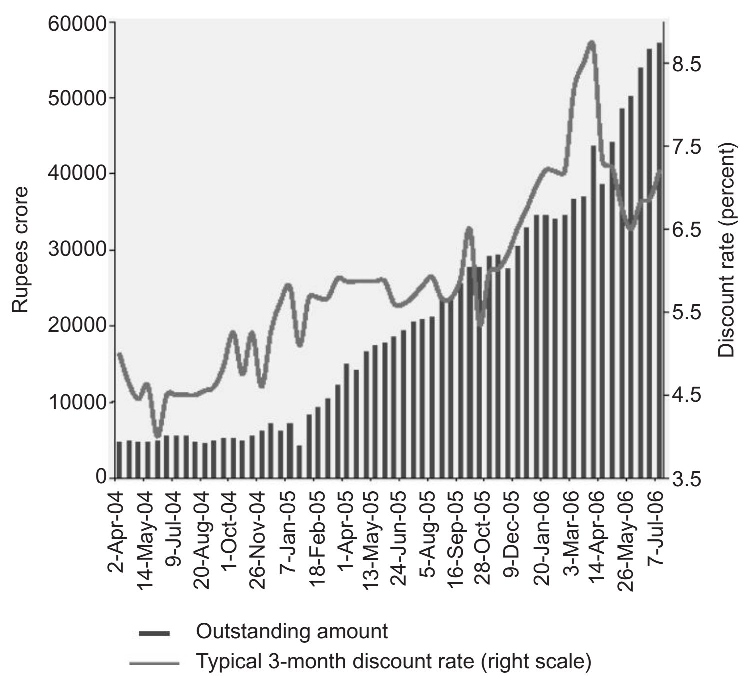
Source: RBI Annual Report 2005-06

2.3.3 Certificates of Deposit or CDs

These are similar to CPs except that **the issuer is a bank**, not a corporate entity. Banks have freedom to issue CDs depending on their requirements, but financial institutions' issues have to be within the overall fund raising limits fixed by RBI. The minimum amount of a CD can be Rs 1 lakh, and the maturity of bank CDs between 7 days and 1 year; on the other hand, financial institutions can issue CDs only for maturities between 1 and 3 years. While CDs may be issued at a discount to face value, where the issue is on a floating rate basis, it would be expressed by way of a margin over a suitable benchmark, and re-set periodically. CDs can be used in both physical and dematerialized formats.

The standard procedures and operational guidelines for issue of CPs and CDs have been circulated by FIMMDA and are available on its website.

Chart 2.4 Certificates of Deposit



Source: RBI Annual Report 2005-06

2.3.4 Term Interbank Market

Term interbank market is the longer term counterpart of the call/notice market described in paragraph 2.2.4 above. The participants are banks and primary dealers. The principal differences between CDs and the term interbank market are:

- CDs are negotiable and can be sold by the holder in the secondary market; and
- CDs attract stamp duties and can be purchased by any investor.

2.3.5 Size of the Market

Data about the transactions in the money market are given in the following table:

Table 2.1 Transactions in the Money Market

Month	Average Daily Turnover			Outstanding Amount	
	Term money market	Repo market (Outside the LAF)	Collateralised borrowing and lending obligation (CBLO)	Commercial paper	Certificates of deposit
1	2	3	4	5	6
2004-05					
April	325	15,195	2,496	10,362	4,725
May	372	15,932	3,872	11,038	4,860
June	274	17,517	4,015	10,950	5,438
July	445	19,226	4,508	11,038	5,478
August	311	13,561	4,962	11,002	4,480
September	487	18,178	6,149	11,371	5,112
October	539	15,719	8,466	10,409	4,785
November	407	18,560	9,651	10,719	6,118
December	504	21,922	9,962	13,272	6,103
January	514	17,556	7,701	13,092	4,236
February	878	17,562	8,952	13,189	9,214
March	1,253	14,688	9,625	14,235	12,078
2005-06					
April	661	12,174	10,369	15,598	16,602
May	545	13,688	12,233	17,182	17,689

June	534	17,163	12,075	17,797	19,270
July	717	18,103	15,292	18,607	20,768
August	754	21,325	14,544	19,508	23,588
September	1,116	18,872	17,143	19,725	27,641
October	734	20,980	21,763	18,726	29,193
November	917	25,660	20,496	18,013	27,457
December	775	25,574	21,265	17,234	32,806
January	1,089	24,596	25,634	16,431	34,521
February	813	24,096	34,162	15,876	34,487
March	1,338	31,964	35,775	12,718	43,568
2006-07					
April	894	21,914	32,657	16,550	40,059
May	945	36,107	34,293	17,067	50,228
June	1,256	42,250	27,617	19,550	56,390
July	864	38,684	31,340	20,602	57,256*

* As on July 7, 2006
Source: Report on Banking and Finance, 2004-05 and RBI Annual Report 2005-06.

It will be noticed that volumes in the term money market are much smaller than in the call money segment. Again, transactions in the CBLO market have grown rapidly since the inception of the market. Currently, the daily turnover in the CBLO segment exceeds that in the call and repo markets.

2.4 Market Stabilization Scheme

The Reserve Bank has taken monetary policy measures on many occasions in response to what is happening in the exchange market. For instance, the 2003-04 Report on Currency and Finance lists 15 different occasions on which monetary measures were taken for exchange rate management during the last 10 years.

The RBI's intervention in the exchange market, by selling or buying dollars, also affects liquidity in the banking system and hence, indirectly, the level of interest rates. This is because, when RBI buys dollars in the market, it is supplying rupees; contrarily, when it sells dollars it mops up rupees from the system putting upward pressure on interest rates. The RBI also endeavours **to neutralize the impact of exchange market operations** on the money supply through what are known as **sterilization measures**: sale of government securities to mop up excess supplies of rupees arising from purchase of dollars, or vice versa.

For sterilizing excess money supply, the RBI needs to hold government securities in its books. As RBI holdings of government securities dwindled in 2003-04 and 2004-05 with repeated sales of government securities from the RBI stocks to mop up excess liquidity, a Market Stabilization Scheme (see Box 2.3) was introduced. At one time, it had a limit of Rs 80,000 crore and involved sale of government paper by RBI, not because the government needs the money, but to absorb excess liquidity in the market. The proceeds remain to the credit of the government without earning any interest and, therefore, MSS entails a cost to the government, which is in pursuit of the exchange rate policy. For the buyer of the securities issued under the stabilization scheme, there is no difference in prices. A large proportion of securities issued under MSS have been in the form of T-bills.

Box 2.3 Liquidity Management and Market Stabilization Scheme

Pursuant to the recommendations of the Working Group on Instruments on Sterilization Chairperson: Smt Usha Thorat, a Market Stabilization Scheme (MSS) was introduced on April 1, 2004 following a Memorandum of Understanding signed between the Government and the Reserve Bank on March 25, 2004. The ceiling on the outstanding amount under the MSS, fixed by mutual consultation, was raised from the initial Rs 60,000 crore to Rs 80,000 crore on October 14, 2004.

The MSS is designed to absorb liquidity of an enduring nature by way of sterilisation. Used in conjunction with the LAF, it allows the absorption of surplus liquidity built up into various maturity buckets ranging from overnight (under the reverse repo window) to the short-term (91-day, 182-day and 364-day Treasury Bills under the MSS) and the medium-term (dated Government securities with residual maturity up to 2.5 years). Under the MSS, the Government issues Treasury Bills and dated Government securities (with the same features as existing paper) to mop up rupee liquidity and parks the proceeds in a separate identifiable cash account maintained and operated by the Reserve Bank. These funds can be appropriated only for the purpose of redemption and/or buyback of paper issued under the MSS. The resultant decline in net Reserve Bank credit to the Government nullifies the expansionary impact of an accretion to the Reserve Bank's net foreign assets resulting from capital flows. The impact on the revenue/fiscal accounts of the Government is limited to the discount on Treasury Bills and coupons on dated securities (net of premium/discount and accrued interest) issued under the MSS. Interest payments under the MSS were placed at Rs 2,969 crore during 2004-05.

Source: RBI Annual Report 2004-05

Table 2.2 Liquidity Absorbed through LAF and MSS

(Rupees crore)

Outstanding at Month End	LAF	MSS	Total (2+3)
1	2	3	4
2004			
April	73,075	22851	95,926
May	72,845	30701	1,03,546
June	61,365	37812	99,177
July	53,280	46206	99,486
August	40,640	51635	92,275
September	19,245	52255	71,500
October	7,455	55087	62,542
November	5,825	51872	57,697
December	2,420	53481	55,901
2005			
January	14,760	54499	69,259
February	26,575	60835	87,410
March	19,330	64211	83,541
April	27,650	67087	94,737
May	33,120	69016	1,02,136
June	9,670	71681	81,351
July	18,895	68765	87,660
August	25,435	79,936	105,371
September	24,505	67,328	91,833
October	20,840	69,752	90,592
November	3,685	64,332	68,017
December	–27,755	46,112	18,357
2006			
January	–20,555	37,280	16,725
February	–12,715	31,958	19,243
March	7,250	29,062	36,312
April	47,805	24,276	72,081
May	57,245	27,817	85,062
June	42,565	33,295	75,860
July	44,155	38,995	83,150

Source: RBI Annual Reports of 2004-05 and 2005-06

Notes: 1. The figures are not quite comparable: LAF absorption is typically for a much shorter maturity than MSS instruments.

2. Negative sign in column 2 indicates injection of liquidity through LAF Repo.

2.5 Market Transactions and Reporting Requirements

Trading in T-Bills and call money has commenced on the NDS OM platform. (See Chapter 5.) All repo, call money and other transactions are required to be reported to RBI by banks and primary dealers, on the NDS platform.

Chapter 3

Bond Market in India

3.1 Introductory

We discuss in this chapter the major issuers and investors in the bond market, the types of bonds, the benchmark for pricing, risks in bond market investments, etc.

It is important to keep one perspective about the bond market in India, while looking at some of the details. The aggregate amount of outstanding central government bonds as on 31.3.06 was of the order of Rs 11,36,000 crore. Again, in the current year 2006-07, the aggregate amount of bond issues is expected to be of the order of Rs 200,000 crore—including the central and state governments and government undertakings, the private corporate sector, etc. These numbers clearly emphasise **the importance of the bond market to the economy**.

3.2 The Issuers

3.2.1 The Central and State Governments

By far the largest issuer of bonds is the central government. The main purpose of the debt securities issued by the central government is to finance the fiscal deficit. The amount of bonds issued by the central government has been growing year after year. The maturities of the central government bonds extend **up to 30 years**, but the bulk of the issues are of less than 10-year maturity. Tables 3.1 and 3.2 summarise the bond issues over the last 5 years, and a maturity profile of the bonds presently outstanding.

It will be noticed that, at present, **more than a hundred bond issues** of the central government **are outstanding**. (Note that the difference with the figure quoted in paragraph 1.1.3 is because of the issuance of certain special

Table 3.1 Central Government Bond Issues

Gross Borrowings and Net Borrowings of Central Govt. (excluding 364-day T-Bills)		
Year	**Gross Borrowings (Rs crore)**	**Net Borrowings (Rs crore)**
2000-01	1,00,183	71,787
2001-02	1,14,213	87,714
2002-03	1,25,000	97,580
2003-04	1,21,500	88,806
2004-05	80,350	46,034
2005-06	1,31,000	95,370
2006-07 (Budget estimates)	1,55,018	1,15,939

Source: RBI Annual Report 2005-06

Table 3.2 Maturity Distribution of Central Government Bonds as on 31.3.2006

Outstanding G-Secs 2005-06		
Residual Tenor	**No. of Securities**	**Maturing Amount (Rs crore)**
0-5 years	71	**3,44,510**
6-10 years	36	**2,93,508**
11-15 years	16	**2,00,565**
15-29 years	12	**1,80,038**
Total number of securities	135	**10,18,621**

central government bonds like oil bonds, bank recapitalization bonds, etc. on a bilateral basis, i.e. not sold in the market.)

Box 3.1 Oil Bonds

With a view to compensating oil marketing companies for under-recoveries in their domestic LPG and kerosene sales under the Public Distribution System (PDS) during the financial year 2005-06, the Government of India issued six special marketable dated securities to oil marketing companies on two occasions, viz., March 7, 2006 and March 23, 2006, aggregating Rs 11,500 crore. These securities with interest rates in the range of 7.07 per cent and 7.61 per cent were issued with 3 years, 6 years and 9 years maturities without SLR status as these were not part of the approved market borrowing programme of the Government. The coupon rates on these bonds were fixed on the basis of prevailing secondary market yields with a suitable non-SLR spread of 20-25 basis points.

Recapitalisation Bonds

The Union Budget 2006-07 announced the unwinding of entire outstanding Recapitalisation Bonds/Special Securities issued to nationalized banks, amounting to Rs 20,809 crore, through conversion into tradable, SLR eligible, Government of India dated securities. The substitution of nontradable securities with tradable securities having SLR status would facilitate increased access of the banking sector to additional resources for lending to productive sectors especially agriculture and SME sectors, in the light of the increasing credit needs of the economy.

Source: RBI Annual Report 2005-06

State governments also issue bonds, once again to finance their deficits. State government bonds are generally of a **shorter maturity** than the central government's: most state government bonds are of 10-year maturity. The aggregate amount outstanding as on March 31, 2006, was Rs 2,33,000 crore.

Besides bond issues in their own names, state governments have guaranteed a large number of bonds issued by state electricity boards, irrigation projects, etc. While these issues are made in the respective corporate names, in many cases, these are off balance sheet borrowings of the states themselves. While there have been few defaults in respect of bonds issued by state governments directly, recent years have witnessed several instances of defaults on guaranteed bonds.

Lately, the central government has followed a policy of not guaranteeing PSU bonds. Successful PSUs however access the bond market based on their own corporate ratings.

Coming back to central government bonds, there has been one issue of **capital indexed bonds**, where the principal amount was indexed to the inflation rate in order to protect the purchasing power of the investment. Such bonds however have not proved very popular. Please see paragraph 3.3.1 below.

3.2.2 Financial Institutions and Banks

Traditionally, financial institutions, which cannot access public deposits, have depended on the bond market for raising resources. In recent years, however, major financial institutions like IDBI and ICICI have converted themselves into commercial banks and are no longer very dependent on the bond market for raising resources.

Commercial banks have issued so-called **subordinated bonds**, i.e. bonds which rank lower than deposit liabilities should the issuer become insolvent, in order to supplement their capital resources. Perpetual debt instruments, i.e. those with no specified maturity, are eligible for inclusion in tier I capital; those qualifying for inclusion in upper tier II capital, need a minimum maturity of 15 years.

3.2.3 The Corporate Sector

While highly rated companies (AA or AAA) are quite active in the domestic bond market, the market is not very deep. Again, given that a significant portion of corporate bond issues is subscribed by banks and other institutional investors, the maturity in the corporate bond market remains limited to around 5 or, in a few cases, 7/8 years. The maturity limitation also arises from the fact that the secondary market in corporate bonds is not very liquid. Therefore, the investor has to consider the possibility of having to hold on to the bonds until maturity, and hence the investor may not be very interested in longer maturity corporate bonds. The maturity limitation does create problems where bond issues are made to finance long gestation projects, particularly in the infrastructure sector.

No proper data on corporate/bank bonds issued annually are, however, available. The Reserve Bank of India Annual Report shows only two bond issues based on prospectus, in the whole of 2005-06. On the other hand, private placements totaled Rs 96,000 crore in that year, but separate data for equity and debt issues are not available for this segment. Presumably, most private placements were in the form of debt issues. Given that corporate/bank issues are for relatively shorter term maturity, the aggregate corporate/bank bonds outstanding are probably of the order of around Rs 350,000 crore.

As stated earlier in Chapter 1 (see paragraph 1.1.4), corporate issuers have to pay a higher return than the central government and this depends on the credit rating: the lower the rating, higher will be the return demanded by the investor. The actual extra return, **or premium over G-Sec yields**, is also a function of the liquidity conditions in the money and banking markets. During times of strong liquidity, the premium tends to narrow: it widens when money is tight. The premium for variously rated bonds over G-Secs ruling on 31.3.2006 is summarized in Table 3.3.

Merchant/investment banks play an important role in structuring, pricing and marketing corporate bonds; so do rating agencies as it is the rating which influences the pricing significantly. Corporate bonds, also referred to as debentures, are sometimes issued on a secured basis with, typically, some of the issuer's assets charged to the bond holders. Corporate bond issues also have trustees, generally a trustee company, to look after the interest of the bond holders, to monitor the observance of any covenants agreed to by the

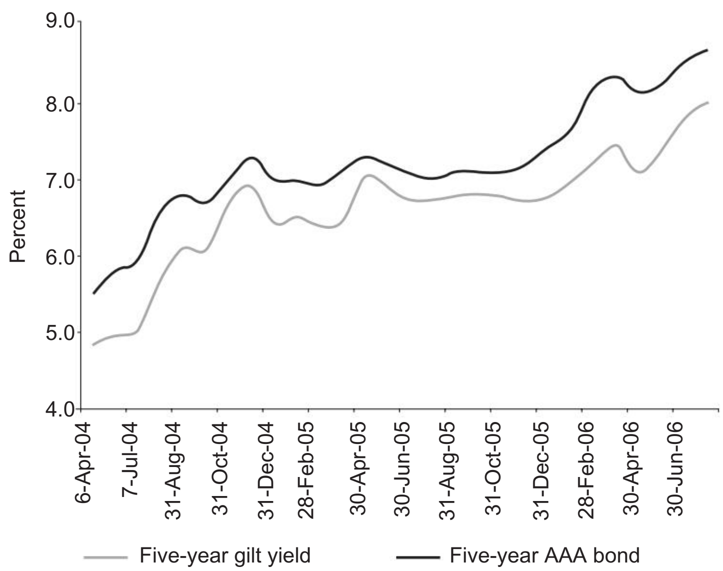
Table 3.3 Corporate Bond Spreads Over Central Government Bond Yields

Spreads over FIMMDA-PDAI-Bloomberg Gilt Curve in bps Updated on 31.3.06										
Annualised spreads	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
AAA	142	127	126	112	98	97	96	96	97	97
AA+	157	144	141	128	114	113	111	112	112	113
AA	163	155	155	144	133	135	137	138	139	140
AA–	182	175	175	164	153	155	157	163	170	176
A+	212	207	208	196	184	188	191	196	200	205
A	247	246	251	242	233	237	240	243	247	250
A–	279	282	284	271	258	260	261	267	274	280
BBB+	321	326	321	310	298	304	309	316	323	330
BBB	367	371	392	389	385	390	395	399	404	408
BBB–	423	427	454	448	441	449	457	461	465	469

Source: fimmda.org.in

The figures are in basis points i.e. one-hundredth of a percentage point

Chart 3.1 Yield Spreads



Source: RBI Annual Report 2005-06

issuer as part of the bond, creation of security, listing and other relevant factors. The cost of the trustee(s) or trustee company is borne by the issuer although the trustee's primary responsibility is towards the investor. From the issuer's perspective, the **total cost of a bond issue** would comprise not only the return to investors but also front end costs like the fees of the merchant/ investment banks, brokerage in the case of public issues, legal, documentation and other issue expenses, security creation cost, the fees of the trustee company, etc.

While the principal amount of most bonds is repayable on maturity, there are also issues of amortising bonds: a predetermined proportion of the principal is repaid in, say, annual instalments. The instalments may be payable every year through the life of the bond, or only during the concluding 2 or 3 years.

A related issue is that of the bond issuer creating a "sinking fund" for honoring the bond. The issuer makes contributions to the fund periodically and it is sometimes managed by interdependent trustees. The fund can be used to buy back bonds from the market—or invested in safe avenues to be available for meeting the bond liability.

3.3 Bond Variations

In paragraph 1.1.1, we have already noted three variations—fixed interest (or coupon) bonds, zero coupon bonds and floating rate bonds. There is a variety of benchmarks used for periodic refixation of the floating rate—see paragraph 3.3.2 below. The central government has also issued one capital indexed bond.

3.3.1 Inflation (or Capital) Indexed Bonds

Such bonds are aimed at **protecting the purchasing power** of the investment, by indexing the maturity proceeds to the change, in a suitable inflation index, over the life of the bond. Such bonds have been successfully, and regularly, issued by governments in U.S., U.K. and many other countries.

In India, a '6 percent Capital Indexed Bond 2002' (CIB) was issued for the first time in December 1997. Subsequent to that issuance, there has been no further issuance of CIB mainly due to lack of an enthusiastic response of market participants for the instrument, both in primary and secondary markets. Some of the reasons cited for the lackluster response are:

(a) it only offered inflation hedging for the principal, while the coupons of the bond were left unprotected against inflation; and

(b) complexities involved in pricing of the instrument.

Besides, the natural market for such bonds is retail investors and pension funds. Institutional mechanisms for the participation of such investors are still to be developed in India.

In the case of the one bond issued, for calculation of the index ratio, the monthly Wholesale Price Index (WPI) for all commodities was used. The capital redemption ratio was based on the August 2002 index over the August 1997 index (base).

3.3.2 Floating Rate Benchmarks

There have been 10 issues of floating rate bonds by the central government. In these cases, the **floating rate benchmark used has been the yield on treasury bills**. The average of the cut off yields on the last six 364 day T-bill auctions (see Chapter 4) has been used as the T-bill rate: note that the benchmark is calculated on the basis of 364 day T-bill yields, but the refixation of the floating rate is done every 6 months. Again, the actual applicable rate is at a spread over the T-bill rate ranging from –0.05 to + 0.5% p.a.

There have also been corporate issues of floating rate bonds with different benchmarks. In principle, these could be the ruling CP or CD rate (say), but most **often the floating rate benchmark has been the ruling government bond yields**: the issuer of course pays a premium over the specified G-Sec yield, depending on the credit rating and market conditions. Several bond issues have used a floating rate benchmarked to the 1-year G-Sec yield, but to be refixed every six months. In a few cases, the spread and benchmark also vary from year-to-year. In one case, the floating rate for the first year was 0.15% over the 3-year G-Sec, in the second year 0.25% over the 2-year G-Sec and in the third year 0.35% over the 1-year G-Sec yield. However, such complex structures are not many.

Yet another recent innovation in pricing of corporate bonds has been that the coupon is a combination of

(a) the difference between 5 and 1 year G-Sec yields; and

(b) a fixed premium.

The coupon will be refixed every year depending on the ruling 5 and 1 year yields.

Floating rate bonds are also sometimes referred to as variable or adjustable rate bonds. They can be embedded with a cap or floor (or both) on the coupon. This would mean that the actual coupon would not exceed the cap (or fall below the floor) irrespective of the floating rate benchmark.

3.3.3 Inverse Floaters

A few issues of so-called "inverse floaters" have also taken place in India, both by way of straight issues, as also part of a process of securitization (see Chapter 11). Inverse floaters are bonds where the applicable interest rate is expressed as **a fixed rate *minus* a specified floating rate**, and is refixed periodically based on the ruling floating rate. The most popular benchmark floating rate used in the inverse floater markets has been the MIBOR (the Mumbai Interbank Offered Rate). For example, the applicable interest rate could be expressed as, say, "12% – MIBOR": in this structure, when MIBOR goes up the effective interest rate falls, and vice versa.

3.3.4 Callable, Puttable and Convertible Bonds

"Callable" bonds give the right to the issuer to prepay the bond before maturity, but generally after expiry of an initial period. Obviously, the issuer will exercise the option if it is economic for him to do so: in other words, when the marginal cost/yield on the funds is less than the coupon on the bond.

"Puttable" bonds give to the holder/investor the right to insist on premature repayment of the bond: such rights can be exercised at the discretion of the holder but generally after expiry of some specified period, and giving notice to the issuer, or if there is a breach of credit covenants or other conditions.

"Convertible" bonds offer conversion of a part or whole of the principal amount of the bond into equity of the issuer at a predetermined price, on or after a specified date. Such conversion can be at the option of the holder or, sometimes, compulsory. Where an option exists, the investor will exercise it only if the share price is more than the conversion price.

3.3.5 Bonds from Securitization of Assets

The topic is discussed is Chapter 11.

3.4 Risks for the Investors in Bond Markets

Debt securities issued by the Government of India **(G-Secs) are often referred to as "risk-free" securities**. They are risk-free in the sense that they are free of credit risks—in the jargon of credit rating, such securities in the domestic currency are often referred as being "AAA+", the plus coming from the right to print currency notes! To be sure, one can recall few instances of defaults on governments' local currency bonds. One notable exception was

Russia in 1998. A few post-revolutionary governments have also reneged on the bond obligations of previous regimes.

But such exceptional situations apart, G-Secs can be regarded as being free of credit risks, and are so regarded by financial markets and, indeed, bank regulators — the credit risk weight for calculating capital on such securities is zero. Credit risk-free does not necessarily mean that G-Secs are free of all risks. In theory, this would be the case only if the investment were to give real returns as calculated at the time the investment was made, at any point of time up to maturity. By this stricter definition, G-Secs are not risk-free as they suffer from:

(a) Reinvestment return risk for coupon bonds (Chapter 8);
(b) Purchasing power or "real" return risk, with changes in inflation rate; and
(c) Market price risk if there is a difference between the time horizon of the investment and the maturity of the bond.

The first risk is not there for zero coupon bonds or STRIPS (paragraph 3.5); the second for inflation indexed bonds (paragraph 3.3.1). The only "truly" risk-free bonds will be zero coupon, inflation indexed, with the maturity coinciding with the time horizon of the investor. (Purists could argue that, even here, the protected inflation index may not parallel the investor's consumption pattern, and therefore may not protect his purchasing power!)

Bonds other than G-Secs carry credit risks as well. Several cases of default have occurred in respect of state government guaranteed bonds. Even a public sector financial institution (Industrial Finance Corporation of India Ltd.) has defaulted on its bond issues; so have other issuers in the public and private sectors.

For the individual investor, the best indicator of the credit risks is the rating. Institutional investors generally try to make their own appraisal of the credit risks: in fact, the Reserve Bank of India requires banks to make their own internal assessments, and ensure "*that ………. their investment policies duly approved by the Board of Directors are formulated after taking into account the following aspects:*

A. The Boards of banks should lay down policy and prudential limits on investments in bonds and debentures including cap and on private placement basis, sub limits for PSU bonds, corporate bonds, guaranteed bonds, issuer ceiling, etc.
B. Investment proposals should be subjected to the same degree of credit risk analysis as any loan proposal. Banks should make their own

internal credit analysis and rating even in respect of rated issues and should not entirely rely on the ratings of external agencies. The appraisal should be more stringent in respect of investments in instruments issued by non-borrower customers.

C. Strengthen their internal rating systems which should also include building up of a system of regular (quarterly or half-yearly) tracking of the financial position of the issuer with a view to ensuring continuous monitoring of the rating migration of the issuers/issues.

D. As a matter of prudence, banks should stipulate entry level minimum ratings/quality standards and industry-wise, maturity-wise, duration-wise, issuer-wise etc. limits to mitigate the adverse impacts of concentration and the risk of illiquidity.

E. The banks should put in place proper risk management systems for capturing and analysing the risk in respect of these investments and taking remedial measures in time."

(RBI Master Circular July 12, 2005)

A couple of other points may be noted. **Debenture trustees have a very important role** to play in protecting the interests of the holders; they are responsibly for example, for ensuring that the security, if any, has been properly created; that the issuer is not contravening any of the credit covenants stipulated, etc.

In the case of issuing companies which have become insolvent, bondholders have to look to the receiver to get paid on realization of the issuer's assets. In some cases, negotiated restructurings of bond issues have also taken place: these have involved lower interest rates, write off of a part of the principal ("hair cut"), or a combination of the two.

3.5 STRIPS

Separate Trading of Registered Interest and Principal Securities (STRIPS) is well established in the U.S. and other bond markets. STRIPS are also likely to be introduced in India shortly.

As the name signifies, **STRIPS involve treating each inflow from a coupon security**, i.e. coupons and principal, **as a separate, zero coupon security**. Thus a 10-year bond paying half-yearly interest can be converted into 21 zero coupon bonds (20 coupons plus one principal amount) with maturities ranging from six months to ten years. The present value, or price, of each can be calculated by using the spot rates for different maturities (Chapter 9). To facilitate the introduction of STRIPS, *"Dates for consolidation of* *coupon strips (March 25/September 25 and May 30/November 30) would be aligned with coupon payment dates in future issuances. Towards this, the coupon payment dates of 6.01 per cent Government Stock 2028, issued on August 7, 2003, were aligned to March 25/September 25. Primary Dealers who meet certain financial criteria would be authorised to undertake stripping and reconstitution of securities."* (Report on Trend and Progress of Banking in India 2003-04, RBI.) The proposal is however still to be implemented.

Chapter 4

The Primary Market in G-Secs

4.1 Introduction

As we have seen earlier, by far the largest segment of the bond market is the securities issued by the central government: they also provide the pricing benchmark for all other issuers. Major changes have taken place in the G-Sec market since the beginning of the 1990s. There have been two principal drivers of the changes:

- Economic reforms in the country following the balance of payments crisis of 1991; and
- The "securities scam" of 1992 which exposed weaknesses in the system of custody of and trading in G-Secs. (A brief outline of the scam is in Chapter 17.)

The Reserve Bank has played a major role in reforming the money and bond markets in its capacity as manager of government debt and also the supervisory/regulatory authority for the banking system which, as we have noted earlier, is by far the largest investor in the bond market. The **reforms and changes have come in both pricing of G-Secs** in the primary market and in secondary market trading. The **infrastructure of the market** has also seen a number of changes like custody of securities in dematerialised form, electronic trading, guaranteed settlement system operated by the Clearing Corporation of India Ltd., etc. On another front, in its role as banking supervisor, the RBI has put in place mark-to-market regulations, and imposed capital adequacy norms for price/credit risk on debt securities. We discuss the primary market in G-Secs in the following paragraphs.

4.2 Primary Market Pricing

4.2.1 A Brief History

Prior to June 1992, central government bonds were issued at coupons fixed by the Reserve Bank and sold at par. In order to keep the cost of government borrowing low, the **coupons were generally lower than desired by the investors**. Therefore, there was little voluntary investment in the issues. Consequently, their absorption by the banking system required successive and large increases in statutory liquidity requirements of the banking system, to provide a captive market. At one time, SLR requirements were as high as 38.5%. When even this was insufficient to meet the government's need of funds, **recourse to central bank finance was taken, through automatic monetisation**, i.e. purchase of securities by the Reserve Bank in the primary market.

Besides monetisation of G-Secs, the government was also using a system of so-called **ad hoc treasury bills**—these too were purchased by the central bank to finance the deficits. In effect, this was an unlimited source of cheap finance for the government. As part of the reform process, the issue of ad hoc T-bills was first capped, then discontinued from April 1997—they were replaced by Ways and Means Advances (WMA) at the Bank Rate and with a limit on the outstanding amount. The new system gave more autonomy to the central bank to conduct monetary policy. Consequent upon this, the outstanding ad hoc bills were converted and added to the stock of special securities with the RBI.

In the absence of market determined returns, a "market" for government securities did not develop, and could not provide an exit route for the investor. It was only in June 1992 that the coupon rates on Government securities were raised to near-market rates and sale of G-Secs in auction was initiated, paving the way for developing a proper "market" in government and non-government securities, at both the primary and secondary levels.

4.2.2 Maturity of G-Secs

In 1992-93, when the Government started borrowing at market rates, most of the new maturities were below 10 years. The result was that the share of shorter maturity debt issues (loans maturing within a period of 5 years) in the total outstanding market debt stood at 41% at end-March 1999, as against 8.6% at end-March 1991. Correspondingly, the share of long-term loans (i.e. above 10 years) declined from 85.8% to 16.1% during the same period. To correct the imbalance, RBI started issuing longer maturity securities (up to 30 years). This has resulted in the average maturity of new debt (issued during a year) rising from 6.6 years in 1996-97 to 16.90 years in 2005-06. The result has been to increase the weighted average maturity of the outstanding stock to almost 10 years, as the following table witnesses.

Table 4.1 Maturity of G-Sec Issues

Years	Range of Maturities of New Loans	Weighted Average Maturity	Weighted Average Maturity of Outstanding Stock	Weighted Average Coupon of Outstanding Stock
1997-98	3-10	6.6	6.5	–
1998-99	2-20	7.7	6.3	–
1999-00	5-19	12.6	7.1	–
2000-01	2-20	10.6	7.5	–
2001-02	5-25	14.3	8.2	10.84
2002-03	7-30	13.8	8.9	10.44
2003-04	4-30	14.94	9.78	9.30
2004-05	5-30	14.13	9.63	8.79
2005-06	5-30	16.90	9.92	8.75
2006-07*	4-30	12.73	10.12	8.64

* Up to 21 August 2006

Source: RBI Annual Report 2005-06

4.3 Issue Mechanics

4.3.1 Issues of Treasury Bills

RBI announces the calendar for sale of T-bills for the fiscal year, through a press release. Auctions of 91 day bills are held weekly; those for 182 and 364 day bills fortnightly. The calendar for 2005-06 is appended.

Type of T-Bills	Periodically Auction	Notified Amount (Rs crore)	Day of Auction	Day of Payment
91-Day	Weekly	500	Every Wednesday	Following Friday
182-Day	Fortnightly	500	Wednesday Preceding the non-Reporting Friday	Following Friday
364-Day	Fortnightly	1000	Wednesday Preceding the non-Reporting Friday	Reporting Friday

4.3.2 Other ("Dated") Securities

As the debt manager of the government, the Reserve Bank of India conducts the central and state governments' borrowing programmes. While deciding upon individual issues under the programme, the Bank takes into account the needs of the Governments, liquidity conditions in the market, market preference for maturity vis-à-vis the desired maturity, and yields in the primary and secondary markets. An element of judgment on the part of the RBI is also involved. On the basis of the above parameters, beginning April 2002, RBI has been releasing an issuance calendar for dated securities every half year. An issuance calendar enables institutional and retail investors to plan their investments better and imparts transparency and stability to the Government securities market. These calendars sometimes need to be modified as regards the timing of the issue, its amount and tenor, etc. depending on the borrowing requirements and market conditions.

Primary market issues of Government securities consist of either the reissuance of an existing security (i.e. having the same coupon and maturity as an existing security), or an entirely new one. Lately, RBI has been almost exclusively depending on reissues to limit the number of outstanding securities with varying parameters. (In 2005-06, 30 of the 31 issues during the year represented reissues of existing securities.) The reopening of existing issues has resulted in consolidation of the outstanding debt, evolution of benchmark securities, and better liquidity in the market.

There is a variation in the way in which issues of new securities and reissues of old securities are priced in the primary market. As we shall see later (see paragraph 4.3.4) issue announcements of new securities indicate only the amount of the issue and its maturity. Participants in the primary market are required to bid for them on the basis of the desired yield. On the other hand, for re-issues of existing securities, the parameters such as coupon and maturity are known; therefore, participants in the primary market are required to bid for them by quoting prices, and not yields. As we shall see later in Chapter 8, there is a mathematical relationship between the price and yield of a security.

4.3.3 Uniform and Variable Price Auctions

There are two generally accepted methods in which auctions are conducted:

- uniform price based, or Dutch, auctions, in which bids are accepted at the same price. The identical, or cut-off, price is the highest price (or lowest yield) at which the issuer can get the entire issue subscribed.

- Multiple/variable price, or French, auctions, where bids are accepted at different prices/yields quoted in the individual bids. While successful bidders get the prices/yields they had bid, the bidder at the cut off price/yield gets the best price.

While initially 91-Day T-Bill auctions were conducted using the uniform price auction, this practice was discontinued in December 2002 and currently price auctions are used for dated securities and Treasury Bills. While variable price auctions are the rule, some uniform price auctions are also conducted by RBI. This seems to be the case in respect of long dated securities, or when markets are volatile, and there are uncertainties about the pricing.

4.3.4 Issue Announcements

The new issue process starts with the issue of a notification by the Government of India, Ministry of Finance, specifying the following details:

(a) The aggregate amount of the issue (nominal or face value).

(b) Whether it is re-issue of an existing security or a new issue.

(c) In the case of re-issue, the parameters of the security to be re-issued, for example, "7.95 percent Government Stock, 2032".

(d) Maturity in the case of a new issue.

(e) The date of the auction, the auction being yield based for new issues and price based for re-issues.

(f) Whether the auction is on a uniform price basis or multiple (variable) price basis, etc.

Based on the government notification, the Reserve Bank of India invites bids for the auction, specifying the time and date, the date for payment for the allotted securities, which will be typically a day or two later than the bid date. New issues mature after an exact number of years from the date of payment. (For example, if payment date is say May 4th, 2006, maturity 10 years, coupon payment dates will be November 4th and May 4th, until redemption of the bond on May 4th, 2016.) For successful bidders having a current account with the RBI, the purchase price is debited to it and the stock allotted is credited to the bidder's Securities General Ledger (SGL) account with the RBI.

Treasury bills are auctioned on the basis of price bids.

4.3.5 Allotment Mechanics

While we have given in paragraph 4.3.3 above the general principles of uniform and multiple price auctions, it will be useful to illustrate the allotment mechanics with a numerical example.

Consider a price-based auction, i.e. in respect of the re-issue of an existing security. Let us assume that the issue amount is Rs 1,000 crore and the bids received, ranked in descending order of prices, are as follows:

Bidder	Amount of Bid Rs crore	Price per 100
A	300	105.30
B	200	105.28
C, D and E*	700	105.27
F	100	105.26
G	400	105.25
H	250	105.24
I	450	105.23

(*In this case, three bidders have made aggregate bids of Rs 700 crore at the identical price of 105.27.)

Note that the entire issue of Rs 1,000 crore has been bid at a price of Rs 105.27 ("cut off yield") or higher, and that, obviously the issuer would like as high a price as possible. In the above situation, the allotment will be done as follows:

(a) Bidders F, G, H, and I will not get any allotment;

(b) Bidders A and B will get the full allotment;

(c) Bidders C, D and E will get allotment proportionate (5/7) to the amount bid;

(d) Under the uniform price auction, all the successful bidders will pay a uniform price of 105.27;

(e) Under the multiple price auction, A and B will pay prices respectively of 105.30 and 105.28, while C, D, and E will get the stock at a lower price of 105.27.

(Note that these prices are the clean prices and allottees will pay accrued interest on the security from the last interest payment date to the settlement date, separately—for a discussion of "clean" and "dirty" or "full" prices, please refer to Chapter 8.)

The allotment mechanics in respect of yield-based auctions is similar except that the bids are ranked in increasing order of the yield for allotment purposes. Obviously, the issuer would like to allot the issue to those quoting the lowest yields.

In the context of the need to attract retail investors in the government securities market, bids received on non-competitive basis, that is outside the auction process, are cut-off at the weighted average yields derived in the auction. Non-competitive bidding has been allowed since January 2002, and up to 5% is allocated to non-competitive bidders at the weighted average cut-off rate. In a move towards a more effective market clearing price, non-competitive bids are now kept outside the notified amount.

4.3.6 State Government Securities

State government securities, often referred to as State Development Loans (SDLs), are also, in principle, sold by the RBI in auctions. The scale of issues is much smaller as compared to G-Secs. Lately, SDLs have been sold in the primary market at a yield premium of 0.5% over G-Secs of corresponding maturities.

4.3.7 When Issued Market

In some countries, a "When Issued Market" is an integral part of the treasury auction system for government securities. WI trading takes place between the announcement of the auction date and the date of the issue: the trades are for settlement at a future date, which is normally the issue date. Thus, WI trades are essentially forward transactions in a security which is still to be issued. Yields in the WI market are pointers to the pricing and yields on the security to be issued, for the central bank.

A 'WI' market has been introduced in India recently. 'WI' transactions are to be settled only if the underlying security is issued: in other words, they are null and void if the issuance is cancelled after a 'WI' contract has been entered into. To start with, 'WI' trades were permitted only in the case of re-issued securities; this has been extended to new issues as well. However, only primary dealers can be net sellers under the 'WI' transaction. Certain prudential limits have been prescribed for 'WI' positions.

4.4 Primary Dealers

The system of Primary Dealers (PDs) was introduced in India in 1995, with the objective of developing underwriting and market making capabilities in the primary and secondary markets in G-Secs. PDs are also an effective conduit for the central bank's open market operations (see next paragraph).

Earlier, Primary Dealers had to be separate entities floated for the purpose, and approved by the RBI. Recently, banks have been allowed to undertake activities as a Primary Dealer departmentally. In that case, banks are required to maintain separate accounts for the PD activity, but the holdings of the PD department in approved securities, qualify for meeting the SLR obligation of the bank.

The obligations of the PDs include the following:

(a) PDS are required to support auctions for issue of dated securities and treasury bills, through underwriting. Underwriting commitments are in two parts

    (i) a minimum underwriting commitment, so computed as to ensure that at least 50% of each issue is underwritten—in other words, each PD will currently underwrite about 3% of the notified amount under each auction, by way of its minimum underwriting commitment;

    (ii) additional competitive underwriting—the balance portion of the issue is open to competitive underwriting through underwriting auctions, which are held before the auction for sale of the security.

    PDs get an underwriting commission from RBI subject to fulfilment of certain conditions.

(b) PDs are also required to offer firm two-way quotes (i.e. separate prices for selling and buying a security) in G-Secs, for the purpose of promoting liquidity in the secondary market.

(c) PDs have to fulfil certain minimum turnover ratios in respect of both dated securities and treasury bills.

In return for undertaking the obligations, PDs have access to opening current and SGL accounts with RBI; operate in the money and derivatives markets; have access to the RBI's liquidity adjustment facility; and additional liquidity support under a separate scheme. PDs can also invest in securities other than government securities.

4.5 Monetisation and the Fiscal Responsibility and Budget Management Act

While, in principle, government securities are sold in auctions and their yields are therefore market determined, the central bank can always influence them in various ways:

- by its monetary policy;
- open market operations, i.e. sale and purchase on its own account, in the secondary market; and
- monetisation, i.e. purchase of an issue in the primary market.

To elaborate the last point, if the RBI felt that the market yield at a given point of time was too high, it used to purchase the issue itself and credit the amount to government account.

The Fiscal Responsibility and Budget Management Act precludes the central bank from monetising debt issues by buying them in the primary market. Therefore, after April 2006, the central bank will have to use only monetary policy and open market operations to influence yields.

4.6 Custodial Services

It was recognised that one of the system weaknesses which facilitated the securities market scam of 1992 was weaknesses in custodial and settlement systems for G-Secs. As a part of the reform, RBI introduced the book keeping of government securities in Subsidiary General Ledger (SGL) accounts, maintained by banks and primary dealers with the RBI's Public Debt Offices (PDOs), in electronic form.

In turn, the entities holding SGL accounts with RBI offer custodial services to their own constituents. Such holdings on behalf of constituents are, however, required to be kept separate from the entities' own holdings. In order to segregate the custodial holdings from their own investments, SGL account holders are allowed to maintain one more SGL account with PDOs, called "Constituents' SGL account".

Physical transfer of government securities has been discontinued in 2005.

4.7 Corporate Debt Issues

Public/listed issues of debt paper are governed by the Securities Exchange Board of India (SEBI). The guidelines are available on SEBI's website.

Chapter 5

The Secondary Market

5.1 Introduction

A liquid and efficient secondary market in bonds is an integral element of financial markets. (The term financial market or markets generally also covers equity, foreign exchange, money and derivatives markets.) It facilitates "price discovery"—in other words, at what kind of returns, or yields, a new issue is likely to be successful. Again, it helps attract investors to the primary issue market: the exit route it provides is clearly attractive to investors. **In short, a vibrant secondary market is essential for smooth floatation of new bonds at reasonable prices/yields**.

In this chapter, we look at the important features of the secondary bond market in India.

5.2 Why Investors Trade

The reasons which motivate investors to buy or sell debt securities in the secondary market are many and diverse. Some of the important ones are as follows:

(a) Investment of surplus funds in between primary bond issues;
(b) Contrarily, selling bonds from the portfolio to generate funds and meet demand. For example, an open-ended bond fund may face redemption requests to meet which it may need to sell existing investments;
(c) To meet regulatory requirements;
(d) To restructure existing portfolios as part of asset liability management, or to take advantage of temporary mispricings;

(e) For trading, or speculation, in price movement of bonds in anticipation of yield change;

We discuss (d) and (e) in some detail in Chapter 15.

5.3 Trading System

Historically, bond trading was done on stock exchanges. Later, it became an over-the-counter (OTC) market in which trades were settled (i.e. prices and other terms agreed) directly between the buyer and the seller over telephone, or, more frequently, through the intermediation of brokers. In fact, **for a long time, broker intermediation was the standard way to contract trades**. A buyer or seller of debt securities would communicate his requirements to a broker, **with or without price limits**, and the broker would find a counterparty to the trade. Once terms were agreed, a trade contract would result. The broker was paid a commission for his services.

While in existence for a long time, broker intermediated trading has certain weaknesses:

(a) It requires longer time to conclude a deal, leading to higher average transaction times. This can be particularly inefficient when volumes are heavy or markets are volatile.

(b) The dealer, or even the broker, may be unaware of all the prices in the market, and the former has to rely on the broker's information, which itself is based on limited data. There is inadequate transparency of the prices.

(c) Transaction costs can be, often are, higher because of larger bid/offer spreads and broker fees.

This apart, in India, various malpractices crept in the broker-driven market, resulting into what has come to be known as the "Securities Scam" of 1992. (The scam is discussed in Chapter 17.) Thereafter, a series of reforms in market practices were introduced, starting with the holding of securities in dematerialized form (see paragraph 4.1) and strengthening of delivery vs payment (DvP) systems. The Clearing Corporation of India Ltd. (CCIL) was formed to undertake clearing and settlement of trades. DvP and CCIL's role are discussed in paragraphs 5.3.2 and 5.3.3 below.

The worldwide trend, in equity, bond and derivatives markets, is to move towards electronic trading. The reason is that screen-based trading is faster, cheaper and, in an order driven system, trades are settled at the best available prices in the market at a given point of time. In fact, most of the bond markets in the advanced economies have moved to electronic trading platforms (see Box 5.1).

Box 5.1 Introduction of Screen-based Trading System for Government Securities in India

In recent years markets all over the world have been working to automate and introduce screen-based trading systems. More sophisticated strategies and investors' desire to have more direct market access and greater control over trading, are leading to growing interest in screen-based trading systems. Screen-based electronic markets are gaining trading volumes at the expense of traditional over-the-counter 'telephone' markets all over the world. The last decade has witnessed a dramatic increase in both the number and the market share of screen-based trading systems. The adoption of screen-based trading systems has transformed the economic landscape of trading venues and is proving a force for change in market architecture and consequential trading possibilities. The effect, however, is not merely "to build a better telephone", but potentially to create a new way of trading, different from either floor-based or telephone trading. Electronic trading both removes geographical restraints and allows continuous multilateral interaction. It allows much higher volumes of trades to be handled, and in customized ways that until recently would have been technically impossible or prohibitively expensive.

Within the fixed income sector, electronic trading has made most inroads into many government bond markets. As per a Survey by the Bond Markets Association of USA, there were 77 electronic, fixed-income trading systems operating in the U.S. and Europe in late 2003 versus 81 in 2002 and 11 in 1997. Of the 77, 46 are based principally in the U.S. and 31 are based principally in Europe.

Source: K. Biju, *Rakshitra*, September 2005

5.3.1 NDS and Electronic Trading

The first step towards electronic bond trading in India was the introduction of the RBI's Negotiated Dealing System (NDS) in February 2002. NDS was intended to be used principally for bidding in the primary auctions of G-secs conducted by RBI, and for trading and reporting of secondary market transactions, as the name itself signifies. However, because of several technical problems and system inefficiencies, NDS was being used as a reporting platform for secondary market transactions and not as a dealing system. For actual transactions, its role was limited to placing bids in primary market auctions. Much of secondary market trading in the bond market continued to be broker intermediated.

It was therefore decided to introduce **a screen-based** (i.e. electronic) **anonymous order matching system**, integrated with NDS. This system (NDS-OM) has become operational with effect from August 1, 2005. While initially only banks and primary dealers could trade on it, NDS-OM is being gradually expanded to cover other institutional players like insurance companies, mutual funds, etc. The trades agreed on this system are reported automatically through the NDS and further to CCIL for settlement. (It should be noted however that presently only trades between banks and PDs qualify for settlement through CCIL—others need to be settled separately.)

The order matching system is a transparent, neutral and anonymous trading platform. Investors enter purchase/sale (bid and offer) orders on the system for individual securities they wish to deal in. The system ranks the orders in terms of prices and, for more than one order at the same price, in terms of timing of the orders (the earlier order gets priority). It then tries to match the sale orders with the purchase orders available on the system. When a match occurs, the trade is confirmed. The counterparties are not aware of each others identities—hence the anonymous nature of the system.

The NOD-OM system has several major advantages over the erstwhile telephone-based market—it is **faster, transparent** (since all orders are entered on the system and available on the screen) **and cheaper**. Straight through-processing (STP) of transactions means that, for participants using CCIL's clearing and settlement systems, once a deal has been struck on NDS-OM, no further human intervention is necessary right up to and including settlement, thus eliminating possibilities of human errors. NDS-OM provides other benefits like audit trails etc. (see Box 5.2).

Box 5.2 Screen-based Trading in Government Securities

1. *The Negotiated Dealing System (NDS) is an electronic platform owned and maintained by RBI. It has been posted on the Indian Financial Network (INFINET) maintained by Institute for Development and Research in Banking Technology (IDRBT), a fully owned initiative of RBI. Originally conceived to facilitate dealings in government securities—Central/State Government securities and Treasury Bills (gilts) and money market instruments, NDS was intended to be mainly used as a trading/reporting system for secondary market gilts transactions and for electronic submission of bids in primary auctions of gilts by RBI. Over time, while the nature and scope of activities carried out in NDS has expanded, as indicated below, its primary focus remains the gilts market.*

NDS – Current Activity Scope

2. *NDS current activity scope includes:*
   - *Reporting of all outright and repo gilt trades concluded in the Over-the-Counter (OTC) secondary market;*
   - *Order entry for quote driven market in gilts;*
   - *Negotiation mode for concluding gilts deals;*
   - *Submission of bids for primary gilts auctions;*
   - *Reporting of call and notice money transactions;*
   - *Reporting of term money transactions;*

- ✧ *Value free transfer of gilts;*
- ✧ *Electronic down-load of security balances in SGL/CSGL Accounts with PDO*

3. *NDS operations commenced on February 15, 2002. Almost all market participants who maintain Current and SGL accounts with RBI have joined NDS. Most SGL transactions at the Public Debt Office (PDO), Mumbai are now on electronic mode through NDS. Similarly, bids in LAF, gilts auctions are being generally submitted electronically through NDS resulting in reduced auction bid processing time, besides minimising clerical errors. To provide wider access to the data on the gilts market, information on trades captured by the NDS is being disseminated through the RBI's website since October 25, 2002 on near real time basis. With mandatory reporting requirement in respect of all call/notice money and term money market transactions, regulatory access to such information is now better with reduced reporting time lags. Although several members fail to report all their money market transactions or report them with considerable time lags, market players have generally benefited from the reporting system in that assessment of market trends are now more meaningful.*
4. *NDS has helped in achieving paperless and straight through clearing and settlement of secondary market gilts trades through CCIL as a central counterparty. The system has brought about significant improvements in transactional efficiency and transparency. Better dissemination of information on market deals and moves towards deepening the gilts market have also been facilitated as reflected in the better price discovery and increased market turnover. NDS has had its share of woes and problems too. These problems faced by the NDS could be classified into two categories, viz.; technical issues and business related issues.*
5. *On the technical front, problems have largely hovered around the periodic disruptions in NDS usage, loss of network connectivity, performance related issues, inadequacy of technical/help-desk support, etc. The common perception on business related issues point largely to the lack of user-friendly features and functionalities of the NDS. Resultantly, the core aim of proper development of the domestic gilts market has perhaps not kept pace with the original intent.*

Source: Report of the Working Group, appointed by RBI (July 2004)

The result of the successful launch of the electronic trading system has been that the **number of transactions routed through brokers has fallen**, and will continue to fall as an increasing proportion of all securities and T-bills gets traded on the system. This trend is in alignment with what is happening internationally where too an increasing share of bond trading has shifted to electronic platforms. NDS-OM provides many other benefits to its users like transparency, straight through processing, audit trails for transactions, etc. (see Box 5.3).

Box 5.3 Introduction of Screen-based Trading System for Government Securities in India

(a) Transparency

The trading system provides timely information, both pre-trade (for example, bid, offer and depth) and post-trade (for example, last trade price and volume), and disseminates it widely real-time to all interested entities both within the NDS domain as also Non-NDS entities through the RBI website. This enables better price discovery and provides increased opportunities to market participants to respond to new information.

(b) Straight Through Processing

The trading system allows straight-through processing (STP), i.e. the seamless integration of the different parts of the trading process, starting from displaying pre-trade information and ending with settlement and risk management. Since trades done on the platform flow directly for settlement, members would benefit in terms of reduced operation cost and risk because of STP. Trades done on the system will be treated as confirmed and not be subject to the confirmation processes as existing in the present NDS environment.

(c) Trading Protocols

The trading system allows traders to set their preferences in terms of orders. The system allows traders to enter either price based orders (market orders, limits orders) or time based orders (good till day orders and immediate or cancel orders). Traders can also set the quantity to be disclosed to the market in case of large trades which ensures better pricing for them.

(d) Scalable

The system will facilitate trading by members on behalf of their constituents. The system will also be scalable in terms of addition of new instruments and also additional of new user groups like corporate and retail investors. For instance going forward corporate and retail investors could be allowed to place their orders through web-based interfaces which will then be routed to the order book of the system. This will lead to deepening of the market as also better pricing for such class of investors.

(e) Audit Trails

The system provides a precise audit trail of transaction especially in light of the extant guidelines of sale of government securities and DvP III mode of settlement. This would facilitate electronic supervision and surveillance of the market.

(f) Market Making

The system would facilitate the operiationalisation of market making in right earnest. For instance PDs could be committed to quoting two-way prices in an instrument, either continuously or for certain periods within the day, within a predefined bid-ask spread and minimum trade size. It is expected that such market-making efforts will enable smooth price adjustment and ensure a certain degree of liquidity in all market conditions. MTS (Mercato Telematico dei titoli di Stato) markets are an example of inter-dealer electronic markets for fixed income *instruments, whose distinguishing feature is the presence of strict market making obligations for some participants. Besides having to comply with stringent capital requirements and trading protocols, market-makers have the obligation to continuously post firm two-way prices for a selected subset of securities. Prices usually have to be posted for at least five hours per day and for a certain minimum quantity, and can be subject to maximum spread obligations. Each market-maker can voluntarily quote other securities as well, facing in this case no constraint on price proposals.*

Source: K. Biju, *Rakshitra*, September 2005

5.3.2 DvP

The accepted method for settlement of trades in the secondary market is known as **"delivery versus payment" (DvP)**: literally, simultaneous transfer of the security by the seller to the buyer and payment of the price by the buyer to the seller—or, at least, creating a strong linkage between the two. When delivery and payments are simultaneous, neither the seller nor the buyer is exposed to the risk of default by the counterparty. In most major bond markets, the settlement systems are administered by specialized clearing companies. In India, the function is performed by the Clearing Corporation of India Ltd. as far as trades between CCIL's members are concerned: these include all the banks and primary dealers.

There are three variations of the DvP system in different markets. The principal features of the three are as under:

(a) DvP I: DvP I involves **simultaneous exchange of a security and payment therefor**, separately for each trade, even if there are more than one trade between the same counterparties and involving the same security. Under DvPI, no settlement or payment would occur if the seller does not have adequate holdings of the security to be delivered or the buyer does not have enough funds. Since each trade is settled separately, i.e. on a gross basis, DvPI requires participants to keep large holdings and funds in their accounts to avoid default, but the advantage is that there are no counterparty risks or exposures.

(b) DvP II: Gross, i.e. **individual delivery/transfer of securities** under each trade, **followed, in batches, by net settlement of funds**. Under this system, securities are transferred before funds and, in the meantime, the seller is exposed to the risk of the payment not coming. On the other hand, fund settlement is done on a net basis. This means that, if a particular participant has done say four sales and five purchases of various securities in a given settlement period, fund settlement would represent only the net amount due or payable for all the trades taken together. Such settlement of funds occurs at least once a day or, more generally, several times a day at specified hours. This system reduces the need for participants' funds earmarked for securities transactions. But, in the absence of other safeguards, it does lead to counterparty exposures and risks.

(c) DvP III: This system involves **simultaneous net settlement (or transfer) of both securities and funds**. Such settlements occur at least once a day, sometimes several fixed times during a day, and that too on a multilateral netting basis—in other words, each participant would have a single receipt or delivery as the case may be, of a security, and also a single receipt or payment of funds.

Before the advent of CCIL (see below), the system in the Indian market was similar to DvP I, where every trade was individually settled bilaterally by the market participants. With the inception of CCIL, DvP II was introduced in February 2002. Since April 2004, DvP III has been implemented in the Indian market, but with a single daily settlement. This is expected to continue even after CCIL starts participating in the real time gross settlement (RTGS) system, already functioning in India.

5.3.2.1 Settlement Dates

Another point to note is the **effective date,** or **value date, for settlement of a trade**. The systems are known as "T+0" (settlement on the same day as the trade date), "T+1" (settlement one working day after the trade date), etc. Sometimes, there are longer gaps between trade and settlement dates. In earlier years, a large majority of the transactions in the Indian market used to take place on "T+0" basis. Currently, most trades take place on "T+1" basis.

5.3.3 The Role of CCIL

CCIL was incorporated in April 2001 to create an infrastructure for efficient settlement of trades in the money, securities and forex markets. In effect, CCIL steps in between the buyer and the seller and guarantees settlements to the counterparty. CCIL has been promoted and owned by commercial banks and other financial intermediaries, and primary dealers. As far as the secondary market in government securities is concerned, CCIL settles all trades reported on the Negotiated Dealing System (NDS). **CCIL-settled trades currently comprise almost 94%, of the total,** most of the balance representing transactions where RBI is a counterparty. CCIL settles outright as well as repo transactions.

In the money market, CCIL has developed and introduced a product called "Collateralised Borrowing and Lending Obligation" (CBLO) (see paragraph 2.2). While only participants in the RBI's Negotiated Dealing System (NDS) are currently eligible for the securities settlement segment of CCIL's operations, the CBLO facility is available for non NDS members as well. CCIL makes a small charge for the service it performs.

As stated above, **CCIL guarantees the settlement of all trades** eligible to participate in its securities segment, thus eliminating counterparty risks. In effect, CCIL becomes the counterparty for both the buyer and the seller. CCIL manages the counterparty risk through a Settlement Guarantee Fund (SGF) maintained by each participant with CCIL. The **contributions to SGF are, in effect, margins deposited by participants** as security for their obligations. Margins can be paid in the form of either cash or specified G-Secs and/or T-bills. The margin amounts are calculated on the basis of the securities involved and value dates for settlement, and participants are expected to maintain adequate balance in the SGF to cover the risk on the unsettled trade exposures.

To get a better idea of the risks, consider that a seller does not have adequate balance in the SGL account to effect the contracted delivery. Since CCIL has guaranteed the trade, it will have to purchase the security in the market from another holder for the purposes of delivery. While, in such an eventuality, the funds received from the buyer will not be transferred to the seller, there is still a price risk in that the price of the security may have gone up from the traded price. It is to cover this risk that margins are collected in the SGF.

Instead of buying the security in the market when the seller fails to deliver it, CCIL has also been allowed to "borrow" it from specified security lenders, to effect the delivery (see paragraph 5.3.3.1).

The other risk CCIL takes on is that the buyer may not have adequate funds in his account to pay for the security he has purchased. In that case, since the seller has not defaulted in his delivery obligations, CCIL will have to pay him from its own resources. It will not transfer the security to the buyer and could sell it in the market, if required, to recover its funds paid to the seller. Here again, there is a price risk to CCIL as the price of the security may have fallen from the price in the defaulted trade. The margin in the SGF is needed to meet such shortfalls. It would also be evident that, in the event of failure of the buyer to pay, CCIL would need to make funding arrangement to pay the seller. For this purpose, CCIL has arranged various lines of credit.

5.3.3.1 Securities Borrowing and Lending

While the practice of lending and borrowing securities is not generally prevalent in India, it is quite common in major markets, particularly for effecting deliveries of securities sold short (see paragraph 5.5 below).

In such transactions, the lender:

- has the right to have the lent security replaced as per the terms of the lending agreement;
- receives payments reflecting any coupons, interest or other rights that may arise during the pendency of the lending transaction;
- receives a fee for lending the security;
- may require collateral from the borrower in the form of cash or other securities (generally, the value of the collateral will be higher than the value of the securities lent); and
- retains the price risk on the security.

The borrower pays the fee, is bound to replace the security, and uses the borrowed security to effect delivery of securities which he may not be owning, but is committed to delivering.

5.4 Trading Volumes and Market Liquidity

Compared to an earlier era, secondary market trading volumes have risen in recent years. Much of this trading is in a small number of G-Secs and T-bills. The largest share of trading is accounted for by primary dealers. Trading volumes of private and foreign banks are comparable to those of public sector banks although, in asset size, the PSBs are far larger than the other segments.

One other feature of the secondary market trading is that much of the activity is confined to a few securities. For instance, in March 2006, only two securities recorded more than a thousand trades, and only five securities were traded on twenty days or more during the month. Less than ten of the more than hundred outstanding central government securities, recorded average daily trading volume in excess of Rs 100 crore in 2005-06. In general, the half a dozen or so liquid securities account for as much as 80% of the market turnover. The liquid securities also keep changing, with some dropping out of the category and others joining in. The question of secondary market liquidity is of importance for measurement of the price risk on portfolios of debt securities, as we shall see in Chapter 16.

If there is selective liquidity in G-Secs, in general, state government securities are traded even less frequently. The secondary market in corporate bonds is also quite illiquid, except for a few AAA issuers. The Patil Committee estimated secondary market volumes in corporate bonds at about Rs 40,000 crore each in 2003-04 and 2004-05.

5.5 Short-selling of Securities

In February 2006, a beginning was made in short selling of securities when the Reserve Bank permitted banks and primary dealers to undertake outright sale of dated securities that they do not own, subject to the short sale being covered by an outright purchase later in the day. Maintenance of short positions for an extended period of 5 trading days has since been permitted. This will involve the short seller to borrow the security to be delivered, through the repo market.

Chapter 6

Interest Rate Derivatives

6.1 Introduction

The last three decades have witnessed a phenomenal growth in financial derivatives. As the name signifies, these are **instruments whose value is based on, or derived from, the prices of currencies, interest rates (i.e. bonds), shares and share indices, commodities, etc.** To be sure, derivatives have been a part of the market place since a long time. The Babylonians used them in agriculture produce markets and, in the seventeenth century, options and futures were a dominant part of the trading in the Amsterdam Stock Exchange. By the next century, Osaka boasted of a well-organised futures market in rice. Commodity futures exchanges have functioned in the U.S. for much of the 20^{th} century. Exchange traded financial derivatives however are a more recent phenomenon.

6.1.1 Forwards and Options

While financial derivatives are structured in a bewildering variety of ways, in substance there are only two elementary instruments:

- forwards; and
- options

The former create a right and an obligation to exchange cash flows on a predetermined future date(s), on the basis agreed now. **The latter confer on the buyer of the option contract the right** to exchange cash flows at a future date, on the basis agreed now—**but it creates no obligation** on the buyer to go ahead with the exchange. All the derivative mechanisms fall in one of the two categories, or a combination thereof. For example, forward contracts on exchange or interest rates, currency and interest rate futures, interest and currency swaps, all are part of the family of forwards. Similarly, caps and collars, range/participating forwards, currency options, etc. are part of the options family.

A few other types of financial derivatives are worth taking note of. Derivative contracts where the **underlying is in one currency, but the settlement is in another currency** at a fixed rate of exchange, **are referred to as quantos**. For example, the Chicago Mercantile Exchange trades a futures contract on the Nikkie index (which is calculated in yen), providing for settlement at USD 5.00 for every 0.01 change in the value of the Index. In other words, under such a contract, while the trader is taking a position on the Index, he does not need to worry about the USD: JPY exchange rate. Similarly, under quanto options, while the strike and the underlying are denominated in a foreign currency, the intrinsic value is converted to the domestic currency for settlement purposes at a fixed exchange rate. Differential swaps (exchanging USD LIBOR for GBP LIBOR –0.5) are also often quanto swaps.

6.1.2 Using Derivatives

Financial intermediaries use derivatives for various purposes as follows:

(a) Asset: Liability or balance sheet management. Maturity gaps between assets and liabilities create an interest rate risk. Interest rate derivatives can be used to hedge the risk.

(b) Management of price risk. Banks, primary dealers and other financial intermediaries are required to mark-to-market certain categories of investments, including in debt securities. Derivatives can be used to hedge such price risks.

(c) As a service to customers. Banks offer derivative contracts to their corporate customers for managing the latter's exposure to the interest rate fluctuation risk and also for reducing cost by taking a view on the likely movements in interest rates.

(d) Trading, banks and other financial intermediaries often run trading books in derivatives as a profit centre.

In short, derivative contracts are designed to transfer price risk from one party to another. They can also be used to take complex, highly leveraged speculative bets on price movements.

6.1.3 Transactions in Derivatives

Derivative contracts are entered into, or traded, either over-the-counter or on exchanges. The differences between the two types of trading may be summarized as follows:

(a) **OTC or over-the-counter market.** In such a market, trades are contracted and prices agreed bilaterally, i.e. between a pair of one seller and one buyer, either directly or through the intermediation of brokers. Communication between the parties is typically through a telephone, although electronic communication systems are also being increasingly used in the OTC market. There are two major weaknesses to OTC trading:

   (i) It leads to counterparty credit risk in the event of the failure of either of the contracting parties, before maturity of the transaction. If the market price has moved against the solvent party, a loss can result.

   (ii) For obvious reasons, there is no single, transparent market price for the contract at a given point of time since two simultaneous trades can, and do, get transacted at different prices, sometimes even when one contracting party is common to both the trades.

(b) **Exchange traded.** The other way of transacting trades is through an exchange. Exchanges traditionally were following the so-called "open outcry" system of doing trades on the floor or pit of the exchange. "Open outcry" trading is often noisy, involves shouting and/or use of arcane hand signals by traders to conclude trades, and requires large trading floors. Increasingly, the open outcry system is being supplemented and, indeed, supplanted by electronic trading. In the latter case, prices are displayed on terminals installed in the offices of the members of the exchange, and they undertake trading through the exchange's computer system. Electronic trading has significant advantages over the open outcry system—it is cheaper, more convenient and efficient. Therefore, most of exchange trading all over the world is now moving towards electronic trading platforms.

A corollary of exchange trading is the existence of clearing and settlement facilities, generally through a separate system/company. The clearing and settlement systems use margins recovered from counterparties and eliminate the counterparty risks: in effect the clearing company steps in between the buyer and the seller, becoming the counterparty to both sides of a contract.

Trading on exchanges eliminates the one-to-one limitation of the OTC market, and there is a single, transparent price of an instrument at a given point of time.

6.1.4 Volumes

Globally, in recent years, banks have increased their exposure to derivative instruments at a very fast rate (see Tables 6.1 and 6.2).

The biggest commercial and investment banks with excellent credit ratings are the primary players in the market. For example, a few years back just the seven largest players in the United States accounted for as much as 90% of the total exposures of American banks to derivatives.

The explosive growth in derivatives has been the result of both intense competition amongst major international banks as their traditional role of financial intermediaries got eroded, and new avenues of profitability had to be explored, and the need of the corporate world, indeed the whole "real" economy, to hedge exposures in volatile markets.

6.2 Derivatives in India

The present status of derivatives markets in India is summarised hereunder:

(a) **Equity derivatives** of both the futures and options varieties, and on recognised indices as well as individual stocks, are being traded over NSE and BSE for the last several years.

(b) There are also exchanges trading **commodity derivatives**. These cover commodities like pepper, castor seed, turmeric, cotton, sugar, etc.

(c) **Interest rate derivatives** were introduced in the over-the-counter (OTC) market in mid-1999. Over the following five years, the notional principal of outstanding interest rate derivatives had grown to Rs 600,000 crore. Transactions are predominantly in overnight MIBOR (i.e. the Mumbai Interbank Offered Rate in the call money market), INBMK and MIFOR (see paragraph 6.3.1 below) swaps. Exchange trading of interest rate futures contracts commenced on BSE and NSE in mid-2003, but the market is not active.

(d) There is an active OTC market in **INR: USD options and long-term USD: INR swaps**.

(e) Asset or mortgage backed securities (ABS/MBS) also derive value from the portfolio of underlying assets/mortgages and are also

Table 6.1 Amounts Outstanding of Over the Counter (OTC) Derivatives by Risk Category and Instrument

(In billions of US dollars)

Risk Category/Instrument	Notional Amounts Outstanding					Gross Market Values				
	Dec 2003	Jun 2004	Dec 2004	Jun 2005	Dec 2005	Dec 2003	Jun 2004	Dec 2004	Jun 2005	Dec 2005
Total contracts	**197,167**	**220,058**	**251499**	**271,282**	**284,819**	**6,987**	**6,395**	**9,244**	**10,417**	**9,139**
Foreign exchange contracts	**24,475**	**26,997**	**29,289**	**31,081**	**31,609**	**1,301**	**867**	**1,546**	**1,141**	**998**
Forwards and forex swaps	12,387	13,926	14,951	15,801	15,915	607	308	643	464	407
Currency swaps	6,371	7,033	8,233	8,236	8,501	557	442	745	549	452
Options	5,717	6,038	6,115	7,045	7,193	136	116	158	129	139
Interest rate contracts	**141,991**	**164,626**	**190,502**	**204,795**	**215,237**	**4,328**	**3,951**	**5,417**	**6,699**	**5,463**
Forward rate agreements	10,769	13,144	12,789	13,973	14,483	19	29	22	31	29
Interest rate swaps	111,209	127,570	150,631	163,749	172,869	3,918	3,562	4,903	6,077	4,864
Options	20,012	23,912	27,082	27,072	27,885	391	360	492	592	570
Equity-linked contracts	**3,787**	**4,521**	**4,385**	**4,551**	**5,057**	**274**	**294**	**498**	**382**	**560**
Forwards and swaps	601	691	756	1,086	1,111	57	63	76	88	105
Options	3,186	3,829	3,629	3,464	3,946	217	231	422	294	455
Commodity contracts	**1,406**	**1,270**	**1,443**	**2,940**	**3,608**	**128**	**166**	**169**	**376**	**523**
Gold	344	318	369	288	334	39	45	32	24	51
Other commodities	1,062	952	1,074	2,652	3,273	88	121	137	351	472
Forwards and swaps	420	503	558	1,748	2,319					
Options	642	449	516	904	955					
Other	**25,508**	**22,644**	**25,879**	**27,915**	**29,308**	**957**	**1,116**	**1,613**	**1,818**	**1,595**
Memorandum item:										
Gross Credit Exposure						1,969	1,478	2,075	1,897	2,003

Source: BIS (Quarterly Review, September 2006)

Table 6.2 Derivative Financial Instruments Traded on Organised Exchanges by Instrument and Location

(Notional principal in billions of US dollars)

Instruments/Counterparty	Notional Amounts Outstanding					Gross Market Values				
	Dec 2003	Jun 2004	Dec 2004	Jun 2005	Dec 2005	Dec 2003	Jun 2004	Dec 2004	Jun 2005	Dec 2005
Total contracts	**141,991**	**164,626**	**190,502**	**204,795**	**215,237**	**4,328**	**3,951**	**5,417**	**6,699**	**5,463**
Reporting dealers	63,579	72,550	85,258	87,049	90,984	1,872	1,606	2,155	2,598	2,066
Other financial institutions	57,564	70,219	85,729	92,092	99,162	1,768	1,707	2,631	3,265	2,719
Non-financial customers	20,847	21,857	22,516	25,655	25,092	687	638	631	837	677
Forward rate agreements	**10,769**	**13,144**	**12,789**	**13,973**	**14,483**	**19**	**29**	**22**	**31**	**29**
Reporting dealers	5,344	6,851	6,502	7,150	7,648	7	10	7	9	6
Other financial institutions	4,790	5,360	5,478	5,993	6,313	10	13	12	18	21
Non-financial customers	636	933	808	831	522	3	6	3	4	2
Swaps	**111,209**	**127,570**	**150,631**	**163,749**	**172,869**	**3,918**	**3,562**	**4,903**	**6,077**	**4,864**
Reporting dealers	49,648	56,422	64,669	67,994	70,657	1,689	1,435	1,898	2,290	1,771
Other financial institutions	45,194	54,870	68,888	75,378	81,160	1,627	1,570	2,435	3,022	2,473
Non-financial customers	16,367	16,279	17,074	20,377	21,051	602	557	596	764	619
Options	**20,012**	**23,912**	**27,082**	**27,072**	**27,885**	**391**	**360**	**492**	**592**	**570**
Reporting dealers	8,587	9,277	11,086	11,905	12,678	177	161	249	298	288
Other financial institutions	7,581	9,990	11,363	10,721	11,689	132	124	184	224	226
Non-financial customers	3,844	4,645	4,634	4,447	3,518	82	76	59	69	56

Source: BIS (Quarterly Review, September 2006) derivatives, but of a different nature than forwards or options. ABS/MBS issues have taken place in India since 1992.

Legislation to strengthen the legal framework underlying derivative instruments like swaps, FRAs and also asset/mortgage backed securities is expected shortly.

6.2.1 Interest Rate Derivatives

In this book, we are concerned primarily with interest rate derivatives of the forward family—at present, there are no INR interest rate options in the Indian market. There has been a sharp increase in the volumes of rupee interest rate derivatives. Since their introduction in 1999, the market has been growing in terms of both the number of outstanding contracts (forward rate agreements and interest rate swaps), and their notional principal.

Outstanding contracts rose from 13,960, with a notional principal of Rs 372,896 crore in April 2004, to 37,864 contracts with a notional principal of Rs 10,62,242 crore in March 2005. By mid 2005-06, the number of outstanding contracts had grown further to 59,285, with a notional principal of Rs 13,42,335 crore.

The daily turnover in the INR interest rate derivatives market is of the order of Rs 2,000 crore. Exchange traded interest rate derivatives were introduced in India in mid-2003 but trading volumes have been minimal. One feature of the interest rate derivatives market in India is the use of FX market prices as benchmarks for INR derivatives; in effect, these are a type of quanto swaps.

6.2.2 Products

Forward rate agreements (FRAs) and interest rate swaps were introduced in the INR market in India in 1999, based on the guidelines circulated by RBI (Circular dated July 7, 1999). The guidelines define the products as follows:

A. A Forward Rate Agreement (FRA) is a financial contract between two parties to exchange interest payments for a 'notional principal' amount on settlement date, for a specified period from start date to maturity date. Accordingly, on the settlement date, cash payments based on contract (fixed) and the settlement rate, are made by the parties to one another. The settlement rate is the agreed benchmark/reference rate prevailing on the settlement date.

B. An Interest Rate Swap (IRS) is a financial contract between two parties exchanging or swapping a stream of interest payments for a ‘notional principal’ amount on multiple occasions during a specified period. Such contracts generally involve exchange of a ‘fixed to floating’ or ‘floating to floating’ rates of interest. Accordingly, on each payment date—that occurs during the swap period—cash payments based on fixed/floating and floating rates, are made by the parties to one another.

In the interest rate derivatives market, it is customary to refer to the fixed rate payer as the buyer of the contract and the counterparty as the seller.

6.3 Interest Rate Swaps

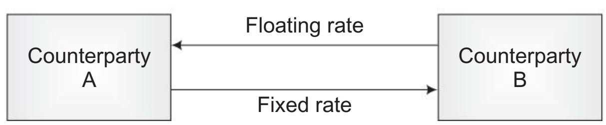
A swap has been defined as “**a financial transaction in which two counterparties agree to exchange streams of payments, or cash flows, over time” on the basis agreed at the inception** of the contract. From the definition itself, it is evident that a swap is like a series of forward contracts. Under a forward exchange contract, for example, counterparties agree to exchange “x” units of one currency for “y” units of the other.

Under an interest rate swap, interest payment streams of differing character, **on an agreed, or notional**, principal, are periodically exchanged. There are two main types:

(a) Coupon swaps: fixed for floating rates; and

(b) Basis, or floating to floating, swaps: the exchange of one benchmark for another (e.g. CP for T-bill rate)

Diagrammatically,



In the INR market, one has not come across many floating to floating (i.e. basis) swaps.

Conceptually, cash flows under an interest rate swap—say, pay floating rate, receive fixed—is similar to issuing a floating rate bond, which involves payment of interest at floating rate, and using the proceeds to invest in a fixed rate bond, from which periodical receipts of fixed interest rate will be received.

6.3.1 Floating Rate Benchmarks

The RBI has not prescribed any benchmark. As the abovereferred circular says, "*The benchmark rate should necessarily evolve on its own in the market and require market acceptance. The parties are therefore, free to use any domestic money or debt market rate as benchmark rate for entering into FRAs/IRS, provided methodology of computing the rate is objective, transparent and mutually acceptable to counterparties*".

The more popular floating rate benchmarks in the Indian market are as follows:

(a) **Overnight MIBOR**: This is the interbank rate for placement of overnight funds with other banks.

(b) **MITOR**: This is the theoretical or notional rate at which rupee funds could be generated by using foreign currency funds. In theory, dollars can be sold value today to generate rupees, and re-purchased for tomorrow delivery, to eliminate the exchange risk. The cost of such rupee funds is a combination of the foregone interest on dollar funds, and the difference between the prices of selling dollars today and simultaneously buying them back for tomorrow's delivery.

(c) **MIFOR**: Conceptually, the MIFOR rate is similar to the MITOR rate in that it involves borrowing 1/3/6 month dollar funds at LIBOR; selling them for rupees; and simultaneously buying them back in the forward foreign exchange market for repaying the dollar borrowing. The total cost of the rupees so generated is the dollar LIBOR and the difference between the exchange rates for selling dollars and buying them back.

(d) **MIOIS**: This is like the term interbank rate, and technically the fixed rate at which overnight MIBOR could be swapped for designated, relatively short maturities (14 days, 1-month, 3 months, etc.).

(e) **INR-BMK**: In effect, this is the one year yield in the government securities market.

Other floating rate benchmarks like the CP and the T bill rates are also used, but are not widely traded. A couple of other points need to be noted about the various floating rate benchmarks, and the periodicity of exchange of cash flows. As will be readily appreciated, none of these floating rates would be constant through the day. The overnight MIBOR, for instance, will keep changing through the day; so will the other variables underlying the different floating rates described above. Therefore, **for the purpose of their use as floating rate benchmarks** in the swap market, **FIMMDA has defined them**, and it is the benchmarks so defined that are used for arriving at the amounts to be exchanged under the swaps.

There are similar conventions and rules about the periodicity of exchange of cash flows. Generally, this corresponds to the periodicity at which the floating rate is re-fixed. However, as for MIBOR and MITOR swaps, the daily floating rate is compounded so that exchanges of cash flows take place only at periodical intervals.

In practice, only the difference between the amounts to be received and paid is settled/paid by the net payer.

We describe the MIBOR and MIFOR swaps in some detail in paragraphs 6.3.3 and 6.3.4 below. The exact definitions etc. of all the standard benchmarks and their calculations are given in FIMMDA's Handbook of Market Practices, January 2003. The relevant chapter is annexed.

6.3.2 Swaps and their Users

RBI has allowed that "*Scheduled commercial banks (excluding Regional Rural Banks), primary dealers (PDs) and all-India financial institutions (FIs) are free to undertake FRAs/IRS as a product for their own balance sheet management or for market making. Banks/FIs/PDs can also offer these products to corporates for hedging their (corporates) own balance sheet exposures.*"

Banks active in the INR swap market not only use these instruments for **hedging interest rate risks and managing gaps** in assets and liabilities, **but also for trading**. In fact, the maximum number of transactions are for trading purposes. Of all the above interest rate swaps, the two most liquid contracts are the overnight indexed swap based on the MIBOR, and the MIFOR swap. The third most important contract is the so-called INRBMK swap. The principal users of the third contract are banks, for the purpose of hedging the gaps in the balance sheets. It has also been used as the floating rate benchmark in some corporate bond issues.

Corporate end-users also use swaps but as per the RBI circular, should do so "for hedging their own balance sheet exposures".

It will be worth looking at some specific, illustrative uses of interest rate swaps:

(a) a bank may issue a CD and place funds in MIBOR-linked paper. It may like to use the MIBOR OIS swap (receive fixed, pay floating) to hedge the interest rate risk and lock into the margin.

(b) MIFOR swap is a contract unique to the Indian market, and its use is discussed in some detail in paragraph 6.3.4 below.

(c) a bank which has surplus assets in the 5-year time bucket and excess liabilities in the one year time bucket, may like to consider entering into an INR BMK swap—pay 5 years fixed, receive one year floating— to hedge the gap.

6.3.3 MIBOR-OIS Swap

While this is one of the two most liquid swaps in the market, and often referred to as either MIBOR Swap or OIS, a couple of points should be noted:

(a) MIBOR refers to Mumbai inter-bank offered rate—for overnight, 14 days, one month and three months. All these rates are published by FIMMDA and NSE (see Table 6.3). However, the latter three markets are not very liquid and the overnight MIBOR as at 9.40 a.m. is the benchmark for most of the swaps.

Table 6.3

FIMMDA-NSE MIBID/MIBOR as on 25 May, 2006					
Category	**Time**	**Rate**	**MIBID standard deviation**	**Rate**	**MIBOR standard deviation**
Overnight	9:40 a.m.	5.50	0.00290	5.60	0.0012
14 Days	11:30 a.m.	5.79	0.12740	6.09	0.0667
1 Month	11:30 a.m.	6.00	0.10800	6.37	0.0579
3 Months	11:30 a.m.	6.38	0.12870	6.84	0.0755

(b) To avoid exchange of the difference between the MIBOR and the fixed rate every day, the principal amount is compounded at the MIBOR ruling on every business day. Where there is a gap, because of Sunday, holiday, etc. in MIBOR fixation, for that period the preceding day's MIBOR is not compounded but multiplied by the number of days till refixation, i.e. the next working day. This practice parallels what actually happens in the interbank market when there are intervening holidays.

The following extract from the FIMMDA Handbook will clarify the calculation.

Formula for Calculation of the Floating Rate

"INR-MIBOR-OIS-COMPOUND" will be calculated as follows, and the resulting percentage will be rounded in accordance with method set forth in Section 8.1(a) of the 2000 ISDA Definitions, but to the nearest one ten-thousandth of a percentage point (0.0001%)

$$\left[\prod_{i=1}^{d_0}\left(1+\frac{R_i \times n_i}{365}\right)-1\right]\times\frac{365}{d}$$

where:

"d_o", for any Calculation Period, is the number of Business Days in the relevant Calculation Period;

"i" is a series of whole numbers from one to d_0, each representing the relevant Business Days in chronological order from, and including, the first Business Day in the relevant Calculation Period;

"n_i" is the number of calendar days in the relevant Calculation Period on which the rate is R_i;

"d" is the number of calendar days in the relevant Calculation Period; and

"R_i", for any Business Day "i" in the relevant Calculation Period means:

(a) the Mumbai Inter-Bank Offered Rate (as published jointly by Fixed Income Money Market and Derivatives Association of India (FIMMDA) and the National Stock Exchange of India (NSE)) for a period of the Designated Maturity which appears under the heading "MIBOR" on Reuters Screen "MIBR=NS" as of 9:40 a.m. India Standard Time on that Business Day.

(b) The same rate can also be picked up from the NSE website or from the Benchmarks Menu on the Home Page of FIMMDA (www.fimmda.org).

A specimen of the interest computation methodology is given below:

- ***Interest computation methodology:*** *The computation of the interest on the fixed leg would be done assuming that the fixed rate quoted is a nominal rate. The floating rate, if it is an overnight rate, would be compounded every Mumbai business day. This implies that the floating rate interest would be compounded on a daily basis except when there is a holiday. In case of a holiday, the interest would be computed on simple interest basis for the holiday and the preceding Mumbai business day. This is best illustrated by means of an example.*

  Example—One week swap:

  Bank A is a fixed rate receiver for Rs 10 crore, tenor one week at 5% and Bank B is a floating rate receiver.

  The overnight call money rates (FIMMDA-NSE-MIBOR rate) on the 7 days are as per the table below:

  On Day 8 Bank B should pay Bank A interest of Rs 95,890 (10,00,00,000 × 5% × 7/365) and Bank A needs to pay bank B interest of Rs 108,265 as per the calculation shown:

Day	NSE Mid Rate Floating Index %	Notional Principal Amount (NPA) Rs	Floating Rate Interest Rs	NPA + Compounded Interest @ MIBOR Rates Rs	NPA+ Simple Interest @ Fixed Rate Rs
Day 1	6.50	100,000,000	17,808		
Day 2	5.00	100,017,808	13,701		
Day 3	3.00	100,031,509	8,222		
Day 4	5.00	100,039,731	13,704		
Day 5 & 6 (Sat & Sun)	7.00	100,053,435	38,377		
Day 7	6.00	100,091,812	16,453	100,108,265	100,095,890

They will settle the difference of Rs 98,890 and Rs 108,265 i.e. Bank A will pay Rs 12,375 to Bank B.

6.3.4 MIFOR Swap Market

The MIFOR swap market was born as a **proxy for the term interbank market**. (However, most actual market transactions seem to be for trading purposes, no actual money being lent or borrowed in the INR market at MIFOR.) This was needed because the term interbank market is not very liquid. MIFOR is the sum, in percentage p.a. terms, of the USD LIBOR and the forward margin on the US dollar in the Indian forex market (see below for a more technical definition). This acts as a proxy for cost of raising term INR funds as, in theory, a bank could

(a) borrow USD internationally at LIBOR;
(b) sell the amount borrowed at the ruling spot rate; and
(c) buy USD (plus the interest on dollars borrowed) in the domestic forward market, for repaying the dollar loan, thereby eliminating the exchange risk.

This is a fully hedged transaction and the cost of rupees generated at (b) is USD LIBOR plus the forward premium.

It should however be noted that the forward foreign exchange market in India is not liquid beyond one year, nor does interest parity with the forward margin prevail always. (The forward margin is often a function of demand-supply.)

The MIFOR swap market, which exchanges rupee interest flows but with the floating rate benchmark based on forex market variables, is perhaps unique to India. To quote from the FIMMDA Handbook,

"INR-MIFOR

"INR-MIFOR" means that the rate for a Reset Date will be the Mumbai Inter-Bank Forward Offered Rate for a period of the Designated Maturity which appears on Reuters Screen "MIFOR=" as of 16:30 p.m. India Standard Time on the day that is two Mumbai Business Days preceding that Reset Date or from the Benchmarks Menu from the Home Page of FIMMDA (www.fimmda.org).

If such rate does not appear on the Reuters Screen "MIFOR=" prior to 17:30 p.m. India Standard Time on such date, the rate for that Reset Date will be determined as if the parties had specified "INR-Reference Banks" as the applicable Floating Rate Option. In such case the Calculation Agent will ask each of the Reference Banks to provide a quotation of their offered side of INR/USD forward points for the forward sale of INR against USD for settlement on the last day of a period equivalent to the Designated Maturity and commencing on the Reset Date and the forward points so determined by the Calculation Agent shall be the "Forward Points" for purposes of the following formula. The Calculation Agent will then determine the rate for that Reset Date by applying the following formula:

*Floating Rate = {[(Spot Rate + Forward Points) / Spot Rate * (1+ LIBOR * N1)] – 1} * N2*100*

where:

"Spot Rate" means the Reserve Bank of India's published USD/INR spot rate (expressed as a number of INR per one USD) which appears on Reuters Screen "RBIB" as of 13:00 p.m. India Standard Time on that Reset Date (if such rate is not available, the Calculation Agent will ask each of the Reference Banks to provide a quotation of such rate);

"LIBOR" means USD-LIBOR-BBA for a period of the Designated Maturity commencing on the Reset Date;

"N1" means the number of days in the Calculation Period divided by 360;

"N2" means 365 divided by the number of days in the Calculation Period."

In practice, the theoretical basis of **MIFOR as a proxy benchmark for term rupee funds, suffers from several technical weaknesses:**

- the timings of the three elements, BBA LIBOR, spot rate and forward margin are not uniform;
- it includes forward margin calculated on the principal amount only while, in theory, a fully hedged raising of rupee funds will require the USD interest also to be hedged;

- hardly any Indian bank can borrow term USD internationally, at LIBOR.

Nevertheless, the benchmark has been accepted by the market; in effect, the derivative market exists in the absence of an underlying.

6.3.4.1 Using MIFOR Swaps

For a proper understanding of MIFOR swaps, knowledge of foreign exchange is essential. The following discussion assumes that knowledge on the part of the reader.

In the Indian market, MIFOR swaps can be used to hedge long-term USD/INR currency swaps, even in the absence of a long-term forward exchange market. For example, consider that a bank wants to price and hedge a three-year maturity currency swap as follows:

(a) Pay USD LIBOR every six months, and USD principal at the end of three years; and

(b) Receive INR fixed rate every six months and INR principal at the end of three years, the amount being calculated at the spot exchange rate.

The steps would be

(c) Buy USD forward for six months;

(d) Enter into a MIFOR swap, receive six months floating, pay fixed for three years; and

(e) Rollover (c), five times, by undertaking sell buy exchange market swaps.

The premium on USD paid under (c) and the LIBOR to be paid to the swap counterparty will be received under 'd'. The fixed rate payment under (d) will be the base for quoting the INR fixed rate. There is a residual risk, namely, the USD: INR exchange risk on the LIBOR amount, which will be received in INR but will have to be paid out in USD.

Consider another example: you wish to price and hedge a three-year maturity, receive USD, pay INR principal only swap or a long-term forward contract of similar maturity. This could also be done by using the MIFOR swap market as follows:

The steps will be:

(f) Sell USD 6 months forward;

(g) Enter into a MIFOR swap: Pay 6 month floating, receive fixed;

(h) Enter into a USD IRS: Receive 6 months LIBOR, pay three-year fix;

(i) Rollover (f), 5 times.

It will be noted that the premium on USD received under (f) plus the LIBOR receipt under (h) together hedge the MIFOR payout under (g). The residual flows, both fixed, are

(i) Fixed rate INR receipt under (g); and

(ii) Fixed rate USD payment under (h).

The difference can be quoted as the premium on the swap. This structure also leaves a residual risk — namely the exchange risk on the USD amounts receivable/payable under the USD interest rate swap.

Both the structures have a "basis" risk in that the notional principal of the MIFOR swap will need to be rebalanced at the time of each rollover to the ruling rupee equivalent. This, as also the rupee cash flows at the time of each rollover and the interest thereon, imply that the MIFOR swap is not a perfect hedge but it works quite well in practice. For a better understanding of the pricing issues and the residual/basis risks, please refer to Chapter 12.

Corporates can also use MIFOR swaps to hedge LIBOR and premium risks on rollover forward contracts covering long term forex loans.

MIFOR swaps can be used only for **market making/trading** and with reference to **transactions having underlying forex exposures**, not as floating rate benchmarks in pure INR swaps.

6.3.5 Market Quotations

The fact that only the OIS and MIFOR swaps are liquid is also evidenced by the fact that these are the only two prices regularly quoted on the FIMMDA site. The quotes available on 25th May are incorporated in Table 6.4.

Table 6.4

FIMMDA-Reuters Prices as on 25 May, 2006			
MIOIS Rate			
Tenor Months	**Bid**	**Offer**	**Mid Rate**
2	5.68	5.78	5.73
3	5.82	5.88	5.85
6	5.97	6.05	6.01
12	6.23	6.25	6.24
24	6.33	6.35	6.34
36	6.53	6.55	6.54
60	6.84	6.86	6.85

MIFOR Rate

Period Months	Spot To	Paise Bid	Paise Offer	Percent Bid	Percent Offer	Imp Bid	Imp Offer
2	31-Jul-2006	2.50	3.50	0.32	0.45	5.56	5.69
3	30-Aug-2006	3.75	4.75	0.32	0.41	5.62	5.71
6	30-Nov-2006	12.50	13.50	0.54	0.58	5.95	5.99
12	30-May-2007	36.50	37.50	0.80	0.82	6.32	6.34

MITOR Rate

Period1	Period2	Paise Bid	Paise Offer	Perc Bid	Perc Offer	Rate Bid	Rate Offer
22-Dec-2004	23-Dec-2004	0.45	0.50	3.75	4.17	6.04	6.46

MIOCS Rate

Tenor Years	Bid	Offer
3	6.37	6.42
5	6.51	6.56
7	6.56	6.68
10	6.62	6.76

As for the MIOIS quotation in the above table, it will be noticed that the prices are for various tenors from two months to sixty months: these can be looked upon as the fixed rate quotations where the floating rate is the overnight MIBOR. They could also be used as floating rate benchmarks for longer term swaps. For example, a fixed rate payer would quote 6.23% fixed rate for 12 months against receipt of the 3 month MIOIS, which is currently 5.85 (the middle rate). Similarly, the fixed rate for the MIFOR swap is the same as the currency swap rate (MIOCS).

The FIMMDA site also quotes commercial paper and treasury bill benchmarks for various maturities.

6.4 Forward Rate Agreements

FRAs are forward contracts to exchange interest payments on a notional principal for a specified period to begin at a future date. One of the contracting parties will pay interest at the rate agreed now (the forward rate) while the counterparty will pay interest at the actual ruling rate for the benchmark, on

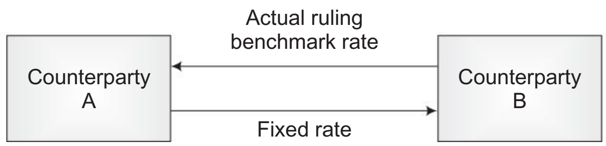
Table 6.5

Commercial Paper Benchmark as on 25-May-2006	
Tenor	**Benchmark**
30	6.1250
60	6.3250
90	6.5250
120	6.6500
150	6.7750
180	6.9000
210	7.0019
240	7.1038
270	7.2057
300	7.3076
330	7.4095
364	7.5250

Treasury Bill Benchmark as on 25-May-2006	
Tenor	**Benchmark**
7	5.4857
14	5.4981
30	5.5637
60	5.6186
90	5.6750
120	5.8189
150	5.9582
180	6.0901
210	6.1804
240	6.2357
270	6.2846
300	6.3146
330	6.3479
364	6.3800

the future date. The benchmark can be any INR interest rate like say the CP rate, T-bill rate, etc. Obviously, the benchmark needs to be clearly defined and acceptable.

Diagrammatically,



Since interest payments, as a rule, are made in arrears, i.e. at the end of the interest period, and as FRAs are settled at the beginning of the period, the amount to be exchanged on that day will be **the present value of the difference in the interest amounts to be exchanged.**

Relevant extracts from the FIMMDA Handbook of Market Practices, are appended

Chapter 8

Forward Rate Agreement

8.1 Definition

A Forward Rate Agreement (FRA) is a financial contract between two parties to exchange interest payments for a 'notional principal' amount on settlement date, for a specified period from start date to maturity date. Accordingly on the settlement date, cash payments based on contract (fixed) and the settlement rate, are made by the parties to one another. The settlement rate is the agreed benchmark/reference rate prevailing on the settlement date.

8.2 Features and Documentation

- *It is expected that the minimum notional principal amount for which market makers will stand committed to their two-way quote is Rs 25 crore.*
- *The FRA will follow the same day count convention as that applicable to the underlying benchmark (floating) rate.*
- *The rate fixing notices have to be exchanged between the counterparties.*
- *The Benchmark for the FRA can be any Indian Rupee interest rate benchmark. However the Benchmark should be clearly defined, widely disseminated and acceptable to the market.*
- *Unless otherwise stated the Modified Following Business Day convention will be followed for settlement.*
- *No fixng of rates and compounding of interest will be done on a Saturday.*
- *It is recommended that regardless of the center where the deal is transacted, the benchmark and the holiday calendar for the purposes of computation of interest streams be as that in Mumbai.*

8.3 Settlement

8.3.1 Interest computation methodology

The computation of the interest on the fixed leg would be done assuming that the fixed rate quoted is a nominal rate. Interest computation on the floating rate would be as per the convention used by the underlying benchmark.

8.3.2 The settlement of an FRA will be on the start date of the FRA

8.3.3 Example

Bank A and X Ltd. enters into a 3 × 6 FRA. X Ltd. pays FRA rate at 9.00 %. Bank A pays benchmark rate based on FIMMDA Moneyline Telerate 90 Day CP Benchmark.

Additional details:

Notional principal amount (NPA)	:	*Rs 1 crore*
FRA trade date	:	*January 3, 2002*
FRA start/settlement date	:	*April 3, 2002*
FRA maturity date	:	*July 3, 2002*
FRA fixing date	:	*April 2, 2002*

Assume, FIMMDA Moneyline Telerate 90 Day CP Benchmark on fixing date (April 2, 2002) is 8.50 %.

Cash flow calculations:

- *Interest payable by X Ltd.:*

$$\frac{\text{Rs. 1 crore (NPA)} \times 9.00 \text{ (rate)} \times 91 \text{ (no of days from April 3 to July 3, 2002)}}{365 \times 100}$$

  i.e. Rs 2,24,384/-

- *Interest payable by Bank A:*

$$\frac{\text{Rs. 1 crore} \times 8.50 \text{ (Benchmark rate)} \times 91 \text{ (same as above)}}{365 \times 100}$$

  i.e. Rs 2,11,918/-

- *Therefore, a net interest amount of Rs 12,466/- is receivable by Bank A on the maturity date i.e. July 3, 2002. However, the settlement of the amount is to be done on April 3, 2002 on the discounted value i.e.*

$$\frac{12{,}466}{\left\{1 + \frac{8.50 \times 91}{365 \times 100}\right\}}$$

  i.e. Rs 12,207/-

- *X Ltd. will pay to Bank A Rs 12,207/- on April 3, 2002.*

Note: *It may be noted that, the suggested FIMMDA guidelines are intended to bring in uniformity and standardization in the market and does not intend to restrict the freedom of the parties to bilaterally decide terms and conditions different than as suggested above.*

6.4.1 FRAs and Swaps

While an FRA involves a single exchange of interest payments, interest rate swaps involve a series of such exchanges. Therefore, **conceptually, an interest rate swap is similar to a series of FRAs on the same underlying floating rate** in its implications. There are two differences:

(a) As a rule, FRAs for different interest periods in the swap will be at different rates, while the fixed rate under an interest rate swap will be unchanged through its life.

(b) Interest exchanges under an FRA are settled at the beginning of the interest period, while those under a swap are settled at the end of each interest period.

In an efficient market, the prices in the FRA and swap markets with the same underlying benchmark and maturity, will be such that the exchanges, in present value terms, under a series of FRAs and an interest rate swap will be identical.

6.4.2 Bank's Exposures to Derivatives

There has been an explosive growth in the exposures of banks to derivatives, accompanied also by a change in the composition of the portfolio. As recently as March 2002, 80% of the banking system's portfolio of derivatives was accounted for by forward foreign exchange contracts; by March 2006, the proportion had fallen to 43%, with interest rate derivatives accounting for 54% of the portfolio. Again, the combined share of the top 15 banks has grown from 74% in March 2002 to 82% in March 2006; foreign banks accounted for 62% of the latter.

6.5 Interest Rate Futures in India

In June 2003, trading in the following interest futures contracts was initiated on the principal stock exchanges in Mumbai:

- A notional 6% coupon bearing government security with a 10-year (balance) maturity at the time the futures contract matures;

- A notional zero coupon government security with a 10-year (balance) maturity at the time the futures contract matures; and
- A notional treasury bill with a 91-day maturity at the time the futures contract matures.

There are, however, no transactions in the market because of various reasons. The most important reason is that banks are not allowed to trade the futures contracts. They can use it only for hedging.

6.6 Interest Rate Options

While **there are no interest rate options in the INR market at present**, these are likely to be introduced. This paragraph gives an introduction to the subject.

6.6.1 Definition

An option contract has been defined as an agreement between two parties in which one grants to the other the right to buy ("call" option) or sell ("put" option) an asset under specified conditions (price, time), and assumes the obligation to sell or buy it. The party who has the right, but not an obligation, is the buyer of the option, and pays a fee, or premium, to the "writer" or seller of the option. The "asset" could be a currency, bond, interest rate, share, commodity or a futures contract.

6.6.2 Common Terms

Some of the terms commonly used in the option market are as follow:

(a) Parties to an Option Contract

Writer or seller of the option	:	The party who has the obligation to buy/sell the asset underlying the contract, at the agreed price and time, if the option is exercised by the buyer of the option.
Buyer of the option	:	The party who has the right, but not the obligation, to sell/buy the asset underlying the contract, at the agreed price and time.

(b) Types of Option

Call option	:	The right, without the obligation, to buy an asset
Put option	:	The right, without the obligation, to sell an asset
American option	:	An option, which can be exercised at any time until the expiry date
European option	:	An option, which can be exercised only on expiry
Bermudan option	:	An option which is exercisable only during a predefined portion of its life.

(c) Expiry

Expiry	:	The last date on which the option may be exercised.
Expiration time	:	It is specified in the contract.

(d) Exercise, or Strike, Price

Exercise, or strike, price	:	The specified price at which the buyer of the contract can exercise his right to buy or sell the asset.
At-the-money (ATM)	:	An option with a strike price equal to the current price of the asset. In currency options, this can refer to the current spot rate (at-the-money-spot) or the forward rate ruling for the expiry date of the option (at-the-money-forward).
In-the-money (ITM)	:	The strike price is more favourable to the buyer of the option than the current market rate. The premium is, therefore, higher than for an at-the-money option.

Out-of-the-money (OTM)	:	The strike price is less favourable to the buyer than the current market exchange rate. Therefore, the premium is lower than for an at-the-money option.

(e) Value/Price of an option

Option premium	:	Fee or price paid by the buyer of the option to the seller of the option.
Value of an option	:	The market price of the option.
Intrinsic value	:	The difference between the strike price and the current market price, in the case of an "in-the-money", American style option. It is zero in the case of "at-the-money", or "out-of-the-money" American options, and all European options. In other words, intrinsic value is the profit available on immediate exercise of the option.
Time value	:	The difference between the option premium and the intrinsic value, reflecting the value arising from the time left until its expiry.

(f) Miscellaneous

Cash market	:	The market in the actual financial instrument on which an option contract is based

6.6.3 *Types of Interest Rate Options*

In interest rate options, three principal variations should be noted:

- Options on the price of a bond;
- Options on a specified interest rate, for example the term interbank rate;
- Options on a swap, or swaptions.

For the concepts underlying the pricing and hedging of options, please refer to Chapter 12.

6.7 Regulatory Requirements

As far as the swap and FRA markets are concerned, the Reserve Bank has put few restrictions on banks undertaking swap transactions whether for hedging or market making/trading purposes. On the other hand, while primary dealers have been allowed to trade in the futures market, banks can use futures only for hedging purposes.

The Reserve Bank has specified hedge effectiveness criteria for the banks as follows:

Guidelines on Exchange Traded Interest Rate Derivatives (for Banks) — June 3, 2003

(i) *Eligible underlying Securities: For the present, only the interest rate risk inherent in the government securities classified under the Available for Sale and Held for Trading categories will be allowed to be hedged. For this purpose, the portion of the Available for Sale and Held for Trading portfolio intended to be hedged must be identified and carved out for monitoring purposes.*

(ii) *Hedge Criteria: Interest Rate Derivative transactions undertaken on the exchanges shall be deemed as hedge transactions, if and only if,*

  (a) The hedge is clearly identified with the underlying government securities in the Available for Sale and Held for Trading categories.

  (b) The effectiveness of the hedge can be reliably measured

  (c) The hedge is assessed on an ongoing basis and is "highly effective" throughout the period.

(iii) *Hedge Effectiveness : The hedge will be deemed to be "highly effective" if at inception and throughout the life of the hedge, changes in the marked to market value of the hedged items with reference to the marked to market value at the time of the hedging are "almost fully offset" by the changes in the marked to market value of the hedging instrument and the actual results are within a range of 80% to 125%. If changes in the marked to market values are outside the 80%–125% range, then the hedge would not be deemed to be highly effective.*

At present, the investments held in the (a) AFS category are to be marked to market at quarterly or more frequent intervals (b) HFT category are to be marked to market at monthly or more frequent intervals. The hedged portion of the AFS/ HFT portfolio should be notionally marked to market, at least at monthly intervals, for evaluating the efficacy of the hedge transaction.

RBI has also laid down capital adequacy norms for the market and credit risks in the derivatives book: credit risks arise from counterparty exposures which participants in the swap market face. We discuss the conceptual framework underlying counterparty exposures in the following paragraph. The mathematical treatment and more advanced issues on pricing, hedging, risk management, accounting and disclosure norms are discussed later in the book.

6.8 Counterparty Exposures

Every over-the-counter derivative contract leads to a counterparty exposure. Consider the simple example of an OIS swap. In the event of a counterparty failure, the other (i.e. solvent) party can suffer two kinds of losses:

(a) For the net amount to be received under the swap, it could rank as an unsecured creditor and a loss could be incurred. On the other hand, if the contract is "in-the-money" for the counterparty, such amount may have to be paid;

(b) Again, it may need to re-enter into the swap with another counterparty at the currently ruling prices. If these are adverse compared to the original price, a loss may occur.

Hence the need for measurement of credit risks, a topic discussed in some detail in Chapter 12.

Counterparty credit risks are eliminated in trading of derivatives on exchanges, through the margining system (see Chapter 16).

6.9 Documentation

The standard agreement used by counterparties is the ISDA Master with some modifications for India.

The important provisions of the ISDA Master Agreement include:

- Netting of amounts payable on one day;
- Events of default and termination events;
- Payments on early termination;
- Governing law and jurisdiction;
- Definitions, etc.

Chapter 7

Market Practices and Data Sources

7.1 Introductory

It is essential for every participant in the debt market to be conversant with market practices and data sources. If practices are important for market operations, data sources and their analysis are at the heart of managing portfolios.

In this chapter, we discuss some of the important practices and data sources. The chapter also covers the topic of bond indices.

7.2 Market Practices

7.2.1 Clean and Dirty Prices

In common with other bond markets, the practice in India also is to quote the price of a coupon bond, net of interest accrued at the coupon rate from the last interest payment date to the trade settlement, or value, date of the transaction. This price is also referred to as **"clean" or "nominal" price**.

The full, or "dirty", price which is actually paid and received, is inclusive of the accrued interest.

7.2.2 Other Market Practices

Other market prices are detailed in FIMMDA's Handbook of Market Practices which is also available on its website. It includes an enunciation of general principles, market terminology, etc. There is a chapter on management control also: in this book, the topics of risk management and internal controls are discussed in Chapters 16 and 17. Similarly, the portion on interest rate swaps and forward rate agreements is covered in Chapters 6 and 12. It is proposed to cover here two issues: day count conventions in the money, bond and derivatives markets, and pricing of money market instruments like T-bills, CPs, etc. sold at a discount.

7.2.2.1 Bank Receipts

Sometimes, so-called 'bank receipts', BRs, are used in lieu of physical delivery of securities. The BR format and other regulations are given in the Indian Banks' Association circular of May 1991. Misuse of BRs was at the root of many of the wrong practices which resulted in the 'Securities Scam" of 1992 (see Chapter 17), and are hardly used now.

7.2.3 Day Count Conventions

Day count conventions are very important for the smooth functioning of the money and bond markets, and avoiding disputes between counterparties. It is the day count on which interest payments are based. The need for proper prescriptions arises from the fact that in actuality a year comprises 365 or 366 days (leap year). How should the "p.a." rate be converted for half year or other broken periods? The day count in a half year itself varies from say 181 to 185 days. Should interest be based on half the annual rate, or on the actual number of days? The day count conventions are necessary to avoid any disputes on such issues.

As far as day count conventions are concerned, two separate implications need to be taken note of:

- **Day count for interest calculation for payment** purposes. There are some currencies/instruments where interest is calculated, for payment purposes, on the basis that the rate "p.a." is for 360 actual days. Thus, the actual one year interest on say, a 6% p.a. bond from 15.2.2006 to 15.2.2007 will be $(6 \times 365)/360$, and that between 15.2.2008 to 15.2.2009 will be $(6 \times 366)/360$. This practice is not prevalent in India where the annual quoted rate on a bond is for a year—365/366 days as the case may be.
- For **calculation of fractional interest periods for discounting purposes and for accrued interest** in between interest payment dates. These calculations are necessary for arriving at the clean/quoted price of a bond (see paragraph 7.2.1).
- The various conventions are as follows:

(a) Actual/Actual (in period): If interest period is say May 17 to November 17, and one is calculating accrued interest to say 10th July, the **fraction for multiplying the half yearly interest** will be (actual number of days between 17th May and 10th July)/(actual number of days between 17th May and 17th November); or 54/184.

(b) Actual/365: The **factor for multiplying the annual coupon** in the example cited in (a) above will be 54/365. Two variations are

  (i) Actual (NL)/365 which ignores February 29 in a leap year; and

  (ii) Actual/365 (366 in a leap year).

(c) Actual/360: Used where interest is calculated (for payment purposes) on 360-day year basis—please see the beginning of this paragraph.

(d) 30/360. There are two variations—American and European. The calculation of accrued interest between two dates (D_1 M_1 Y_1 and D_2 M_2 Y_2) is done as follows:

$$(Y_2 - Y_1) \times 360 + (M_2 - M_1) \times 30 + D_2 - D_1$$

In the American convention, if D_1 or D_2 is the end of the month, **the number is changed to 30** (unless it is already 30) for calculation purposes. In the European convention, if D_1 or D_2 (or both) are 31, the number is charged to 30 for calculation purposes. Difference in the number of days under the two 30/360 day rules arises if one of the two dates is the last date of February. In that case the American rule requires the day to be charged to 30; the European variation leaves it unchanged. Consider, for example, counting the number of days between say 28th February (not a leap year) and 1st March.

The variables are as follows:

	American	European
M_2	3	3
M_1	2	2
D_2	1	1
D_1	30	28
Number of days by formula	1	3

7.2.4 Interest/Discount Calculations: Money Market

(a) Call/Notice Money in Interbank Market: The formula given in the FIMMDA Handbook is

- *Interest is calculated on Actual/365 day basis.*
- *Interest payable to be rounded off to the nearest rupee.*
- *Interest on the amount borrowed/lent =*

$$\frac{\text{Amount borrowed/lent} \times \text{No. of days} \times \text{Rate of Interest}}{365 \times 100}$$

(Para 6.1.1—FIMMDA Handbook)

(b) Term Interbank Market: Similar to above, but periodicity of payments (quarterly etc.) should be agreed.

(c) Bill Discounts: Day count actual/365: The formula given in the FIMMDA Handbook is

***Transaction Amount**:* *Rs 10,00,00,000/-(Rupees Ten Crore)*
(Principal amount)

***No. of Days**:* *45 days*

***Rate of Discount**:* *10.25% p.a.*

***Discount**:*

$$\frac{\text{Transaction Amount} \times \text{No. of days} \times \text{Rate of interest/discount}}{365 \times 100}$$

$$\text{i.e. } \frac{10{,}00{,}00{,}000 \times 45 \times 10.25}{365 \times 100}$$

i.e. Rs 12,63,699 (rounded off)

Amount payable: Transaction Amount – Discount/Interest
i.e. 10,00,00,000 – 12,63,699
i.e. Rs 9,87,36,301/-

***Amount to be repaid on maturity**:* *Rs 10,00,00,000/-*

(Para 6.3.2—FIMMDA Handbook)

Note that discount is calculated on the face value, therefore, the effective rate of interest, or yield, is higher since only the net amount is paid. In the cited example, the effective rate of interest is

$$\frac{12{,}63{,}699 \times 365}{45 \times 9{,}87{,}36{,}301}$$

or 10.38% p.a.

(d) Commercial Paper, Certificates of Deposits, Treasury Bills: The day count convention is actual/365, but the instruments are quoted/priced on yield, i.e. effective interest rate, basis. The formula given in the FIMMDA Handbook is

- *Case 1: In case yield is given then:*

$$Price = \frac{100}{\left(1 + \dfrac{\text{Yield} \times \text{No. of days to maturity}}{365 \times 100}\right)}$$

- *Case 2: In case price is given then*

$$Yield = \frac{(100 - \text{Price}) \times 365 \times 100}{(\text{Price} \times \text{No. of days to maturity})}$$

(Para 6.7.1—FIMMDA Handbook)

7.2.5 *Dated Securities Market in India*

The standard rule for determining dates for payment of interest on dated government securities is to repeatedly deduct full six months from the maturity date. Thus, if the final maturity is say 17th May 2010, interest payments will be due on 17th May and 17th November every year. This rule can be used to determine the interest payment dates on re-issues of existing securities in the primary market. For new issues, the final maturity date is exactly …. years from date of issue: thus, a 5-year security issued on say 24th April 2006 will mature on 24th April 2011.

Each payment of interest will be equal to half the annual coupon or interest rate—irrespective of the actual number of days. Unlike some other markets, in the Indian market, there are no dated securities where the last or first interest period differs from the standard 6 months. Again, the so-called **end-of-month (EOM) rule does not** apply in the Indian market. The following examples illustrate its implications:

Example	Maturity Date	Interest Payments Dates EOM	Interest Payment Dates NO EOM
1	30/9	30/9 and 31/3	30/9 and 30/3
2	28/2 (no leap year)	28/2 and 31/8	28/2 and 28/8
3	28/2 (leap year)	28/2 and 28/8	28/2 and 28/8

For calculation of accrued interest, **the day count convention in the Indian market is 30/360 European.**

7.2.6 Interest Rate Derivatives

In the swap market, the day count convention is **actual/365**. In the FRA market, the day count rule is the one applicable to the underlying benchmark on which the FRA has been written.

7.2.7 Repo Market

Day count rule is **actual/365** for the funds lent, but **30/360** for arriving at the clean prices of the security for the two legs.

7.3 Data Sources

The important sources of data about the debt securities market are

- RBI;
- FIMMDA; and
- CCIL.

Besides, NSE provides data based on the transactions reported to it in the wholesale debt market (WDM) segment and on NSE MIBOR. CRISIL, the rating company, also provides pricing data which are used by mutual funds to value debt securities.

As far as the primary market in G-Secs is concerned, the principal data source is RBI. It publishes the calendar for auction of T-bills and dated securities, and issue announcements. Besides, its Annual Report, Report on Currency and Finance, Report on Trend and Progress of Banking in India and other publications are rich sources of macro level information and analysis of money, bond and derivatives markets. Nor can any participant afford to miss its statements of monetary policy and quarterly reviews, which give an indication of RBI's thinking on other relevant issues like exchange rate policy, inflation and interest rates, etc. Newsletters of market participants like I-Sec, IDBI Capital Markets, etc. are also useful.

7.3.1 Secondary Market: CCIL

CCIL's website and its monthly publication, Rakshitra, are important sources of information about the secondary market in government securities. CCIL gets the data as part of its settlement activities and analyses them in various ways.

Some of the data regularly compiled and published by CCIL include:

(a) Settlements volumes in outright, repo, forex and CBLO segments;
(b) In G-Secs, average number of trades and value per day, also by trade type;
(c) Deal size analysis;
(d) Value date analysis (T+0, T+1, >T+1 etc.);
(e) Repo term analysis;
(f) Instrument-wise settlement volumes;
(g) Maturity-wise settlement;
(h) Participants analysis;
(i) Liquidity analysis and turnover ratios of different securities; etc.

CCIL's Rakshitra and the annual Fact Book also contain very useful data and analysis.

CCIL's website publishes

- prices of securities settled on a settlement date, with details like
  - Security code and name
  - Coupon rate
  - Maturity
  - Price (weighted average deal price (WADP) and also market price)
  - YTM (WADP YTM and market YTM)
- 1 to 30 year zero coupon yield curve (see Chapter 9).
- an MS Excel-based tool for valuation of G-Sec portfolios.

7.3.2 Secondary Market: FIMMDA

FIMMDA website is also an important source of data and information, including on corporate bonds. Besides, it provides a number of analytical tools. The FIMMDA month-end prices are used by banks and primary dealers for valuing debt securities, including corporate bonds. Some of the other data available include:

(a) G-Sec prices and yields, trades;
(b) Zero coupon yield curves up to 30 years;
(c) Corporate bond yield spreads, rating wise;
(d) Derivatives prices and settlement rates;
(e) MIBOR rates;
(f) Commercial paper benchmark yields, etc.

Analytics, as distinct from data, available on the FIMMDA website include corporate bond calculator, price volatility calculator, etc.

The process by which the prices of various securities (benchmark, liquid, semi-liquid, etc.) are arrived at is discussed in Chapter 9.

7.3.3 NSE MIBOR

As has been stated in the last chapter, the most popular and liquid swap in the Indian market is the one based on the overnight interbank rate. Since the interbank market functions through the day and the rate is fluctuating, obviously it is necessary to have a single rate for calculation of the floating rate leg. This is the so-called NSE-MIBOR.

Like many other benchmarks, BBA LIBOR for example, **this is a "polled rate"**. It is therefore useful to have some idea of the polling methodology. Such polls use a sample of leading banks active in that particular market. Dealers can be asked to quote the rates at which they would deal as principals — or their estimate of the market rate.

For the NSE MIBOR, at the specified time (0940 hours for the overnight rate and 1130 hours for the 14 day, 1 month and 3 month rates), the dealers are asked over the telephone for their bid and offer rates for a deal of Rs 100 mn. All the rates received are tabulated and averaged after eliminating so-called "outliers", or extreme bids; or by using more sophisticated statistical techniques.

The result, namely the NSE-MIBOR, is disseminated by 9.55 hours for the overnight rate and 1215 hours for the term interbank rates. These then become the benchmarks for settlements of the floating rate leg of interest rate swaps.

7.4 Bond Indices

Indices are regarded as a general indicator of market movements. Most financial and real asset markets usually monitor the performance of the market using indices. They also form a crucial input to the design of security portfolio of investors. Economists and statisticians use these indices to study trends.

The more common indices are those that analyse stock prices, viz. stock indices. These are usually price indices. Bonds, on the other hand, are usually monitored using return indices. This difference stems from the very nature of bond markets. Bond portfolios are held for their coupons as well as the appreciation of the asset. Under these circumstances, a returns index that also factors the change in price is more helpful.

A good sovereign bond index should be:

(a) a benchmark for portfolio management;

(b) an indicator of market performance and development;

(c) the basis on which market options and futures may be derived; and

(d) a comparison tool for different markets.

A good index should therefore have the following characteristics:

(e) **Representative:** The index should be representative of the market as a whole.

(f) **Easily replicable:** The total returns of the index should be replicable by the market participants, by constructing a portfolio with similar returns as the index.

(g) **Transparent:** The index should be transparent. All changes should be easily understood and predictable. The computational methodology along with all required data should be available in the public domain.

Some of the major entities that provide sovereign bond indices in India are I-Sec, J. P. Morgan, CRISIL, CCIL, NSE, etc. NSE, J. P. Morgan and CCIL also publish T-bill indices.

Chapter 8

Valuation of Fixed Income Securities: Basic Concepts

8.1 Introduction

In this chapter, we discuss the basic concepts underlying the valuation of, and returns on, fixed interest securities. In particular we would look at the mathematics of yield to maturity (YTM), before and after tax yields, the limitations of YTM, the concept of holding period returns, and the basics of annuity and equated monthly installments (EMI) mathematics. We would also discuss the concept and algebra of continuously compounding rates.

As argued in paragraph 1.1.1, the total income from a **bond held to maturity** is a combination of the coupon, or periodic interest payments, and the difference between purchase price and the face, or redemption, value. The total return would include, in addition, interest on coupon inflows as these would be invested up to the maturity of the bond. Ideally, what is needed is a measure which expresses, in a single number, the total return from the three sources: this is known as the "yield to maturity" or YTM of a bond.

8.2 Present and Future Values (PV and FV)

For understanding YTM, we first need to discuss the concepts of present and future values of money, often referred to as time value. Rs 100 received today does not have the same value to the recipient as the same amount of money receivable say a year hence. The reason is simple: Rs 100 received today can be invested at the going rate of return and will be worth more than Rs 100 a year hence.

Given a rate of return of 10% per annum, payable annually, Rs 100 now is equivalent to Rs 110 receivable a year hence (assuming no credit risks), since 110 = 100 × (1.10). In other words, the 1-year future value (FV) of Rs 100 received today is Rs 110. Correspondingly, the present value (PV) of Rs 110 receivable a year hence, at the given rate, is Rs 100. So is that of Rs 121 receivable two years hence, as $100 = 121/(1.10^2)$ or $100 \times (1.10^2) = 121$.

At this stage, it would be useful to clarify the distinction between "discount", and "interest" or "yield". Generally, "discount" is the rate at which future flows are discounted to arrive at their present values. On the other hand, interest or return or yield is the rate at which a present value is compounded to arrive at its future value.

Present and future values also **depend on the periodicity of compounding, apart from the annual rate**. For example, if Rs 121 receivable two years from now is discounted at 10% p.a., compounded half yearly, its PV is 99.5470 ($121/(1.05^4)$), and not 100. Similarly the 2-year future value of Rs 100, at the same rate, is 121.5506 ($100 \times (1.05^4)$), and not 121.

In short, PV is the **discounted** value of a future receivable, at a **given rate applied at a given periodicity**.

8.3 Yield to Maturity (YTM)

By definition, the YTM of a fixed interest security is **the discounting rate at which the sum of the present values of future receivables is equal to its price**. This is also the internal rate of return (IRR) on the investment provided the investment is equal to the price so arrived at. Given the relationship between present and future values, one can either start with the price of a security and arrive at the return (or YTM); or start with a desired rate of return, **discount the future cash flows** from the security **at the desired rate of return**, and arrive at the price to be paid to get the desired rate of return. In other words, the rate to be used for discounting future cash flows is the desired rate of return.

Mathematically, if C_i represents the inflow from a fixed income security at the end of the ith period (all periods equal in length of time), and there are n inflows, the YTM will be such as to satisfy the following equation:

$$\text{Price} = \sum_{i=1}^{n} \frac{C_i}{(1 + \text{YTM})^i} \tag{8.1}$$

(unless otherwise stated, yields or interest rates will be expressed as fractions—in other words, 10 % would be expressed as .1)

The divider of each inflow in the above equation, namely $1/(1 + \text{YTM})^i$, is often referred to as the **discount factor**.

In the case of coupon bonds i.e. fixed interest securities which pay interest periodically, and the principal on maturity,

$$C_i = c \text{ for } i = 1 \text{ to } (n - 1) \text{ and}$$

$$C_n = c + M$$

where c is the interest **for one period** and M is the maturity or face value. In such cases, the formula in Eq. (8.1) I can be simplified to

$$\text{Price} = \frac{c \times (1 - x)}{\text{YTM}} + M \times x \qquad (8.2)$$

where,

$$x = \frac{1}{(1 + \text{YTM})^n}$$

(For proof, see Annexure 8.1.)

Government securities (bonds) in India generally pay interest every half year. The YTM calculated by Eq. (8.1) or (8.2) is therefore half-yearly; also c is the half yearly rate of interest on the bond.

One other point should be noted. Take a look at Eq. (8.1). While considering investment in a given security, the market price would be known; also the C_i's. However, the equation does not give YTM as a function of price and C_i's. Therefore, knowing the price and the C_i's, YTM has to be **calculated by trial and error to the desired degree of accuracy**.

One corollary of the basic price formula, Eq. (8.1) or (8.2), would be evident: for a given bond, higher the YTM, i.e. larger the denominator(s) on the right hand side, lower will be the PVs and hence the price. In other words, for a given bond, the price: yield relationship is inverse. As the following calculations show, **if c = YTM, price equals face value**. It follows that **if YTM > c**, the **price will be less than the face value**; and **if YTM < c, the price will be higher than the face value**.

Consider the following security.

Face value $M = 100$

$n = 3$

$c = 10\%$ annually

If desired return or YTM is 10% p.a.

$$\text{Price} = \frac{10}{1.10} + \frac{10}{1.10^2} + \frac{110}{1.10^3}$$

$$= 9.0909 + 8.2645 + 82.6446$$

$$= 100$$

If the desired rate of return is 9% p.a.

$$\text{Price} = \frac{10}{1.09} + \frac{10}{1.09^2} + \frac{110}{1.09^3}$$

$$= 9.1743 + 8.4168 + 84.9402$$

$$= 102.5313$$

Similarly, for a YTM of 11%,

$$\text{Price} = \frac{10}{1.11} + \frac{10}{1.11^2} + \frac{110}{1.11^3}$$

$$= 9.0090 + 8.1162 + 80.4311$$

$$= 97.5563$$

Have you noticed one interesting feature? For the same change in yield (±1%), **the change in price is not identical**. When the yield falls by 1% to 9%, the price rise in 2.53%; but when it rises by 1% to 11%, the price fall is 2.44%. We will return to this factor, known as **convexity**, in Chapter 13.

8.3.1 Bond Equivalent Yields

As stated above, government bonds in India generally pay interest half yearly. Also Eqs. (8.1) and (8.2) give the relationship between price and half yearly YTM ("*i*" is the half yearly interest). It is customary in India, as also internationally, **to quote the annualized yield at double the half yearly yield**. This ignores the compounding effect of periodic interest payments and therefore the "true" yield is different from the YTM. Since government bond returns are benchmarks for all other issuers, and as some bonds pay interest annually, for comparing yields of the two, the effect of compounding has to be considered. The formula for converting the **YTM of a security, interest on which is paid annually**, to its so-called "bond equivalent" basis, is:

$$\text{YTM on bound equivalent basis} = 2 \times [\{(1 + \text{YTM})^{(0.5)}\} - 1] \qquad (8.3)$$

As will be readily seen, the "bond equivalent" yield of a security with annual coupons is less than its calculated YTM. For example, the bond equivalent yield of the bond cited in the previous paragraph and purchased at 97.5563 is

$$= 2 \times ((1.11^{0.05}) - 1)$$
$$= 2 \times (1.0535 - 1)$$
$$= 0.1070 \text{ or } 10.70\% \text{ p.a., not } 11\%.$$

What of bonds paying interest at monthly or quarterly intervals? The process will be to first calculate the 6 monthly yield by compounding the shorter period returns suitably, and then double it. For example, the bond equivalent yield of a bond with monthly YTM of YTM_m is

$$= 2 \times (((1+YTM_m)^6) - 1) \tag{8.4}$$

Yields on zero coupon bonds are also calculated on bond equivalent basis. Consider a zero coupon bond maturing in two years, face value 100, purchased for 79.2094. Its bond equivalent yield is 12% p.a. since 79.2094 × (1.06^4) = 100, giving half yearly yield of 6%.

8.3.2 Comparing Bond Returns

As stated above, for bonds purchased at par, YTM is equal to the annual interest rate. For ready comparison of bonds priced otherwise than at par, however, YTMs have to be calculated by using the price formula in Eq. (8.1).

Consider the following two securities, both with a maturity of 2 years from now and face value of 100:

Security A: Price 90 half-yearly interest 4

Security B: Price 96 half-yearly interest 5

Which gives the higher return? In the case of the first, **the current yield (i.e. coupon inflow as a percentage of price)** is lower, but the gain on redemption is higher. In order to compare the two, we need to calculate the yield to maturity using Eq. (8.1). The YTM is 0.0695 per half year in the case of the first, and 0.0616 in the case of the second. Obviously, the first security has the higher return, even though the current yield is lower. Note also that current yields, 4.44% per half year for security A and 5.21% for security B, lie between the coupon and the YTM: this is also true of securities priced at a premium to face value.

8.4 More on Price: YTM Relationship

The following table shows the YTMs of a specimen security at different prices.

Table 8.1 Price-yield Relationship

SECURITY: Face value : Rs 100
Half yearly coupon : 5
Interest periods to maturity : 16

Price	–70	–80	–90	–100	–110	–120	–130
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon	5	5	5	5	5	5	5
Coupon + face value	105	105	105	105	105	105	105
YTM per period(%)	8.50	7.14	5.99	5.00	4.13	3.36	2.67

Note: It is the general practice to show the amount invested (or price) with a negative sign since it represents an outflow of funds; inflows are positive. The annual bond equivalent YTM will be double the calculated YTM per period.

The table clearly brings out the inverse relationship between price and YTM: as the former rises the latter falls, and vice versa. Again, it should be noted that, whatever the yield, the price of a security approaches its par value as it nears the maturity date, as Table 8.2 shows—**on maturity it has to be the face value**.

Table 8.2 Price Movement with No Change in Interest Rates

(same security as in Table 8.1)

Price now	70.00	80.00	90.00	100.00	110.00	120.00	130.00
2 yrs later	74.31	83.15	91.71	100.00	108.07	115.94	123.64
4 yrs later	80.27	87.31	93.86	100.00	105.80	111.32	116.58
6 yrs later	88.54	92.79	96.57	100.00	103.14	106.03	108.72
8 yrs later	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Note that price approaches par value as maturity comes near.

8.4.1 Variations of the Formula

There are two other variations of the formula in Eq. (8.1). Multiplying both sides of the equation by $(1 + \text{YTM})^n$ we get

$$\text{Price} \times ((1 + \text{YTM})^n = \sum_{i=1}^{n} C_i \times ((1 + \text{YTM})^{(n-i)}) \tag{8.5}$$

This means that if the price/investment is compounded, at YTM, up to the maturity of the security, the amount equals the total of all the inflows, similarly compounded, from their receipt to the maturity of the security.

This form of the equation also evidences another attribute integral to YTM calculations: that the **coupon inflows are assumed to be reinvested at YTM**—see the calculations in Table 8.3 below.

Table 8.3 Prices and Compounded Returns on Coupon Dates: No Change in Interest Rates

(same security as in Table 8.1)

Purchase price	–70.00	Price at Coupon date	Coupon inflow	Interest on interest	Total return	Investment compounded at YTM
Coupon	5.00	70.95	5.00	0.00	75.95	75.95
Coupon	5.00	71.98	10.00	0.42	82.40	82.40
Coupon	5.00	73.09	15.00	1.31	89.41	89.41
Coupon	5.00	74.31	20.00	2.70	97.00	97.00
Coupon	5.00	75.62	25.00	4.63	105.25	105.25
Coupon	5.00	77.05	30.00	7.14	114.19	114.19
Coupon	5.00	78.59	35.00	10.30	123.89	123.89
Coupon	5.00	80.27	40.00	14.15	134.42	134.42
Coupon	5.00	82.09	45.00	18.75	145.85	145.85
Coupon	5.00	84.07	50.00	24.17	158.24	158.24
Coupon	5.00	86.22	55.00	30.47	171.69	171.69
Coupon	5.00	88.54	60.00	37.73	186.28	186.28
Coupon	5.00	91.07	65.00	46.04	202.11	202.11
Coupon	5.00	93.80	70.00	55.48	219.28	219.28
Coupon	5.00	96.78	75.00	66.14	237.91	237.91
Coupon + face value	105.00	100.00	80.00	78.13	258.13	258.13
YTM (%)	8.50					

Consider another way of looking at the same equation, as follows:

Let P_o = Price at inception; and

$P_i = ((P_{(i-1)} \times (1 + \text{YTM})) - C_i)$ for $i = 1$ to n

Then $P_n = O$

What this means is that if the investment is made at the YTM rate of return, and the inflows deducted from the compounded amount, the end result is zero. This way of looking at the yield to maturity implies that it is the rate of interest, if paid on a bank deposit equal to the price of the security, gives the depositor the same inflows as from the bond, **with no surplus or deficit at the end**. (In the case of bonds priced otherwise than at par, any surplus or deficit on the bank deposit cash flows as compared to the bond, is supposed to be invested, or borrowed, as the case may be, at the same rate of interest: this is the mirror image of the coupon inflow reinvestment-at-the-YTM assumption implicit in YTM calculations.)

An arithmetical example of the three ways of looking at YTM calculations for Security A (paragraph 8.3.2), follows:

Price	Rs 90
Maturity	2 years
Half yearly coupon	Rs 4
YTM per half year	0.0695

(a)
$$90 = \frac{4}{1.0695} + \frac{4}{(1.0695)^2} + \frac{4}{(1.0695)^3} + \frac{4}{(1.0695)^4}$$

$$= 3.7401 + 3.4971 + 3.2699 + 79.4929$$

(b) $90 \times [(1.0695)^4] = 4 \times [(1.0695)^3] + 4 \times [(1.0695)^2] + 4 \times [1.0695] + 104$

or $117.7463 = 4.8931 + 4.5752 + 4.2780 + 104$

(c)
$$P_0 = 90$$
$$P_1 = (90 \times 1.0695) - 4 = 92.2540$$
$$P_2 = (92.2540 \times 1.0695) - 4 = 94.6646$$
$$P_3 = (94.6646 \times 1.0695) - 4 = 97.2427$$
$$P_4 = (97.2427 \times 1.0695) - 104 = 0$$

8.4.2 YTMs After Tax

Hitherto, we have considered the concept of YTM without bringing in the tax angle. Inasmuch as the investor would like to maximise retained earnings, the tax angle is important. **The after tax YTMs** of two securities having the same before tax YTMs **could differ significantly**; an arithmetical example follows:

(a) Tax rate 38 %

(b) Two Securities:

Security C: Price Rs 100, maturity 10 years, half yearly coupon Rs 5

Security D: Price Rs 75.0756, maturity 10 years, half yearly coupon Rs 3

(c) Half-yearly YTM of both is 0.05

(d) Assuming a tax rate of 38%, after-tax half-yearly YTM of Security C is 0.031 (62% of 5%)

(e) For Security D inflows in the form of interest are clearly income and would be taxed at 38%. So, the after tax inflows are Rs 1.86, twenty times. As for the redemption value, if the gain over the purchase price (100 – 75.0756, or 24.9244) is treated as capital gain, it would be taxed accordingly – say at 10%, the tax being Rs 2.4924. Thus, the after tax inflows are:

- Rs 1.86 nineteen times
- Rs 1.86 + (100 – 2.4924) or Rs 99.3676 on maturity.

On an investment of Rs 75.0756, these cash inflows give an after tax half yearly YTM of 0.0353%, much higher than under security C. Even if the "capital gain" of Rs 24.9244 is treated as income and taxed accordingly, the after tax YTM of Security D will be higher than that of Security C, as the tax will be paid at a later date, and will therefore be lower in present value terms.

Clearly, security D has a higher after tax YTM. Should it therefore be automatically preferred to C, if the intention is to hold to maturity? The answer is: not necessarily. For one thing, tax rates may change: an increase just before maturity would reduce the after tax yield on security D much more than on C. For another, the current income under security D, at 2.4775 (1.86 × 100/75.0756) after tax, every 6 months, on an investment of Rs 100, is less than that of security C which is Rs 3.1. Again, as we shall see later (Chapter 13), for a given change in yield, the price volatility of Security D, is higher than that of Security C. A clear choice is available between Security C (higher current yield) and Security D (lower current yield, but higher price volatility and after tax yield).

8.5 YTM Calculations Between Interest Payment Dates

We have so far considered calculations involving full interest periods i.e. on coupon dates. In secondary markets, however, as a rule, transactions take place in between coupon payments. This means that, for the buyer, the first coupon inflow comes not at the end of one full interest period but earlier. Therefore, for calculating its present value, fractional powers of (1+YTM) need to be used, the fraction representing the actual period for receipt of the first coupon inflow. (Future inflows will also include the same fraction.)

The standard formula is

$$\text{Price} = \sum_{i=1}^{n} \frac{C_i}{(1+\text{YTM})^{(n-1+w)}} \tag{8.6}$$

where w = fraction of the current interest period between settlement day and the next interest payment day.

$$\text{Price} = \left[c \times \frac{(1-x)}{\text{YTM}}\right] + M \times x \tag{8.7}$$

Alternatively,

where $x = \left[\dfrac{1}{(1+\text{YTM})^{(n-1+w)}}\right]$

and other notations have meanings already defined. Note that w is calculated with reference to the settlement date of the transaction, i.e. the date on which the price and the security will change hands. Again, the price calculated by the formula is the **full price of the security**, i.e. the full amount to be paid for its purchase**. The practice in government securities markets is to split the full (or "dirty") price of a security in two parts—the "quoted" or "clean" or "nominal" price, and the accrued interest.** The latter is calculated on the face value of the security, at the coupon rate, from the date of the last coupon to the transaction settlement date.

The reason for this practice of quoting prices on a "clean" basis, i.e. "full" or "dirty" price less accrued interest, will be evident if we look at the difference in the accounting treatment of the two elements. For the buyer of the security, the accrued interest he pays will need to be treated as a revenue expenditure going into his profit and loss account; in due course, the coupon inflow(s) will be revenue income. On the other hand, the clean price is part of his investment account, that is an asset on the balance sheet.

Correspondingly, for the seller too, accrued interest received represents revenue income, while the clean price received from the sale is a credit to his investment account. (The difference between the book value of the sold security and the clean price it fetches, will however be treated as income.) This difference in the accounting treatment of the clean price and the accrued interest is the reason for splitting the full price into the two elements.

In India, the practice is to calculate accrued interest, as also the fraction *w* in Eq. (8.7), using the 30/360 European day count convention (for details of calculations, see Chapter 7). The reason for the somewhat artificial looking 30/360 day count convention is that it gives 180 days as the half year irrespective of the actual number of days. For example, consider a bond maturing on say 28th November 2006. If one is looking at it in, say, September 2005, it has three unmatured coupon flows, respectively due on 28th November 2005, 28th May 2006 and 28th November 2006. The actual number of days in the two full half years remaining, i.e. between 28th November 2005 to 28th May 2006, and 28th May 2006 to 28th November 2006, are 181 and 184 respectively, although the interest payment is the same. This means that, on per day basis, the interest rate is higher in the first half as compared to the second! The 30/360 day convention avoids this problem: each half year is treated as 180 days.

8.5.1 An Alternate Approach

There is another way of looking at YTM/price calculations between interest payment dates. This is a two step process:

(a) Calculate the value of the security on the next interest payment date, using Eq. (8.1) and the desired discount rate; and

(b) Discount this amount, plus the interest due on that date, to the settlement date of the transaction, at the same discount rate, to get the price.

Similarly, given price, the YTM can be calculated by trial and error so that the value at the end of the second step above equals the price. This method gives the same answer as Eq. (8.6) (see Annexure 8.1).

Note that the calculated relationships between price and YTM relate to the full, or dirty, price of the security. The nominal, or clean, price can be arrived by deducting the accrued interest from the full price.

8.5.2 Specimen Calculation of YTM, Given Price

Consider the calculation of the YTM of a security with the following parameters:

Face value 100

Maturity 14th May 2010

Settlement date 30th August 2005

Coupon 7.55% p.a.

Quoted or clean price 103.74

The standard and commonly used Excel spreadsheet has a function to do the calculations (see paragraph 8.5.5), but it will be useful for the student to do the calculation without using the function to better understand the mathematics.

The first step is to calculate the fraction w in Eq. (8.6), using the 30/360 day count convention. The number of days to next coupon date is as follows:

Aug	1
Sep	30
Oct	30
Nov	13
	74

This gives us $w = 74/180 = 0.41$

Therefore, accrued interest is $3.775 \times (1 - w)$ or 3.775×0.59, i.e. Rs 2.23, giving a full price of (103.74 + 2.23) or Rs 105.97.

We now have all the information needed to calculate the YTM: by definition, it has to be such that the total of the present values of all the inflows, discounted at YTM, equals the full price. The discounted value can be calculated by using the formula on the right hand side of Eq. (8.6). We have already noted that YTM has to be calculated by trial and error: it comes to 0.03305 per period. The full calculations are shown in Table 8.4.

8.5.3 YTM of a Zero Coupon Bond

This is calculated in the same way as a coupon bond—except that in Eq. (8.7) $c = 0$, since there is no periodic interest inflow. But to arrive at the bond equivalent yield, the notional date of the next (zero) coupon is reckoned by repeatedly deducting full six months from the maturity date and that date is used to calculate w, in accordance with the applicable 30/360 day count convention.

Table 8.4 PVs at 3.3050% per Period

	No. of Days Based on 30/360	Fraction Period	Inflow	Discounted Inflow
30-Aug-05			–105.97	
14-Nov-05	74	0.41	3.775	3.725
14-May-06	254	1.41	3.775	3.606
14-Nov-06	434	2.41	3.775	3.491
14-May-07	614	3.41	3.775	3.379
14-Nov-07	794	4.41	3.775	3.271
14-May-08	974	5.41	3.775	3.166
14-Nov-08	1154	6.41	3.775	3.065
14-May-09	1334	7.41	3.775	2.967
14-Nov-09	1514	8.41	3.775	2.872
14-May-10	1694	9.41	103.775	76.432
			Full Price	**105.97**

On a bond equivalent basis, the YTM is 6.61% p.a.

Consider the following security:

Face value 100

Maturity 25th May, 2011

Settlement date 30th August, 2006

Purchase price 46

The next (notional) coupon date is 25th November, 2006. The number of days to this date from settlement date, using the 30/360 day count, is as follows:

Aug	1
Sep	30
Oct	30
Nov	24
	85

This gives $w = 0.4722$ (n is 10). Since there are no coupon inflows, we need to calculate, by trial and error, the YTM which satisfies the following equation.

$$46 \times (1 + \text{YTM})^{(n-1+w)} = 100$$

(This is derived from Eq. (8.6), with C_1 to $C_{n-1} = 0$, and $C_n = 100$.) This gives (half yearly) YTM as 0.8545, and the bond equivalent yield as 17.09% p.a.

8.5.3.1 Yields on T-bills

In a way, treasury bills are like zero coupon bonds, in the sense that there are no interim interest payments, and the return to the investor comes from the difference between the purchase price and the face value. However, there are a couple of important differences:

- The maturity is less than a year;
- Therefore, T-bills are money market instruments and the day-count convention is actual/365.

A 91-day treasury bill priced at, say, 98.50 will thus yield (1.50/98.50) × 365/91, i.e. 6.1081% p.a. Price, given yield and maturity, can be found by reversing the same calculation.

8.5.4 Clean Prices: Repo Transactions

The mechanics of repo transactions has been discussed in paragraph 2.2.1. Since the market practice is to trade on the basis of quoted, i.e. clean prices, the sale and repurchase prices in repo transactions are also quoted on clean basis. For arriving at the repurchase price, the following points should be kept in mind:

(i) Interest on the amount lent under the repo transaction is calculated on actual/365 day basis;

(ii) However, accrued interest on the security is calculated, on 30/360 day count basis.

The following steps will clarify the methodology:

(a) Security 7.55% G-Sec 2010, maturity May 14, 2010

(b) Face value 430,000,000

(c) First leg settlement 8th October, 2005

(d) Market (clean) price on October 8, say, 103.35

(e) Clean price of lot 444,405,000 (430,000,000 × 103.35/100)

(f) Accrued interest for 144 days (14 May 2005 i.e. last coupon date, to settlement first leg on 30/360 day basis) 12,986,000 (430,000,000 × 0.03775 × 144/180)

(g) Full price (e) + (f) 457,391,000, (i.e. the amount lent assuming no "haircut")

(h) Repo rate for two days' repo 4.9% p.a.

(i) Repo interest for two days (actual/365 days basis) 122,806.35 (457,391,000 × 0.049 × 2/365)

(j) Second leg total consideration (g) + (i) 457,513,806.35, or full price of 106.39855962 (457,513,806.35 × 100/430,000,000)

(k) Accrued interest to settlement of second leg 10th October, 2005, on 30/360 day basis, (146 days) 3.06194444

(l) Therefore, clean price for second leg will need to be 103.33661518 (up to 8 decimals)

Therefore, the prices for the two legs of the transaction are:

1st leg – 103.35

2nd leg – 103.33661518

Note that the quoted price for the second leg is lower than for the first leg; this is because the repo interest rate is lower than the coupon.

8.5.5 Excel Spreadsheet Functions

The popular Microsoft Excel spreadsheet has various functions for fixed income mathematics. Some of the more commonly used are described in the following paragraphs. For illustrating the calculations, we use data, referred by cell addresses, from the following table:

	A	B
1	Settlement date	5-Nov-05
2	Maturity date	22-Sep-07
3	Coupon	10%
4	Price	95
5	Face value	100

Note that the dates should be entered in the mm-dd-yyyy numeric format; coupon is semi-annual; and the price is clean.

8.5.5.1 The Day Count Function

For calculating the number of days from settlement to next coupon, one can use the COUPDAYSNC function, by specifying the various parameters. The function supports 5 different day count conventions as follows:

Code	*Day count basis*
0	US (NASD) 30/360
1	Actual/actual
2	Actual/360
3	Actual/365
4	European 30/360

The last is the convention in use in India in the G-Sec market.

For calculating days to next coupon payment under the 30/360 European day count convention, use COUPDAYSNC(B1, B2, 2, 4) where

- B1 and B2 correspond to settlement and maturity dates
- 2 corresponds to number of interest periods in a year
- 4 corresponds to 30/360 day count convention (European)

This gives number of days to next coupon as 137 and w = 137/180 or 0.76 years.

For arriving at the number of days between the previous interest payment date and the settlement date, the COUPDAYBS function could be used, entering COUPDAYBS(B1, B2, 2, 4)

The answer is 43.

The COUPDAYS function gives the count of total number of actual days in an interest period, after feeding in the same data as above.

8.5.5.2 The YTM Function

To calculate the yield (YTM), use the YIELD function and feed in YIELD (B1, B2, B3, B4, B5, 2, 4) where

- B1 and B2 correspond to settlement and maturity dates
- B3 is the coupon rate expressed in its annual rate
- B4 is the clean price of the security
- B5 is the face value of the security

2 corresponds to interest periods in a year

4 corresponds to 30/360 day count convention (European)

This gives YTM of 13.07% on bond equivalent basis for the bond specified at the beginning of the paragraph.

Note that if the balance maturity of a bond is less than the coupon period, the calculations are done on money market and not bond equivalent basis.

8.5.5.3 Price Function

For calculating the clean price from YTM, one can use the “PRICE” function, and feed in PRICE (settlement date, maturity date, coupon rate, YTM, face value, interest periods in a year, basis of day count convention).

For illustration, to arrive at the clean price of the same bond as above, we input PRICE(B1, B2, B3, 0.1307, B5, 2, 4).

This returns a clean price of 95.

8.5.5.4 XIRR Function

This function calculates the PV of a series of irregularly spaced cash flows. But it uses the actual/365 day count convention.

8.6 Some Points about YTM

While YTM is a very useful and handy single number to calculate and compare returns from, and prices of, fixed interest securities, it also suffers from several weaknesses:

(a) If before tax YTM alone were to be the determining factor in pricing of securities, one should find the YTMs of two securities with similar maturities but different coupon rates, to be near identical. This is not always so even in a liquid and efficient market.

(b) A bigger weakness of the concept **is the implicit assumption that inflows would be reinvested at the YTM rate**—see Eq. (8.5) above. In other words, the assumption is that the graph of YTM (on y axis) and maturity (on x axis)—known as **the yield curve — is "flat"**, i.e. parallel to the x axis, and **unchanged through the life of the bond**. In practice, this assumption will not hold good because of changes in interest rates as also the non-flat yield curve and the differing time periods for which the inflows would need to be invested. To amplify, given a time horizon of 10 years and a 10-year security, the first interest receivable would need to be invested for 9½ years, and the last but one receivable, for only six months, that too at the **rates of interest ruling when the inflows occur**. The rate at which these investments could be made would obviously vary and also be different from the YTM. The **realized compound yield** on a given investment and for a given time horizon could therefore be significantly different from the YTM even in cases where the interest rate structure does not undergo a change. YTM would be the true realised compound yield only in the following cases:
   - A flat yield curve (i.e. identical YTM across all maturities) and no change in interest rates; or
   - zero coupon bonds held to maturity, because there are no interim inflows.

(c) Consider two securities maturing exactly 2 and 3 years later, YTMs 5 and 5.5% respectively. This means that, for calculating the prices of the two securities, flows due **on identical dates** are discounted at 5% in the case of the first security, and 5.5% in the case of second. This clearly is anomalous as there should be a single discount rate for a given maturity.

8.7 Some Other Issues

8.7.1 Portfolio Yields

It may be thought that the yield on a portfolio of bonds can be calculated as the weighted average of the yields on individual bonds in the portfolio, the weights being the market values of each bond in the portfolio. This, however, is not so if portfolio yield is defined in the same way as a bond yield: namely the discount rate which equals the aggregate of the present values of individual cash flows from the portfolio, with its full market value. Table 8.5 illustrates the calculation.

Table 8.5 Portfolio Parameters

Valuation Date	**4th August, 2004**		
	Bond 1	**Bond 2**	**Bond 3**
Maturity date	24 Feb 06	5 Feb 07	19 Sep 08
Annual coupon (paid half yearly)	11%	13%	14.5%
Number of bonds in portfolio	15000	15000	20000
Face value	100	100	100
Clean price	103.5	105.00	111.25
Full price	108.392	111.500	116.81
YTM (% p.a.)	8.54	10.67	11.02
Full price of the lot	1,625,850	1,672,500	2,336,200
Proportion to portfolio value	0.28855	0.29683	0.41462

At the given prices, the full market value of the portfolio is 5,634,550

From the portfolio data, the weighted average yield can be calculated as

$(8.54 \times 0.28855)\% + (10.67 \times 0.29683)\% + (11.02 \times 0.41462)\%$

$= 2.464217\% + 3.167176\% + 4.569112\%$

$= 10.20051\%$

This is significantly different from the portfolio yield calculated in Table 8.5. Even otherwise, the XIRR function cannot be used to calculate the portfolio YTM as it uses a different day count convention (actual/365).

Table 8.6 Portfolio YTM on Total Cash Flow/Market Value Basis by Trial and Error

Date		Cash Flow	30/360 Basis Day Count	*n* – 1 + *w*	Discounted Cash Flows
4-Aug-05					
24-Aug-05	5.5	82,500	20	0.111	82,079
24-Feb-06	105.5	1,582,500		1.111	1,503,657
5-Aug-05	6.5	97,500	1	0.006	97,475
5-Feb-06	6.5	97,500		1.006	93,093
5-Aug-06	6.5	97,500		2.006	88,908
5-Feb-07	106.5	1,597,500		3.006	1,391,245
19-Sep-05	*7.25*	145,000	45	0.250	143,342
19-Mar-06	*7.25*	145,000		1.250	136,899
19-Sep-06	*7.25*	145,000		2.250	130,744
19-Mar-07	*7.25*	145,000		3.250	124,867
19-Sep-07	*7.25*	145,000		4.250	119,254
19-Mar-08	*7.25*	145,000		5.250	113,893
19-Sep-08	107.25	2,145,000		6.250	1,609,093
				SUM	5,634,551
				YTM	9.414%

8.7.2 Holding Period Returns

If the holding period of an investment can be specified at the time the investment is made, then one needs to look at the holding period return, as distinct from yield to maturity. As will be evident from the discussion so far, this will comprise

- coupon inflows during the holding period;
- interest thereon to the end of the holding period; and
- change in the full price of the bond over the holding period.

In a positive yield curve scenario, the investor may deliberately buy a bond of maturity longer than the holding period, and sell it at the end of the period. This can give higher holding period returns than available on a bond with maturity equal to the holding period, in a stable or falling interest rate scenario. For further discussion of the topic, see paragraph 15.3.4 "Riding the Yield Curve".

8.7.3 Annuity and EMI Mathematics

8.7.3.1 Annuities

Annuities typically refer to financial instruments which pay to the investor a fixed sum of money at fixed time intervals, for a fixed period. The instrument has a zero value at the end of the stream of payments, which represent a return to the investor at a given rate of interest. These could be conceptually seen as the mirror image of a recurring deposit: here the investor deposits a fixed sum of money at fixed time intervals, for a fixed period, and receives the compounded value of all the instalments, at the end of the period.

If x is the number of rupees deposited every six months, beginning today, for a period of 5 years, (i.e. 10 instalments in all), at r% p.a. compounded half yearly, what would be the final value (Fi V) of this investment?

Obviously, the compounded amount of the first deposit instalment is $x \times (1 + r/2)^{10}$; that of the second is $x \times (1 + r/2)^9$ and so on, that of the last instalment being $x \times (1 + r/2)$

Therefore,

$$\text{Fi V} = \sum_{i=1}^{10} x \times (1 + r/2)^i \tag{8.8}$$

The present value of an annuity can be calculated by discounting the stream of payments at the desired rate of interest. Let x be the number of rupees to be received every six months for a period of 10 years, the first receipt being six months from the date of the investment. What price should be paid for buying this annuity, assuming the desired rate of return on the investment is r% p.a. compounded half yearly? Clearly, the present value of the 1st receipt is $x/((1 + r/2)^1)$; of the 2nd receipt $x/((1 + r/2)^2)$; and so on, that of the last receipt being $x/((1 + r/2)^{20})$.

The present value (PV) of the annuity is therefore

$$\text{PV} = \sum_{i=1}^{20} x \times (1 + r/2)^i \tag{8.9}$$

It can be shown that the right hand side of the equation can also be more generally (i.e. for n half yearly receipts) expressed as

$$= -x \times \frac{1 - \dfrac{1}{((1 + r/2)^n)}}{r/2} \tag{8.10}$$

(We have come across this formula in Eq. (8.2).)

It is not necessary that receipts under annuities need to be half yearly: they could be monthly, quarterly, or any other desired time interval. However, it is customary to express the rate of interest on a "bond equivalent", i.e. half yearly compounding, basis to facilitate comparisons with other investments.

8.7.3.2 Equated Monthly Instalments (EMI)

Fixed rate housing loans often are repayable in equated monthly instalments of principal and interest together. A part of every EMI goes towards payment of accrued interest, and the balance towards repayment of principal. With each instalment, the principal outstanding reduces and so does the amount of interest payable. Since the aggregate amount of the instalment is constant, the amount available for principal reduction keeps increasing.

From the nature of EMI, it will be evident that such a housing loan (i.e. fixed rate, repayable in equated monthly instalments) is an exact reverse of an annuity where you invest the PV at the start and receive fixed payments representing both principal and interest periodically. Therefore, EMI calculations can be done using Eq. (8.10) above.

Let L be the amount of the loan repayable over 10 years, x the EMI, and r the rate of interest per annum compounded monthly. In that case,

$$L = \frac{x \times \left(1 - \frac{1}{(1 + r/12)^{120}}\right)}{r/12} \tag{8.11}$$

Therefore,

$$x = \frac{L \times r/12}{\left(1 - \frac{1}{(1 + r/12)^{120}}\right)} \tag{8.12}$$

8.7.4 Bonds with Maturity Less than a Year

As we have seen in Chapter 7, interest/yield on money market instruments, including T-bills, is calculated on actual/365 day basis. On the other hand, the day count convention for G-Secs is different: 30/360. In order to compare prices of G-Secs with less than a year maturity, and T-bills, it is customary to calculate the former on money market basis i.e. 365-day year. In other words, the cash flows from such bonds are discounted, at the discount rate applicable for the period of the maturity, but with the actual/365 day count.

There are two situations.

(a) The bond has less than 6 months balance maturity, in other words, only one cash flow is left, which is the remaining coupon plus face value (M), due on maturity date. This can now be considered as a T-bill with the aggregate amount ($c + M$) as the face value. Its price/yield can now be calculated using the T-bill calculation methodology given in paragraph 8.5.3.1.

(b) If balance maturity is between 6 months and 1 year, conceptually, the bond can be considered as a portfolio of 2 T-bills—one with a face value equal to the half yearly coupon c maturing on the coupon date, and the second with a face value of ($c + M$) due on maturity of the bond. The two can now be valued using the appropriate T-bill yields, to arrive at the price of the bond.

(c) If price is given, there is no satisfactory way of calculating the yield on a bond with two interest flows remaining, on money market basis, since money market instruments do not have any interim cash flows. The only alternative is that the first interest inflow can be discounted at the appropriate T-bill yield and the PV deducted from the price. From the balance price and the amount of the maturity proceeds, one can calculate the yield, on money market basis, of the second inflow and compare it with the corresponding T-bill yield.

Illustrative calculations of bond yield on money market basis (maturity less than 1 year) are shown below.

Specifications:

Settlement/calculation date	27-Sep-05
Bond maturity	13-Jun-06
Coupon	6% p.a.

(i) Calculation of price based on yield on 77-day (balance maturity) T-bill (5%) p.a., and yield on 259-day (balance maturity) T-bill (5.50%) p.a.

The balance maturity days coincide with actual day count to 13 December, 2005 and 13 June, 2006, respectively, the dates of coupon inflow and bond maturity. (In practice, if no traded prices of T-bills of the requisite maturity are available, the yields should be calculated by interpolation.)

The bond is equivalent, in money market terms, to two T-bills, one with a face value of 3, maturing on 13 December, 2005, and another with a FV of 103 maturing on 13 June, 2006

PV of 1st T-Bill	$(3/(1 + 0.05 \times 77/365))$	= 2.969
PV of 2nd T-Bill	$(103/(1 + 0.055 \times 259/365))$	= 99.131

Therefore, full price of bond on MM basis (2.969 + 99.131) = 102.100

(ii) Calculation of yield, given the price. Assume that the full price is 101.00. What is the yield?

On MM basis, yield can be calculated not for the bond as a whole, but for its maturity proceeds, given the yield on 77-day T-bills.

The present value of the 1st coupon inflow is 2.969 (as above).

Therefore, notional present value of inflow at maturity is (101.00 – 2.969) = 98.031.

Therefore, the yield for the maturity proceeds is: ((103/98.031 – 1) × 365/259) = 7.14%p.a. This can now be compared with the yield on 259-day T-bill.

8.8 Continuously Compounded Rates

An interest rate of 10% p.a. applied annually gives the same return as 9.76% p.a. compounded half-yearly (i.e. $1.0488^2 = 1.10$), or 9.6% p.a. compounded monthly (i.e. $1.08^{12} = 1.10$). The process carried on further leads to the concept of continuous compounding—the periodicity of compounding tending to zero time interval, but not quite reaching it, a concept familiar to mathematicians for summing up infinite series with a finite sum. The relationship between the continuously compounded (ccr) and periodically compounded (pcr) rates is discussed below.

If *lp* is the interest rate expressed as a fraction for **one period of compounding** (say half year), and the equivalent interest rate, again as a fraction for the same period, on a continuously compounded basis, is *lc*, then

$$1 + lp = e^{lc} \text{ or}$$

$$lc = ln(1 + lp)$$

where

$$e = 1 + 1/1! + 1/2! + 1/3! + \ldots \text{ to infinity}$$

$$= 2.718282, \text{ using the first 50 terms and rounding off.}$$

$(e^x = 1 + x/1! + x^2/2! + x^3/3! + \ldots$ to infinity)

and *ln* denotes the natural logarithm, i.e. logarithm to the base *e*. (There are Excel functions to calculate $ln\, x$ and e^y.)

The important words to be noted are that *lp* is the interest for the period of compounding, in other words, **not the annual rate**. For example, if a bond carries half yearly $lp = 0.05$, then $lc = 0.04879$ per half year.

If the rate is to be expressed on "annual" basis, it is 0.04879 × 2 = 0.09758 or 9.758% p.a.: this is the continuously compounded rate equal to

10% p.a. compounded half-yearly. To understand the issue better, let us calculate the ccr equivalent of 10% p.a. compounded annually (i.e. $ln(1.10)$). It comes to 0.09531 or 9.531% p.a., and not 9.758% p.a. Users of ccr need to keep this difference in mind; else, mistakes will be made. To elaborate, the annualized ccr equivalent of 12% p.a. applied quarterly is not (ln (1.12)), but $4 \times (ln\ 1.03)$). To understand why this is so, note that 12% p.a. applied quarterly is equal to 12.550881% applied annually ($1.03^4 = 1.12550881$). Moreover, ($ln(1.12550881)$) is 0.118236, which is the same as $4\times (ln(1.03))$, or 4×0.029559.

Continuously compounding rates are particularly useful, and give more rigorously accurate results where broken periods are involved. By definition, since ($1 + Ip = e^{Ic}$), pcr and ccr give the same interest calculations for full interest periods. But such is not the case where broken period calculations are involved as they are in all secondary market transactions.

The price equation using continuously compounded rates is the same as Eq. (8.7), except that

$$x = e^{(-\text{YTM}_c \times (n-1+w))} \tag{8.13}$$

where YTM_c is the YTM expressed on a continuously compounded basis, when (1 + YTM) in the denominator becomes $e^{(-\text{YTM}_c)}$

To better appreciate the difference in calculation of returns, consider a simple case. An investor has purchased a bond of the following parameters:

(a) maturity: exact 2 years from date of purchase, which is 22nd September, 2005.

(b) Coupon: 10% p.a. payable half yearly.

(c) Purchase price: 100

Clearly, the bond equivalent yield is 10% p.a. (or 9.758% p.a. on ccr basis). He sells it on 5th November, 2005 (i.e. after 43 days as per the standard 30/360 day count convention) at the same yield. The full price he will get is 101.172 using either pcr or ccr (Eq. (8.7), using the two different definitions of x).

The investor purchased the bond yielding 10% p.a. and sold it also at the same yield. One should expect, therefore, that the holding period yield for 43 days should also be 10% p.a. Actually, it is:

(a) ($1.172 \times 180/43$) or 4.906 for the half-year on 30/360 day count basis (i.e. 9.812 % p.a.), i.e. lower than 10% p.a.; but

(b) 9.758% p.a. on ccr basis (as $100 \times (e^{9.758 \times 43/360}) = 101.172$), which is equivalent to 10% p.a. on pcr basis.

Again, the accrued interest is 1.194, giving the clean price as (101.172 – 1.194) or 99.978. Apparently, the investor has incurred a loss even when the yield curve is flat, and there is no change in yields!

Clearly, ccr gives more accurate calculations whenever broken periods are involved. One reason is that debt security prices in between interest payment dates are calculated using fractional powers which correspond to use of ccr, since *w* can theoretically have infinite values. Thus for instance, we could calculate prices after expiry of, say, 42 days 3 hours by using *w* = (180 – 42.125/180), i.e. 0.766; then a minute later etc. (The concept is not all that farfetched—in real time gross settlement (RTGS) payment systems, intra-day overdrafts are created and charged.) Note another difference: interest accruing **on any given day within the broken period** using conventional interest calculations is identical, but using ccr, it keeps increasing with each passing day (in fact, continuously).

In short, it would be mathematically more accurate to calculate accrued interest using ccr but accounting practice is different and based on pcr. The mathematical accuracy of returns over broken periods is crucial for interpolating data (say YTMs) available for specific, discrete dates into a usable yield curve (see Chapter 9). Hence, for estimating yield curves, analysts find it more useful to use ccr.

Annexure 8.1

Mathematical Proofs

1. Proof of identity of Eqs. (8.1) and (8.2)

   If $n = 1$, Eq. (8.1) says

$$\text{Price} = \frac{(c + M)}{(1 + \text{YTM})}$$

   In Eq. (8.2), for $n = 1$,

$$x = \frac{1}{(1 + \text{YTM})}$$

   Substituting the value,

$$\text{Price} = \left[\frac{(c \times (1 - x))}{\text{YTM}}\right] + m \times x$$

$$= \left[\frac{c \times \left(1 - \dfrac{1}{1 + \text{YTM}}\right)}{\text{YTM}}\right] + \frac{M}{(1 + \text{YTM})}$$

$$= \left[\frac{c \times \dfrac{\text{YTM}}{(1 + \text{YTM})}}{\text{YTM}}\right] + \frac{M}{(1 + \text{YTM})}$$

$$= c \times \left[\frac{1}{(1 + \text{YTM})}\right] + \frac{M}{(1 + \text{YTM})}$$

$$= \frac{(c + M)}{(1 + \text{YTM})}$$

   Thus, for $n = 1$, Eqs. (8.1) and (8.2) are identical.

   We shall now show that if the equation holds good for $(n - 1)$, then it holds good for n.

Given that,

$$\sum_{i=1}^{n-1} \frac{1}{(1+\text{YTM})^i} = \frac{1-x}{\text{YTM}} \text{ where } x = \frac{1}{(1+\text{YTM})^{(n-1)}}$$

Prove that,

$$\sum_{i=1}^{n-1} \frac{1}{(1+\text{YTM})^i} = \frac{1-x'}{\text{YTM}}$$

where $x' = \dfrac{1}{(1+\text{YTM})^n}$

The difference on the left hand side of the two is the addition of

$$\frac{1}{(1+\text{YTM})^n}$$

Therefore, we need to prove that,

$$\frac{1-x}{(\text{YTM})} + \frac{1}{(1+\text{YTM})^n} = \frac{1-x'}{\text{YTM}}$$

Now, substituting the value of x and simplifying,

$$\frac{(1-x)}{(\text{YTM})} + \frac{1}{(1+\text{YTM})^n} = \left[\frac{1/(1+\text{YTM})^{(n-1)}}{\text{YTM}}\right] + \left[\frac{1}{(1+\text{YTM})^n}\right]$$

$$= \frac{1}{(\text{YTM})}\left[\frac{(1+\text{YTM})^{(n-1)}-1}{(1+\text{YTM})^{(n-1)}}\right] + \frac{1}{(1+\text{YTM})^n}$$

$$= \frac{(1+\text{YTM})^n - (1+\text{YTM}) + \text{YTM}}{(\text{YTM})\,(1+\text{YTM})^n}$$

$$= \frac{1}{\text{YTM}}\left[1 - \frac{1}{(1+\text{YTM})^n}\right]$$

$$= \frac{1}{\text{YTM}}(1-x')$$

It follows that since the equality holds good for $n = 1$, it holds good for any value of n.

This proves the identity of Eqs. (8.1) and (8.2).

2. Alternate approach to price calculation in between coupon dates (paragraph 8.5.1)

   The standard equation is (8.6) is

$$\text{Price} = \sum_{i=1}^{n} \frac{c}{(1+\text{YTM})^{(i-1+w)}} + \frac{M}{(1+\text{YTM})^{(n-1+w)}}$$

   where the notations used have the meanings already defined.

   The alternate approach is to first calculate the price on the next coupon date. Using the same notation, it will be

$$P' = \sum_{i=2}^{n} \frac{c}{(1+\text{YTM})^{(i-1)}} + \frac{M}{(1+\text{YTM})^{(n-1)}}$$

   where n is the coupon payments outstanding on settlement day.

   To get the full price on settlement day we will need to

   (a) discount P' to settlement day at YTM, i.e. $\dfrac{P'}{(1+\text{YTM})^{w}}$; and

   (b) add the similarly discounted value of the next coupon inflow (which is not included in P'), i.e. $\dfrac{c}{(1+\text{YTM})^{w}}$

   ∴ full price on settlement is

$$P_o = \frac{c}{(1+\text{YTM})^{w}} + \frac{P'}{(1+\text{YTM})^{w}}$$

$$= \frac{c}{(1+\text{YTM})^{w}} + \sum_{i=2}^{n} \frac{c}{(1+\text{YTM})^{(i-1+w)}} + \frac{M}{(1+\text{YTM})^{(n-1+w)}}$$

$$= \sum_{i=1}^{n} \frac{c}{(1+\text{YTM})^{(i-1+w)}} + \frac{M}{(1+\text{YTM})^{(n-1+w)}}$$

   Thus, the alternate approach gives the same result as Eq. (8.6).

Chapter 9

Term Structure and Yield Curves

9.1 Introduction

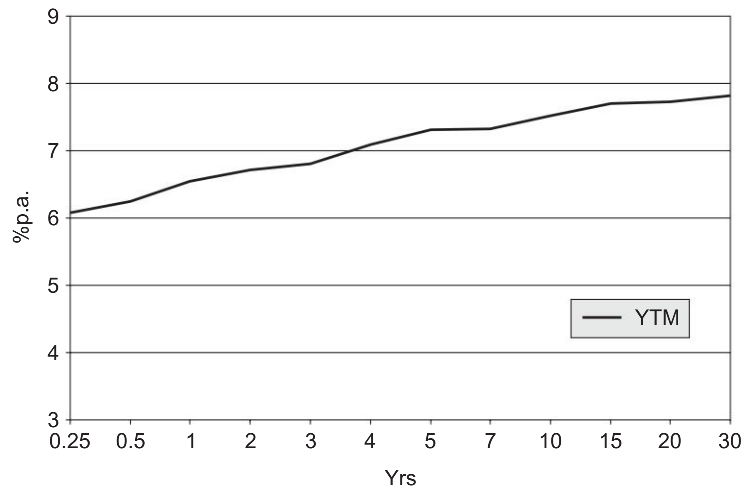
The expression "Term Structure of Interest Rates" refers to the **relationship between maturities and yields in the bond market—**generally of risk-free securities like G-Secs and T-bills. When this relationship is plotted in the form of a graph, it is known as the "yield curve". The term structure of YTMs leads to two other concepts: **spot and forward interest rates** implied by the term structure. Spot rates are the yields on zero coupon bonds and give rise to the **zero coupon yield curve, or ZCYC**.

Inasmuch as, in most debt securities markets, traded prices are available only for a few bonds and maturities, the plotting of a yield curve, whether of YTMs or ZCYC, has to **use interpolation techniques**, to estimate yields of untraded/ill-liquid bonds, as also theoretical yields for maturity dates on which no actual bond may be maturing. The subject is complex and one of most researched topics in fixed income mathematics.

In this chapter, we discuss the term structure and theories which seek to explain it, and the calculation of spot and forward rates implied by the structure. We then consider the plotting of yield curves before discussing valuation of floating rate bonds.

The following graph shows the G-Secs yield curve (YTM) on March 31, 2006.

Graph 9.1 Yield Curve on 31 March, 2006



Source: FIMMDA

9.2 Term Structure of Interest Rates

The concept of term structure of interest rates (i.e. yields for different maturities) is fundamental to management of fixed income portfolios, and to pricing of futures, options, forward rate agreements, caps, etc.

In general, YTMs would be different for different maturities. In a "normal" interest rate scenario, YTM will increase with maturity ("**the positive yield curve**"). There are occasions when the yield curve is inverse, i.e. yields on longer maturities are lower than on shorter ones. The reason is that, in general, monetary policy determines short term interest rates but yields on long term bonds depend on investor expectations of future inflation and interest rates, as also the demand: supply of bonds of various maturities. A credible tight money policy to curb inflation sometimes results **into inverse yield curves** i.e. higher yields for shorter maturity bonds as compared to longer maturities. Positive yield curves are also described as **"steep" or "flat"** depending on the difference between short term and long term yields, and hence the shape of the yield curve.

9.2.1 Theories of Term Structure

There are various theories of the term structure of interest rates. They try to answer the question: **if investments are riskless and markets liquid, why**

should yields differ with maturity? Some of the more important theories are discussed below:

(a) **Unbiased (or "pure") expectations theory**. This argues that yields differ with maturities because of market expectations of future changes in interest rates. Thus, for example, the 2-year yield is higher than the 1-year yield because the expectations about the **1-year yield 1-year from now**, is factored in the 2-year yield ruling now. In fact, this theory is at the heart of the concept of forward interest rates implied by the term structure, discussed in paragraph 9.3.3 below.

The major weakness of the theory is that, were it to be true, since interest rates go up as well as down with (more or less) equal frequency, the yield curve (i.e. graph of maturity against yield) should be downward sloping (implying a fall in future rates) as often as upward sloping (implying a rise in rates). Such is not the case, however. Most of the times, yield curves are upward sloping, or positive.

(b) **Liquidity preference theory**. If YTMs were equal across maturities, investors will prefer shorter maturity bonds because longer the maturity, greater the uncertainties, about future inflation and interest rates for example. As compensation for the higher uncertainties, investors demand a higher yield (or liquidity premium) to invest in longer term securities. This theory is supported by the fact that, most of the times, yield curves are positive, or upward sloping.

The weakness of the theory is that, on first principles, liquidity premium should go up with maturity: empirical research in the U.S. bond market, the world's most liquid, however, does not evidence any increase in liquidity premium beyond one year.

(c) **Market segmentation theory**. There are different investors in different maturity segments, (e.g. short, medium term and long term) depending on their maturity preference and asset liability management needs, and the **yields are independent of each other**. In other words, yields/prices in the long maturity segment are determined by demand supply of bonds in that segment, and are not linked to yields/prices in other maturity segments. However, investors can be induced to move from their "preferred habitat" by yield variations across maturities. To elaborate, an investor whose "preferred habitat" is, say, 1 to 3 years maturity (as this may suit his asset liability management), may be induced, or tempted, to invest in longer maturity paper, if the yield difference between the two segments is attractive enough.

There is not much empirical evidence in support of this theory.

9.3 Spot and Forward Rates

The term structure of interest rates leads to two other concepts—spot and forward interest rates implied by the term structure.

9.3.1 Spot Interest Rates

By definition, the **spot interest rate for a given maturity is the yield on a zero coupon bond of that maturity**. The term structure can be used to calculate the spot rates for different maturities implied by the structure, even if zero coupon bonds for all the maturities are not being traded. This method of calculating the spot rate (or zero coupon yields) implied by the term structure of interest rates is known as "boot strapping".

By way of example, consider two risk-less investments, one with coupon and another zero coupon.

Security E: Price 90, annual coupon 5, maturity two years

Security F: Price 91, no coupon, maturity one year (face value 100 in both cases).

The two annual (i.e. not bond equivalent) YTMs are 10.825835% p.a. and 9.890110% p.a. respectively. The cash flows from security E are as follows:

Table 9.1 Cash Flows from Par Securities

Security	Investment	Inflow Year 1	Inflow Year 2
E	90	5	105

Security E can be conceptually looked upon as a portfolio of two zero coupon bonds, one with a face value of 5 maturing in one year, and the second with a face value of 105 maturing after two years. (Indeed, by following the same logic, any coupon bond can be conceptually considered a portfolio of zero coupons, $n-1$ with a face value equal to the coupon, and 1 with a face value $(c + M)$.) In that case, **the total of the prices today, of the two hypothetical zero coupon bonds, should be 90,** in order to make the portfolio equivalent of security E.

Given the yield on security F (which is a one year maturity zero coupon), the price of the (hypothetical) zero coupon bond face value 5, maturity one year, will have to be (5/1.09890110) or 4.55. Hence, the (hypothetical) investment in the two year maturity zero coupon bond will have to be (90 – 4.55) or 85.45. If the 2 year maturity spot rate implied by the structure is r_2 then,

$$85.45 \times ((1 + r_2)^2) = 105$$

giving $$r_2 = 0.1085$$

And this is the two year spot rate implied by the structure.

In general, if the spot rate for one period is known, that for subsequent period(s) can be calculated by using

$$\text{Price} = \sum_{i=1}^{n-1}\left[\frac{c}{(1+r_i)^i}\right] + \left[\frac{(100+c)}{(1+r_n)^n}\right] \tag{9.1}$$

where c is the periodic coupon rate, n the number of interest periods, and r_i is the spot rate for i periods. In other words, the investment (or price) is **the sum of the present values of inflows discounted at the spot rate applicable to the maturity of the respective inflows.**

For $n = 2$, and r_1 and YTM/price of two-year security known, r_2 can be calculated, as we have illustrated above.

For $n = 3$, and r_1, r_2 and YTM/price of three-year security known, r_3 can be calculated, and so on.

Even in a market where few zero coupons are being traded, spot rates for different maturities can be calculated by using the above methodology, considering the treasury bill as a proxy for a zero coupon bond. A market in "strips", i.e. separate pricing of and trading in each coupon, can be undertaken only through the spot rate calculations implied by the term structure.

The spot rate yield curve, often also referred to as the Zero Coupon Yield Curve (ZCYC), is generally used **for more rigorous pricing of coupon securities**, or cash flows with similar characteristics, as these calculations do not suffer from the weaknesses implicit in the YTM mathematics—see paragraph 9.4.2 below. In principle, the bond price arrived at by using spot rates for the cash flows is the same as by using YTM: this is because spot rates themselves are derived from observed YTMs. Therefore, YTM can be looked at as a (somewhat complicated) average of the different spot rates for the cash flows from the bond.

In practice, prices calculated from ZCYC and YTMs would not exactly match. One reason is that, if there are two traded bonds with different coupons but the same maturity, zero coupon yields will differ depending on which of the two bonds is used for bootstrapping, **even if their YTMs are identical**. Another reason is that, in any market, only a few bonds are traded, and prices/yields for other maturities are estimated by interpolation–see paragraph 9.4.4 below. And, they can differ with the interpolation technique used. As for the first point, if only one of the two bonds is traded, the price/yield of that bond is used for estimating the ZCYC.

It follows that the derived **YTMs of coupon bonds of identical maturities but different coupons are not the same**. This is because, while the same spot rate is used for discounting, the amounts discounted—i.e. coupons—are different, and hence will have varying weights in the price. This phenomenon is known as the **"coupon effect"**: other things equal, in an upward sloping, positive, zero coupon yield curve, higher coupon bonds should have lower YTMs (or higher prices) than lower coupon ones.

9.3.2 Discount Factors

Discount factors are multiplicants of a future value to convert it into present value. For instance, in Eq. (9.1), the discount factor applicable to the ith cash flow is $(1/((1 + r_i)^i))$. In general, the discount factor for a cash flow due at time t expressed in interest periods, is the inverse of the **zero coupon yield, per interest period, for maturity *t*, raised to the power *t***. It is not necessary that t needs to be in full years or interest periods; it could also include fractional periods, the fractions being calculated as per the applicable day count convention (30/360 at present in India).

Using ccr, if Y_{ct} is the annualised continuous compounded zero coupon rate for maturity t expressed in years, then the discount factor is

$$e^{(-Y_{ct} \times t)}$$

The more general form of Eq. (9.1) for calculations in between interest periods, and using ccr, is

$$\text{Price} = \sum_{i=1}^{n} c \times e^{\left[-Y_{c(i-1+w)} X (i-1+w)\right]} + 100 \times e^{\left[-Y_{c(n-1+w)} \times (n-1+w)\right]} \tag{9.2}$$

9.3.3 Forward Interest Rates

Forward interest rates are the spot interest rates expected to rule on future dates, as implied by the term structure. A positive yield curve implies expectations of higher interest rates in the future—and the reverse for an inverse yield curve. The calculations are based on the assumption that **the return on holding a long term bond is equal to the expected return on repeated short term investments, rolled over at the forward rates implied by the term structure.** This enables calculation of the **forward interest rate implied by the structure, or the expected spot rate on the future date.**

While the future spot rate rarely equals the forward rate—this is true of other financial markets like the foreign exchange market as well—it is the only benchmark for the future spot rate which does not provide any risk-free arbitrage opportunity. To understand this, let us first see how forward rates can be calculated from the term structure.

Consider securities E and F described in paragraph 9.3.1. The forward interest rate for the second year implied by the structure needs to be such that the **returns at the end of two years from both the investments are equal**. This requires that the initial investment in both the securities is the same, and the maturity proceeds of F (at the end of one year), as also the coupon inflow from E, at the end of one year, are reinvested for one more year at such a rate that **the aggregate returns from the two securities are identical**: this rate will then represent the one year forward rate for one year, implied by the term structure (say ${}^{1}f_2$).

Let us consider an investment of 91 in both the securities. In that case the face value of security F will be hundred and that of security E will be 91/90 × 100 = 101.1111. The corresponding coupon inflow will be 5 × 101.1111/100 = 5.0555.

Algebraically, with the left hand side calculating the total return from security E at the end of two years (with the interim coupon inflow invested at ${}^{1}f_2$), and the right hand side the maturity proceeds of security F invested for one more year, also at ${}^{1}f_2$, the equation becomes

$$(106.1667) + (5.0555 \times (1+{}^{1}f_2))$$
$$= (100 \times (1 + {}^{1}f_2))$$

or $${}^{1}f_2 = \left[\left(\frac{106.1667}{100 - 5.0556}\right) - 1\right] = 0.01182$$

Any other forward rate would allow risk-free arbitrage profit to be made. For example, if a forward rate (settlement 1 year, maturity 2 years) of 12% p.a., i.e. more than the rate arrived at above, is available in the market, a player will make a risk-free profit by

(a) agreeing to receive 12% p.a. under a forward rate agreement;
(b) selling security E and investing in F; and
(c) rolling over the maturity proceeds of F to effectively yield 12% p.a. irrespective of the actual ruling one year rate.

This will give a profit equal to the difference between 12% and ${}^{1}f_2$, for one year, as **compared to keeping the investment in E**.

Similarly, if the quoted rate is less than ${}^{1}f_2$, a player could offer to pay it and lock into a risk-less arbitrage profit by selling F and investing in E. In fact ${}^{1}f_2$ is the only forward rate which does not provide any risk-free arbitrage profit. A player may take a view that ${}^{1}f_2$ overestimates the future spot rate and enter into an agreement to receive it: he will make a profit it his view is right, but lose if it goes wrong! In other words, ${}^{1}f_2$ does not permit a zero risk profit.

9.3.4 Relationship between Spot and Forward Rates

The spot and forward rates are related as under:

$$1 + {}^{1}f_2 = \frac{(1+r_2)^2}{(1+r_1)}$$

(This can be readily verified using the spot and forward rates calculated respectively in paragraphs 9.3.1 and 9.3.3.)

or in general, $$(1 + {}^{(i-1)}f_i) = \left[\frac{(1+r_i)^i}{\{1+r_{(i-1)}\}^{(i-1)}}\right] \quad (9.3)$$

More generally, if r_i is the spot rate for i periods and r_j the spot rate for j periods ($j > i$), then

$$1 + {}^{i}f_j = ((1+r_j)^j)/((1 + r_i)^i)$$

Note that ${}^{i}f_j$ is the **absolute** (not annual or bond equivalent) forward zero coupon yield for the period beginning i and ending in j. In other words, $i/{}^{i}f_j$ is the forward discount factor for the period j to i.

Also

$$(1 + r_n)^n = (1 + {}^{0}f_1) \times (1 + {}^{1}f_2) \times \ldots \times (1 + {}^{(n-1)}f_n \quad (9.4)$$

The concepts and calculations of spot and forward rates implied in a given term structure of interest rates are the basis of forward (interest) rate agreements (FRAs) and prices of interest futures in financial markets.

9.3.5 Pricing of STRIPS

In paragraph 3.5 we have referred to the likely introduction of STRIPS, i.e. separate trading of registered interest and principal securities, in India, in effect, STRIPS convert a coupon bond into a series of zero coupon bonds. Spot rates for different maturities can be used to price STRIPS.

In a normal positive yield curve scenario, i.e. higher yields for longer maturities, it can be shown that

- While the total of the PVs of the STRIPS equals the price of the bond if the PVs are calculated using the appropriate zero coupon, i.e., spot rates (see Eq. (9.1));
- The total is higher if the discounting of the STRIPS is done by using **YTMs for the corresponding maturities.**

The reason is that, in a positive yield curve scenario, for a given maturity, the spot rate is higher than the YTM.

9.4 Yield Curves

The spot and forward rate calculations by boot-strapping illustrated in the previous paragraphs have assumed that

- Only full interest periods are involved; and
- The maturities of different bonds differ also by full interest periods.

In practice, neither assumption is valid. Zero coupon yields need to be calculated every day from the prices of traded bonds and the maturities of traded bonds differ by irregular periods. In any bond market, bonds of all maturities are not traded equally actively; in the Indian market for example, only a handful of bonds can be considered as being liquid, and their market prices a reliable indicator of their current values. On the other hand, yields for all possible maturities are required to value bonds which may not have been traded. This leads to the problem of fitting a yield curve from the limited number of discrete data points, with differing gaps between the maturities of actively traded bonds. An **ideal yield curve should be smooth**, fit all **observed prices as closely as possible** and **should therefore give a fair idea of the prices of untraded securities**.

9.4.1 Yield Curve Basics

Yield curve refers to the graph plotting maturity against yields, generally of government, that is risk free, securities. Maturity is plotted on the x-axis and the yield on the y-axis.

The variable on the y-axis could be

(a) Coupon bond YTMs;
(b) Spot rates or zero coupon yields;
(c) Discount factors; or
(d) Forward interest rates;

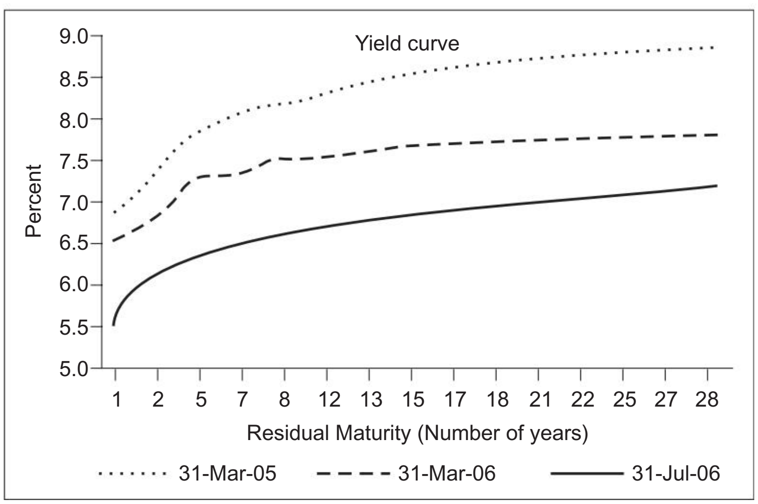
These are alternative variables but they have a mathematical relationship to each other—knowing one, you can calculate the others. Of the variables listed above, the first three have only one value corresponding to a given maturity. Such is not, however, the case of forward interest rates: for example, consider a forward rate ${}^{i}f_{j}$. 'j', i.e. end of the forward interest period, can be any maturity from say (i + 1day) to (i + t years)! Similarly, for a given "j", "i" can be any starting point from 1 day to (j – 1day). And, each combination of (i, j) will have a different value for ${}^{i}f_{j}$. There can, therefore, be an infinite number of forward rate curves, for a given i, or a given j!

The convention therefore is to use the "**instantaneous forward rate"** for plotting the forward yield curve. This is the forward rate as the interest period is reduced towards zero or, say, the forward overnight rate. In other words, this is the value of ${}^{i}f_{j}$ as "j" moves ever closer to "i". Forward yield curves are plotted using instantaneous forward rates. The algebra is easier when ccr are used. In the U.S., where 3-month LIBOR (the London Interbank Offered Rate, the rate at which banks in London offer to place funds with other banks) futures contracts are traded for various maturities up to ten years, their prices are also used to develop the forward yield curve.

Curves of swap rates (i.e. fixed rate leg) are also prevalent and used in the interest rate swap market for valuation of swaps.

YTM curves in the Indian market are appended.

Graph 9.2 Yields on Central Government Securities



Source: RBI Annual Report 2005-06

9.4.2 ZCYC

Of all the variables used for plotting yield curves, the most important is spot rates or zero coupon bond yields. Estimating zero coupon yields for all maturities is extremely important for bond market participants as using YTMs as a measure of yield suffers from two different weaknesses:

- the implicit assumption that the yield curve is flat; and
- YTMs value an inflow at the end of, say, two years differently, depending on whether it is part of a coupon bond with 5-year maturity or 3-year maturity! (STRIPS will have to **price them identically**.)

Because of the weakness of YTM itself, the YTM curve is an imprecise representation of the term structure. The problem with using zero coupon yields is that in most markets there are not many zero coupon bonds being traded across the maturity spectrum. Therefore, zero coupon yields have to be derived from the prices and YTMs of traded coupon bonds by "bootstrapping".

The sequence is

(a) start with market prices of traded coupon bonds;

(b) calculate the implied zero coupon rates;

(c) use interpolation to estimate zero coupon yields for all maturities; and

(d) draw the yield curve.

9.4.3 Problems in Bootstrapping

While theoretically simple and easy to understand, in practice, there are a number of problems in using bootstrapping for estimating a workable ZCYC. The reasons are:

(a) data incompatibility between T-bill and bond yields because of differing interest rate conventions;

(b) "noise" in the data due to distortion of prices, even of securities of similar maturities (some analysts use average yields to smooth out such variations);

(c) Sparseness or inadequacy of data and missing data points.

The problems are particularly acute in the Indian market as there are over a hundred outstanding securities, while barely half a dozen are liquid—and these too keep changing. Moreover, hardly any securities beyond ten years balance maturity are actively traded.

In the circumstances, interpolation techniques become necessary for modelling the curves.

9.4.4 Interpolation Techniques

There are various methods of interpolation, and there is no uniformity in market practice. It should also be noted that, depending on the methodology used, the results of interpolation can differ significantly. Some of the commonly used methods are outlined below:

(a) Linear interpolation, i.e. straight-line between adjacent data points. This suffers from the drawback that at the point where two lines meet the resultant implied forward rates jump suddenly.

(b) Logarithmic interpolation, i.e. straight-lines but between the natural logarithms (i.e. to the base *e*) of the yield points. In this case, the interpolated yields are the anti-logs of the points on the straight-line. Logarithmic interpolation mitigates the sharpness and the angularities of straight line interpolation.

(c) Polynomial models. The objective of the polynomial model is to develop the equation of a curve in such a way that the sum of the squares of the differences between the data points and the corresponding yields on the curve, is minimised.

(d) A variation of the polynomial model is to develop different polynomials for sets of points, which overlap each other. The curves can then be integrated, or spliced together, to produce a single, smooth curve.

(e) Regression analysis can also be used for interpolation, and is as popular as the spliced curves.

Box 9.1 Dynamics of Yield Curve

A yield curve, which is a graphical presentation of yields on securities of various maturities of a debt instrument with the 'same' default risk at a point of time, provides a snapshot of the term structure of interest rates in the market. Typically, yield curves slope upwards with interest rates rising as the tenor of the security increases. The yield curve shifts with a change in generalised perception about interest rates. The slope of the yield curve tends to be influenced by monetary policy action. Typically, when monetary policy is eased and short-term policy rates are reduced, the yield curve tends to get steeper. The curvature of the yield curve may change temporarily on account of specific demand-supply factors pertaining to particular tenors of a security.

An orderly evolution of the Government securities market in India has enabled a maturing of the yield curve into a smooth locus across one to 30-year tenors; however, a progressive flattening of the curve in recent years has engaged the attention of market participants, researchers and the policy makers alike. The narrowing of yield spreads in the 2-year to 10-year residual maturity segment (from 183 basis points to 63 basis points) and in the 10-year to 20-year segment (from 95 basis points to 77 basis points) during the period

September 2001 to May 2004 made the yield curve in India one of the flattest internationally. The presence of a massive liquidity overhang accentuated the flattening of the yield curve, encouraging market participants to demand longer tenor securities so as to increase the duration of their portfolio and scale up potential capital gains amidst softening of interest rates. The Government's tendency to minimise the rollover risk by elongation of the maturity profile of the Government securities in falling interest rate conditions was in consonance with institutional participants' increasing demand for longer tenors. Some steepening of the yield curve was, however, witnessed at the time of easing of monetary measures such as the cut in the repo rate. The yield curve, however flattened as the long term yields fell in the wake of surplus liquidity conditions.

Source: Reserve Bank of India Annual Report: 2004-05

9.4.5 Methodologies used in India

In India, there are at least four ZCYCs and/or valuation systems, using somewhat different methodologies and data, in use:

- CCIL, based on trade settlement data;
- NSE, based on trades reported on NSE's wholesale debt market segment, which is more limited than CCIL's;
- FIMMDA/Bloomberg, based on SGL data (most comprehensive) and used by banks and primary dealers for valuation purposes; and
- CRISIL, prices used by mutual funds for calculating net asset values (NAVs).

We proceed to discuss the more important features of the models used without going into mathematical complexities. Further details of the methodologies are available on the respective web sites.

(a) CCIL uses the Nelson Siegel model (available at www.jstor.org), as modified by Svensson (www.nber.org). The N-S model empirically calculates four parameters, or constraints, (β_0, β_1, β_2, and τ) **by minimising the sum of squared price errors between model and traded prices**. The equation can then be used to estimate the zero coupon yield for any maturity.

The N-S model can cater reasonably well to curves which are smooth, or display at worst one hump (U or inverse U shape). The Svensson modification uses two more parameters and can cater to two humps.

(b) NSE also uses the N-S model but with another modification. The N-S model, based on minimising the price errors, results into larger errors in the YTM of instruments with short maturities. The NSE model therefore uses duration based (duration is a measure of the price sensitivity of a bond to yield changes; see Chapter 13) weighting for the error terms, and minimises the weighted sum of errors. NSE also places some constraints like non-negativity of interest rates, while optimising/minimising the errors.

(c) FIMMDA/Bloomberg methodology starts with bootstrapping of observed/polled prices to arrive at a series of ZCYCs. It then calculates the bond prices using each ZCYC, and the spread that needs to be added to each discount rate to equate the model and actual price of each bond (the so-called option-adjusted spread, OAS). It then calculates the standard deviation of OAS of all the bonds. The model selects the curve which minimises the standard deviation.

(d) CRISIL GILT Valuer first identifies benchmark securities in different maturity buckets based on the frequency at which they are traded. The primary benchmark securities should have been traded on at least 70% of the days in the previous month. Since even benchmark securities are not traded every day, it calculates the correlation between prices of two securities, one benchmark and the other non-traded or ill-liquid. (The methodology for choosing the benchmark security for this purpose is fairly involved.) The correlation is then used to estimate the price of the untraded securities from those of traded ones. CRISIL does the calculation once a month and is the only one which does not rely on first estimating the ZCYC.

9.4.6 Valuations in Practice: Liquidity and Other Adjustments

Apart from the issue of developing a ZCYC, certain other price adjustments may also be necessary for ill-liquid bonds, or bonds not issued by the Central Government. We discuss here some of the methodologies used by CCIL and FIMMDA in this respect.

(a) CCIL, for example, uses a liquidity adjustment factor (LAF) for state government bonds. This is to take care of both ill-liquidity of such bonds in the secondary market and the fact that, while the ZCYC is derived from G-Secs, higher yields are demanded by investors in state government bonds. The methodology followed for calculating LAF is to compare the differences between ZCYC-based, or model, prices, with traded prices of state government bonds falling in different maturity buckets, over a month. This difference is used as the LAF for valuation of state government bonds in the following month. The LAF is reviewed every month on the same basis.

(b) FIMMDA/Bloomberg

Bloomberg itself produces prices for three different classifications of bonds:

(i) Bloomberg generic price (BGN) for liquid (or benchmark) bonds, based on polled prices collected from (currently) 23 contributors specified by FIMMDA;

(ii) Bloomberg fair value price (BFV) for the other bonds trading on the curve, calculated from the OAS-based model described in the previous paragraph;

(iii) Bloomberg FIMMDA prices (BFMD) are estimates of prices of ill-liquid bonds, trading at a spread over (i) and (ii). The spreads themselves are arrived at by polling (currently) 20 market participants.

All these prices are reported by Bloomberg to FIMMDA which validates them before coming out with FIMMDA day-end valuation prices (FIMD) available on both FIMMDA site and Bloomberg terminals.

As for non-SLR/corporate bonds, FIMMDA collects credit spreads from three different sources, **once a month**, for different ratings and maturities. The credit spreads published by FIMMDA for valuation purposes are based on the collected data.

In short, FIMMDA places considerable reliance on the polling process, both for the prices of benchmark bonds as also for credit spreads.

9.5 Valuing Floating Rate Bonds (FRBs)

9.5.1 Theoretical Pricing

(a) The principal features of floating rate bonds have been described in paragraph 3.3.2. To summarise, these are bonds with the coupon refixed periodically with reference to a well-defined benchmark (the "reference rate"). The refixation could be daily (overnight MIBOR-linked bonds), or at specified intervals. In international markets, the most common benchmark is LIBOR. In India, apart from MIBOR, T-bill yields, other government bond yields, CP yields, MIFOR, etc., are also used. In principle, the benchmark reference rate and refixation periods may not have the same maturity, for example, the benchmark could be, say, the ruling yield on 364 day T-bill, coupon to be refixed every six months. In general, the floating rate will be at a spread over the benchmark, the spread reflecting the credit risk of the issuer, the maturity of the bond and its liquidity, demand for that type of instrument in the market etc. In India, both GoI and corporate issuers have issued FRBs.

(b) The theoretical pricing model, **for bonds where coupon payment and benchmark refixation dates are identical**, can be described as follows:

  (i) calculate the forward rates for the benchmark from the term structure;
  (ii) add the contracted spread over benchmark (say x) to estimate the future coupons and cash flows;
  (iii) discount these at the appropriate zero coupon yields **plus the desired spread** (say y), to arrive at the price. Note that the desired spread would also include the yield premium for the issuer's credit rating (if the issuer is not GoI) for the appropriate maturity, if G-Sec zero coupon yield is used for discounting.

It will be appreciated that; where $x = y$ i.e. the contracted and desired spreads are identical, the price of the bond has to revert to par on every coupon refixation day. Therefore, calculating the forward rates etc. is not really necessary: it is enough to **discount the current coupon (known) plus the face value** to the trade date, **at the zero coupon rate** for the balance period of the current coupon, **plus the desired spread**.

(c) However, where $x \neq y$, the assumption of par value at the date of coupon refixation is not valid, since **each coupon will have to yield a return different from the contracted** coupon. The price therefore will differ from par. In that case, the forward rates will need to be calculated and the procedure outlined above will need to be followed.

9.5.1.1 A Special Case

Generally, for most floating rate bonds, the coupon payment date coincides with the refixation of the benchmark floating rate. However, such is not the case in respect of overnight MIBOR-linked bonds. In the case of such bonds, the applicable interest rate is changed every day, and the compounded amount paid periodically. The value of such a bond is the face value plus the accrued (i.e. unpaid) interest—unless there is a credit risk issue involved.

9.5.2 Market Practice

(a) What has been described in paragraph 9.5.1 above is a rigorous system based on the theory of bond pricing. **In practice, however, it is not used by market practitioners**. Apart from its complexity (which can be easily taken care of by specialised software), the reason for its not being used in the market is the need for interpolation of zero coupon curves for the coupon inflow dates. There is no uniformity in market practice in respect of the interpolation techniques to be used for drawing yield curves. There are various techniques and they lead to different interpolated numbers, often differing from each other significantly.

(b) **An alternate approach**

Eugene Fama, well known for his pioneering work in formulating the efficient market theory, developed an equation for the expected price of an asset at a future date based on its current price and the return expected by the investor from now until the future date; the investor will not make the investment at the current price unless his expectations of the future price satisfy his desired rate of return from the investment.

This approach to future prices can be used to develop a model for the price of a floating rate bond on issue or any coupon refixation date. For example, the Italian government's pricing of such bonds was based on the model (the Italian government was historically the largest issuer of floating rate bonds). However, this pricing model **requires two major assumptions** to be made in terms of the future coupons:

- the current (i.e. at the time of valuation/issue) benchmark interest rate will continue through the life of the bond; and
- the market expectations of margin over the benchmark would also remain unchanged.

Fama's model can be used because the final value of the principal amount of the bond is known; by definition, it is the face value. From this, using the cash flows as given by the current value of the benchmark plus the contracted spread over benchmark, discounted at the benchmark plus the desired spread, gives the present value. The mathematical derivation of the issue price formula is described below:

Notation used

P_0 — price on issue date;

P_i — price on the i^{th} coupon refixation date;

r — ruling reference rate;

x — contracted spread over reference rate; and

y — desired spread over reference rate;

n — number of periods to maturity.

(r, x, y in fraction; face value1)

Therefore,

$$P_0 = (P_1 + r + x)/(1 + r + y) \tag{9.5}$$

(The right hand side is the price plus coupon due on the first coupon refixation date, discounted by the desired rate of return: this has to equal the issue price.)

Similarly, on the assumptions of an unchanged reference rate through the life of the bond, and the desired spread,

$$P_1 = (P_2 + r + x)/(1 + r + y) \tag{9.6}$$

Substituting this value of P_1 in the earlier equation,

$$P_0 = \left(\left(\frac{P_2 + r + x}{1 + r + y}\right) + r + x \Big/ (1 + r + y)\right)$$

$$= \frac{r + x}{(1 + r + y)} + \frac{P_2 + r + x}{(1 + r + y)^2}$$

$$= \frac{r + x}{(1 + r + y)} + \frac{r + x}{(1 + r + y)^2} + \frac{P_2}{(1 + r + y)^2}$$

$$= \sum_{i=1}^{2} \frac{r + x}{(1 + r + y)^i} + \frac{P_2}{(1 + r + y)^2}$$

More generally, since $P_n = 1$,

$$P_0 = \sum_{i=1}^{n} \frac{r + x}{(1 + r + y)^i} + \frac{1}{(1 + r + y)^n} \tag{9.7}$$

Note that the issue price will be at a premium if $y < x$, i.e. the desired premium over benchmark is lower than the contracted premium.

This methodology can also be used to calculate the value of the bond on any coupon refixation date.

(c) Where the valuation is being done on a date other than the coupon refixation date, **the first coupon, which is known, and the value of the bond on the next coupon refixation date,** arrived at as per (b) above, would need to be discounted at the current value of the benchmark plus the desired spread, that too for the fraction of the interest period which is still to run before refixation of the coupon.

(d) The generally accepted market practice, including in the huge global floating rate note (FRN) market, uses the approach described in (b) and (c) above. This methodology gives the same value as the method described in (a) above when there is no difference between the desired and contracted spreads, slightly different otherwise. (This practice is expected to be introduced in India shortly.)

In the global FRN market, it is customary to quote prices by means of discount margin, i.e. the desired spread over the reference rate. The valuation then follows the methodology in (b) and (c) above.

Box 9.2 Floating Rate Bonds

Floating Rate Bonds (FRBs) are medium to long term debt instruments offering variable coupons linked to some prefixed benchmark rate, which is usually some short-term rate such as yields on Treasury Bills (TBs) or money market rate. Coupons also include a fixed spread, which may, inter alia, reflect credit risk of issuer, liquidity risk and demand and supply of FRBs at the time of issue. The spread, which remains fixed throughout the tenure of the bonds, is decided at the time of first issuance of the bonds either through an auction or is prefixed by the issuer just before the issuance of bonds. The coupon rate of the bonds is reset at current market rate on every coupon reset date providing market risk immunising characteristic to FRBs. This makes them an attractive investment instrument to depository institutions particularly in a rising interest rate scenario. To the issuer, the bonds offer the advantage of bringing down the cost of borrowing in falling interest rate scenario but in a rising interest rate scenario the debt servicing cost may increase.

In India, the FRBs were issued by the Government of India for the first time on September 29, 1995. As the first issuance failed to generate enthusiastic response, no further issuance of FRBs was undertaken for nearly 6 years. Subsequently, on November 21, 2001, the FRBs were reintroduced with some modification in the structure on the request of market participants. Overwhelming market response showed the way for subsequent issuances and till October 9, 2004 ten issuances of FRBs were undertaken. However, the later phase witnessed gradual erosion in the market interest for FRBs, with last two FRBs devolving partially on the Reserve Bank and the PDs. Erosion in the market interest for FRBs at that time was, inter alia, attributed to strong credit pick-up, low secondary market liquidity in FRBs, structure related issues and consequent complex pricing methodology followed by market participants. As regards low secondary market liquidity in FRBs, it could be attributed to (i) low trading interest of market participants in the FRBs as they, by design, are a hedging instrument and offer limited scope for trading gains, (ii) no reissuance of FRBs on account of complexities associated with pricing FRBs, (iii) preference of the commercial banks to place these bonds under Held to Maturity category reducing the availability of bonds for trading, and (iv) complex pricing method which deterred the market participants from undertaking outright transactions in FRBs.

The complexities in pricing of existing FRBs are associated with the method of valuation used by market participants and the benchmark for determining the semi-annual coupon *payments. Theoretically, an ideal benchmark instrument should have the following characteristics: (i) the tenor of that instrument should equal the coupon payment period as well as the coupon reset period of the bonds, and (ii) the yield of the instrument should reflect the prevailing market yield. In the absence of any instrument fulfilling the above characteristics, 364-day TBs were used as a benchmark instrument at the time of re-introduction of FRBs. The use of cut-off yield of 364-day TBs as benchmark rate for resetting semi-annual coupon has contributed to the complexity in the pricing of FRBs. The issue could theoretically be addressed by making use of 182-day TBs as the benchmark instrument but these TBs have not emerged so far as a liquid instrument.*

The existing valuation method used by market participants assumes FRBs as long term bonds, paying variable coupons till the date of maturity. The (dirty) price of FRBs as per this method is arrived at by discounting the sum of the expected coupon flows on the next coupon payment date and the expected price of the FRBs on the next coupon reset date by a suitable discount factor for a period covering the valuation date to the next coupon reset date. The expected price of FRBs on the next coupon payment date is recursively derived from the expected price on the maturity date. For this purpose, forward rates computed from the zero coupon rates, which are adjusted for convexity and time factors, are used to estimate the expected coupon payment rate on each coupon reset dates and also the suitable discount factor. Besides complexity, the above method also suffers from a lacuna that the price of FRBs under this method does not necessarily come back to its par value on a reset date, which undermines the interest rate risk immunisation characteristic of the bonds. The existing methodology for pricing of FRBs, therefore, needs simplification. A simpler method for pricing the FRBs such as one which uses spread based pricing, as is the case internationally, may perhaps be more appropriate.

References

1. Fabozzi, F.J. and S.V. Mann, *Securities,* John Wiley & Sons.
2. FIMMDA (2001), " Valuation Methodology for SLR and non-SLR Securities".

Source: RBI Annual Report 2005-06

9.5.2.1 The Price Change

It will be useful to discuss one other point: the difference between P_i and $P_{(i-1)}$. Is this constant, or does it vary?

Consider Eq. (9.5) in a recasted form

$$P_1 = P_0 \times (1 + r + y) - (r + x) \tag{9.8}$$

$$P_1 - P_0 = P_0(r + y) - (r + x) \tag{9.9}$$

Similarly,

$$P_2 - P_1 = P_1(r + y) - (r + x)$$

Or more generally,

$$P_i - P_{i-1} = P_{i-1}(r + y) - (r + x) \tag{9.10}$$

If $y > x$, i.e. desired spread more than the contracted spread, $P_1 > P_0$ and more generally $P_i > P_{(i-1)}$. Consider the right hand side of Eq. (9.10). It is obvious that, when $y > x$, the price change from one coupon to another keeps increasing with i—in other words

$$P_2 - P_1 > P_1 - P_0\text{; or}$$
$$P_i - P_{i-1} > P_{i-1} - P_{i-2}\text{; or}$$
$$P_n - P_{n-1} > P_{n-1} - P_{n-2}$$

If, however, $y < x$, then $P_i < P_{i-1,}$ the price change is negative and keeps falling as i increases.

9.5.3 Inverse Floaters

Some time back, a few "inverse floaters" were issued in the Indian market. The applicable rate of interest is expressed as a given number (say, 10%) **minus a suitable floating rate benchmark like T-bill or CP yield**. Thus, for such inverse coupon floaters, the applicable interest rate rises when the benchmark floating rate falls. Inverse floaters have not proved very popular.

An example would be a coupon of say (10%—6 month MIBOR for MIBOR ≤ 10%; zero otherwise). Inverse floaters can be used to hedge the risk of falling interest rates as part of asset liability management. They are sometimes also issued in leveraged form, say (20%—2 × MIBOR), where both the losses, and gains, from changes in interest rates are higher, for a given amount of investment.

Such mechanisms are also used in complex structured finance or derivatives transactions.

There are two ways of looking at the question of valuing inverse floaters:

(a) Consider the ruling "receive floating, pay fixed" swap rate (see Chapter 12 for a discussion of interest rate swap rates). You can calculate the expected inflows by deducting the swap rate from 10%, which is the expected fixed rate coupon on the bond. The fair price of the bond can now be calculated in the normal way.

(b) There is another way of looking at the bond. Consider that the investment in an inverse floater is INR 100 and the coupon (10%—6-month MIBOR). The cash flows from this investment are the same as cash flows from a portfolio consisting of:

   (i) An investment in a 5% coupon bond with a face value of INR 200;

   (ii) Issue of INR 100 face value floating rate bond with a coupon equal to 6-month MIBOR; and

(iii) Purchase of a cap on MIBOR of 10% on a notional principal of INR 100

This combination clearly gives the same cash flows as the cited inverse floater. Therefore, the market price of the portfolio, consisting of the three elements described above, is the fair price of the inverse floater. (At present, there are no interest rate options like caps in the Indian market.)

Chapter 10

Bonds with Options

10.1 Types

While bonds with embedded options are not as prevalent in the Indian debt market as in the more advanced countries, they are by no means unknown. Indeed, several different types have been in vogue for many years now:

- Many highly rated companies have issued **overnight-MIBOR linked bonds with daily call and put options**. Such bonds carry a small premium over MIBOR (i.e. overnight interbank rate). These can be used to reduce the cost of working capital finance as, generally, the overnight MIBOR plus the premium, would be below the interest rate on, say, cash credit accounts. The call option implies that the issuer can choose to prepay the bond on any day—obviously he would do so if call rates shoot up. The risk is that, the put option, which allows the buyer to "put" the bond to the issuer, i.e. insist on prepayment on any day, would be exercised when money market is tight, or the investor needs the funds for any other purpose. (For example, a mutual fund investor in the bond, facing redemption demands from its investors, may exercise the put option.)
- When ruling interest rates are high by historical standards, many companies have issued **bonds with an option to "call", i.e. prepay**, before maturity. With such bonds, the issuer was assured of funds for the full maturity of the bond, but could refinance it at an earlier date should interest rates drop.
- **Housing loans** generally confer an **option to the borrower to prepay** the loan. Therefore, mortgage backed securities are often subject to prepayment risk. This topic is discussed at some length in Chapter 11.

- **Bonds convertible**, fully or partially, **into equity** of the issuing company at the option of the holder and subject to conditions such as exercise date, price etc., have been issued since long. (This option is however of a somewhat different type than the ones discussed earlier.)

At the time of writing, there is only one outstanding G-Sec with call/put options in the Indian market.

10.2 Rationale for the Issuer and Risks for the Investor

Where a fixed interest bond has a call and a put option, there are **strong chances of one of the two being exercised**: if interest rates fall, the issuer may find it economic to exercise the call option. (In principle, this would also depend on the extent of the fall and the overall cost of refinancing including front end fees, rating, legal and other costs.) On the other hand, should interest rates rise, the investor may choose to "put" the bond to the issuer and insist on premature payment as he could then invest the proceeds at the ruling, higher rates.

In the case of such bonds, therefore, one of the two options is more than likely to be exercised—unless the fall in yields is so small that it does not compensate for the refinancing expenses. Therefore, it would be best to make yield comparisons on this assumption. On the other hand, callable bonds with no put options, present certain special features from the investor's angle. Some of the issues involved are discussed in subsequent paragraphs.

10.3 Analysis of Callable Bonds

From the investor's angle, it is obviously necessary to compute and compare the yield keeping in mind the possibility that the call option could be exercised by the issuer. For this purpose, the **exercise price of the option should be considered if it differs from the face value**. Two different situations need to be considered:

(a) Bonds purchased at a discount to the issue price. The purchase price implies that yields have gone up since the bond was issued—making it less likely that the bond would be "called". A prudent investor may therefore like to compute two yields—yield to option exercise as suggested in paragraph 10.2, and the customary yield to maturity. For analytical purposes and yield comparisons, he would choose the lower of the two yields, and compare with yields on other, similarly rated, straight bonds with similar maturity/duration.

(b) On the other hand, bonds quoted at a premium to exercise price are more likely to be "called": the premium implies that the current market yields are lower than at the time the bond was issued. Therefore, there is greater likelihood of the issuer finding it economic to prepay the bond and, therefore, of the bond being called. In such cases, it would be sufficient to consider the yield to exercise of the call option. In general, it is worth noting that the call option would be exercised only if interest rates have fallen and, therefore, the investor will then have to reinvest at lower yields. This will lead to diminished returns if the time horizon of the investor is longer than the date on which the call option can be exercised.

10.4 Analysis of Callable Bonds: Another Approach

From the investor's perspective, a more rigorous way of analysing investments in callable bonds, which quantifies the probability of the bond being called, is to look at it as a portfolio of two instruments:

(a) **investment in a straight, non-callable bond**, with identical maturity and coupon, and

(b) **sale of an option on the bond** to the issuer, giving him the right to prepay at a stipulated time and price

To elucidate the methodology, it will be useful if we take a concrete example. Consider a 5-year maturity bond carrying an 8.5% coupon with an embedded call option in favour of the issuer to prepay the bond at the end of three years. Let us further assume that the issuer's front end cost of prepaying and refinancing the amount at the end of three years, for the balance period of two years, is, say, 1% p.a. In other words, the issuer would choose to exercise the option in his favour only if, at the material time, the coupon or yield on similarly rated bonds is less than 7.5%: the option exercise price is therefore 100 for a two-year bond, yielding 7.5%. The lower the actual yield at the end of three years, higher is the value of this option. Again, the option will not be exercised if the yield on similarly rated 2-year bonds at the time of maturity of the option, is higher than 7.5%.

Therefore, conceptually, the **investor in the callable bond is writing an option to deliver a 2-year maturity, similarly rated bond with a coupon of 7.5%**, at par, at the end of three years. Having defined the parameters of the option, it will now be possible to ascertain its value by the standard option pricing methodologies.

The advantage of such an analysis is that it allows a comparison of the yield on callable bonds with those on straight, non-callable ones. To consider how, we assume that the value of the option is Rs 5 when we are evaluating the pricing, and that the yield on a straight, non-callable, similarly rated 5-year maturity bond is 8% p.a. In that case, the market price of the straight bond could be reduced for analytical purposes, by Rs 5 (i.e. the value of the option embedded in the callable bond), and the yield recalculated. Such recalculated yield can now be compared with the 8.5% coupon available on the callable bond in order to make the investment decision.

An advantage of such an approach is that it **allows yield and price comparisons to be made through the life of the bond** in order to exploit any under- or over-valuation in market prices, for sale/purchase decisions.

To recapitulate, what has been suggested is the following equality between the prices of callable and non-callable bonds of the same maturity and coupon:

Price of a non-callable bond of the same coupon and maturity = the price of a callable bond + the price of the option.

Symbolically, $P_{nc} = P_c + P_o$

This relationship has some interesting corollaries. If interest rates are rising, both P_{nc} and P_c will fall, and so will P_o (because, with rising interest rates, the option is less likely to be exercised). Therefore, to maintain the equality, **P_{nc} will fall more than P_c**. On the other hand, in a falling interest rate scenario, both P_{nc} and P_c will rise and so will P_o. Therefore, the rise in P_c will be less than the rise in P_{nc}. This phenomenon is sometimes referred to **as inverse convexity**. The topic of convexity is discussed in Chapter 13.

10.5 Duration and Convexity of Callable Bonds

Conceptually, the approach is to arrive at the first and second differentials of the price of a callable bond, with reference to yield. This requires us to look at the terms on the other side of the above equation and their differentials: note that the first and second differentials of the price of the non-callable bond are its modified duration and convexity. Similarly, the delta and gamma of the option are the first and second differentials of the option price, with reference to change in the price of the underlying bond.

While the concepts of **duration and convexity of straight bonds are discussed in detail** in Chapter 13, we do not propose to discuss the bond option mathematics as there are no bond/interest rate options in the Indian market currently. However, it is useful to understand the conceptual framework of the approach. Please also see Annexure 12.1.

Chapter 11

Securitisation

11.1 Introduction

Securitisation refers to the **process of pooling and selling existing assets in the books of a lender/creditor** (The "Originator") to a Special Purpose Vehicle (SPV), and repackaging them into tradable, asset-backed securities (ABS). The essential features of securitisation include the following:

(a) the sale proceeds are available to the Originator of the transaction (i.e. the seller) immediately;

(b) the assets are taken off the Originator's books, and are not available to the Originator's creditors in the event of his bankruptcy;

(c) can have higher credit ratings than the Originator's, depending on the quality of assets securitised and the credit enhancements made available.

A wide **variety of assets and their portfolios have been securitised** into tradable securities. Apart from mortgage loan repayments, the more common assets securitised include auto loan repayments and credit card, educational loan, lease and industrial loan receivables, etc. Traditionally, existing receivables, i.e. those not contingent upon any performance of the Originator, were securitised. In some cases, there is also **"revolving securitisation"** where assets are transferred/sold to the SPV as and when they come into existence, or at periodic intervals, and consideration is paid to the Originator only at the time of the transfers. Such "revolving securitisation" is different from "future flow securitisation" described in the next paragraph.

Under **'future flow securitisation'**, cash flows to be generated by the Originator in future are securitised, and the proceeds made available to him up-front. Internationally, future flows like remittances from overseas, cross-border telephone settlements, export receivables, vacation home rentals, music album royalties, movie receivables, income tax revenues, etc., have been successfully securitised. In such cases, the amounts that may be received are forecasts, not contractual obligations. Therefore, the money raised through the securitisation structure is but a fraction of the forecasted receipts. Any surplus with the SPV after servicing the debt is passed back to the Originator of the transaction, under both asset and future flow securitisation.

11.1.1 Asset and Mortgage Backed Securities

The largest segment of asset-backed securities (ABS) in financial markets is formed by the mortgage-backed securities in the United States. These are securities backed by cash flows from a large number of home loans. Bond Market Association data evidence that in 2004 the aggregate new issues of ABS in the U.S. totalled almost $ 900 bn, for the first time exceeding the issue of plain vanilla corporate bonds. Of the aggregate ABS issues, about half were mortgage backed.

The term asset backed securities (ABS) is used when the underlying assets are of a uniform nature, e.g., car loans. There are securitisations of diversified assets also (see paragraph 11.3.1 below).

11.1.2 Securitisation Market in India

Box 11.1 Extracts from "Structured Obligation" (a publication of CRISIL)

"Asset backed securitisation commenced in India with a car loan transaction originated by Citibank in the year 1992. Since then, the market has grown rapidly, with India becoming one of the largest securitisation markets in Asia, after Japan and Korea. As per CRISIL estimates, more than 300 transactions, involving a cumulative volume of Rs 500 Billion have been placed in the market till date."

"The successful execution of a securitisation depends on the investor's uncontested right to securitised cash flows. Hence, securitised loans need to be legally separated from the Originator of the loans. In order to achieve this separation, a securitisation is structured as a three-step framework:

1. *A pool of loans is sold to an intermediary by the Originator of the loans. This intermediary (called a Special Purpose Vehicle, or SPV) is usually incorporated as a trust. The SPV is an entity formed for the specific purpose of transferring the securitised loans out of the Originator's balance sheet, and does not carry out any other business.*
2. *The SPV issues securities (Pass-through Certificates or PTCs), backed by the loans, and by the payment streams associated with these loans. These securities are purchased by investors. The proceeds from he sale of the securities are paid to the Originator as purchase consideration for the loan receivables.*

> 3. *The cash flows generated by the loans over a period of time are used to repay investors. There could also be some credit support built into the transaction to protect investors against possible losses in the pool. However, the investors will typically have no recourse to the Originator.*
>
> (November 2004)

The **first asset backed securitisation in India occurred in 1992**. It involved securitisation of a car loan portfolio by Citibank. Since then several hundred securitisation issues have taken place.

Some of the assets securitised frequently include car and vehicle loans and mortgage loans. Rating agencies have identified at least 16 different types of asset classes, which have been securitised in India. The potential for securitisation is huge also in terms of micro finance loans, non-performing assets of banks, deferred sales tax dues of state governments, and other asset classes or future flows.

There has occurred an explosive growth in housing finance in recent years. Given the long term nature of housing loans, they do create asset liability management problems for housing finance companies and lender banks. Securitisation could be an answer. Again, non-performing assets also present a securitisation opportunity.

The Reserve bank has come out with its Guidelines on Securitisation of Standard Assets in February 2006. The Institute of Chartered Accountants of India issued its Guidance Note on Accounting for Securitisation, in March 2003 (see paragraph 11.9).

11.2 Process of Securitisation

The process of securitisation starts with the Originator desiring to securitize some of his assets. The reasons could be various, and some of them are discussed in paragraph 11.4 below. Having decided in principle to securitize some assets, the **Originator needs to decide the amount** he would like to raise through the securitisation process, and proceeds to **select a pool of homogenous assets** for the purpose. The pool will be such that the securitisation proceeds will meet with the Originator's objective of the amount to be raised.

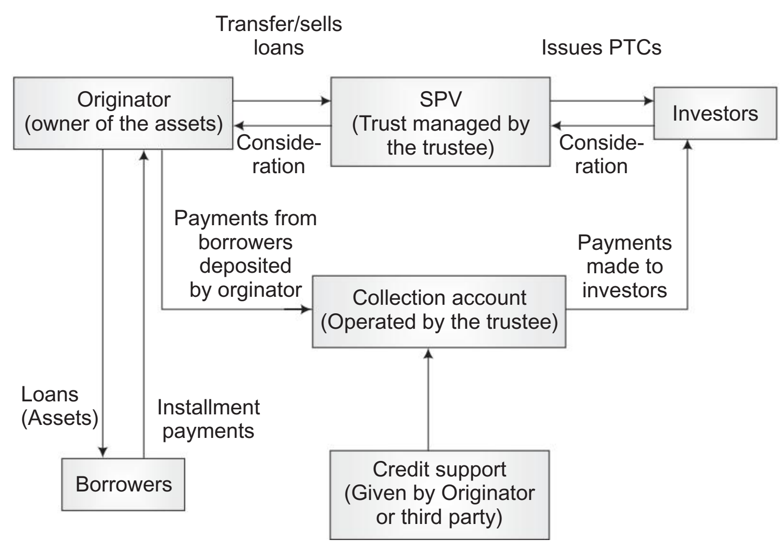
The next step would be the **involvement of a rating company** which will review in detail the portfolio or pool of assets to be securitised, their characteristics as to interest rates, maturity, etc., and the debt servicing record of the borrowers. For this purpose, generally the assets to be securitised would have been "seasoned" for a few months or years so that the past record of servicing of the debts to be securitised, is available. Generally, the Originator specifies the kind of rating he is looking for the securitised paper, and the rating company prescribes the credit enhancements, by way of cash margin or otherwise, that would be necessary to back the transaction so that the resultant security can get the desired rating.

Once all these issues have been sorted out, a **special purpose vehicle**, typically a limited company (or trust) with a nominal capital and independent of the Originator, would be formed. The SPV would buy the designated assets from the Originator, and issue securities ("pass-through certificates", or PTCs) backed by the cash flow from the assets, for sale to investors. The proceeds are used by the SPV to pay for the purchase of assets from the Originator.

The cash flows generated from the securitised assets would be used to honour the obligations to the investors in the securities.

A diagrammatic representation of the process is as follows:

Diagrammatic representation of a securitisation transaction



Source: CRISIL's Securitisation Handbook

Note that, in the diagram, the originator is also performing the role of the servicer (see paragraph 11.2.1).

Credit enhancements aimed at improving the credit rating of the PTCs, are an integral part of securitisation. This point is discussed in some detail in paragraph 11.7 below. RBI Guidelines on securitisation make it mandatory for securities to be issued by the SPV to be rated.

11.2.1 The Different Entities

The various entities in the structure and their brief roles are summarised below:

(i) **Originator**: The seller of the (present or future) receivables. Typically, the Originator is a bank, a non-banking finance company (NBFC), a housing finance company or, occasionally, even a manufacturing/service company.

(ii) **Special Purpose Vehicle (SPV)**: SPVs are the issuers of the securities. SPVs are typically companies with small capital, or sometimes trusts, formed for the specific purpose of issuing securities (pass through certificates, or PTCs) in securitisation transactions. The SPV uses the proceeds of the issue to buy the receivables from the Originator. The remoteness of the SPV from bankruptcy of the Originator is a critical element of such transactions. In other words, it needs to be ensured that the securitised cash flows will not be affected by insolvency of the Originator. The RBI Guidelines have specified detailed criteria for the SPV.

(iii) **Investors**: Investors are the purchasers of ABS. Banks, financial institutions, NBFCs, mutual funds, foreign institutional investors (FIIs) and even individuals could invest in ABS.

(iv) **Servicer**: The Servicer collects the moneys due from individual borrowers in the pool, makes payouts to the investors and follows up on delinquent accounts. The servicer also furnishes periodic information to the rating agency and the trustee on pool performance. There is a service fee payable to the servicer.

(v) **Trustee**: Trustees tend to be reputed banks, financial institutions or firms of Chartered Accountants or Solicitors. The trustees have a fiduciary role to oversee the performance of the transaction until maturity with a view to protect investors' interests. The trustee is vested with the necessary powers for the purpose including, in particular, the power to change the Servicer, if necessary.

(vi) **Rating Agency**: As ABS issues are required to be rated, rating agencies play an important role in the entire structure. Rating agencies typically get involved right from the beginning of the transaction and help the Originator with the pool selection and structuring of the transaction. The rating agency also specifies the level and form of credit enhancement that is needed for the rating desired by the Originator. Rating agencies also make presentations to and hold conferences with merchant bankers and investors to provide information and clarifications on the securitisation programme. Subsequent to the issue and sale of the securities, the agency monitors the pool performance based on the monthly reports from the Servicer. It may revise the collateral level downward if it believes that it is safe to do so without affecting the rating. This would happen only if the pool performance is superior than that estimated/forecast at the time of the original rating (current RBI guidelines disallow this).

11.3 Structured Finance

The term "structured finance" is often used as a synonym for securitisation. More generally, structured finance has been defined as "*a technique where certain assets with cash flows can be isolated from the Originator in order to deal with the risks specific to these assets, the objective being to secure or improve credit*". The definition standardised by the United Nations Conference on Trade and Development (UNCTAD) is similar: "*A technique whereby certain assets with more or less predictable cash flows can be isolated from the Originator and used to mitigate risks (e.g. transfer of foreign exchange, contract performance and sovereign risk), and thus secure a credit.*"

More complex structures like collateralised debt obligations (CDOs—paragraph 11.3.1) and collateralised mortgage obligations (CMOs—paragraph 11.5.4) are also examples of structured finance.

11.3.1 Collaterised Debt Obligations (CDOs)

In **CDO transactions, the debt securities issued by the SPV are backed by a diversified loan or bond portfolio**. There is thus a basic difference between CDOs and ABS, the latter being homogenous pools of assets such as mortgages or credit card receivables, in contrast to the diversified portfolios backing CDOs.

In recent years, **CDO transactions have become increasingly complex**. In their simplest version, the credit risk on a portfolio transaction is typically divided into at least three tranches, each carrying a different level of credit risk and hence coupon. By way of an example, a USD 200 mn portfolio may have say USD 25 mn as the "first loss" tranche, the next USD 40 mn as the mezzanine tranche and the balance USD 135 mn as the senior, or safest, part of the debt. If there is a loss of say USD 45 mn, in the recovery from the debts, the investors in the first loss tranche would lose their total investment of USD 25 mn, and the investors in the mezzanine tranche USD 20 mn. In this scenario, investors in the third, i.e. the senior tranche, would lose nothing. As is to be expected, this tranche will carry the lowest coupon among the three! In most cases of CDOs, the amounts of the three tranches are so structured and secured by credit derivatives, etc., that the most senior debt carries a AAA credit rating.

What has been outlined in this paragraph is the simplest of CDO structures. So far, there has been **no multiple tranche securitisation transaction, with each tranche carrying a different rating, in India**, although several multi-tranche issues of varying maturities and interest rates have taken place.

Internationally, investment banks involved in packaging CDOs often resort to far more complex structures, which even the more sophisticated investors are sometimes finding difficult to assess properly.

11.4 The Originator's Perspectives

The Originator can have different objectives in securitising assets. One is **asset liability management**, for example, an MBS program may help remove long term assets from the Originator's books, as part of overall balance sheet management, and reduce asset liability mismatches. Securitisation would also help in freeing capital for other, more remunerative uses.

Some of the major Originators in the Indian market have been ICICI, Citibank, HDFC, etc.

11.5 The Investors' Perspective

The investors' perspectives in buying such securities could be to diversify assets, meeting housing finance objectives (RBI allows MBS to be counted as housing finance lending to priority sector, subject to fulfilment of certain conditions–Circular of July 20, 2004), or **enhancing yields**. Securitised instruments generally have higher yields compared to straight debt paper with the same rating and duration, but suffer from ill-liquidity and higher interest rate risks.

In the rest of paragraph 11.5, we discuss some issues relating to interest rate risk, a topic discussed in detail in Chapter 13. The reader may therefore like to come back to the following discussion after studying Chapter 13.

11.5.1 Interest Rate Risk for the Investor: MBS

The principal **risk for the investor in mortgage backed securities** is the interest rate risk. This arises from the fact that, the world over, the housing loan borrower has the option to prepay the fixed rate loan at any time without any penalty. When interest rates are falling, a larger number of loans get prepaid as the borrowers prefer to refinance them at the ruling, lower interest rates, or shift to floating interest rates. Loans get prepaid also when the borrower sells the house for whatever reason. Since all cash flows from the underlying pool of assets are passed through to the investors in the PTCs, in this scenario, the investor gets his money back earlier to what he had envisaged, and would now need to **reinvest the prepayments at the ruling, lower interest rates**. Clearly, therefore, the investor faces a significant re-investment risk on mortgage backed securities.

Given the option to the borrower to prepay the mortgage loan, it is customary to calculate the yields and durations (see Chapter 13) of mortgage backed securities **assuming a certain prepayment rate**: this is known as the constant prepayment rate (CPR). In the current Indian environment, there is not enough empirical data to factor such prepayment assumptions in the calculations with any degree of reliability.

The annualised CPR benchmark standardised by the Public Securities Association for 30-year MBS issues in the U.S. market is as follows:

(i) 0.2% of the outstanding principal less scheduled repayment of the month, in the first month of a new pool of assets;

(ii) CPR goes up by 0.2% every month for 30 months; and

(iii) stabilises at 6% p.a. thereafter.

While this is the benchmark, the actual cash flows are sensitised using various percentages of the benchmark (say 75% or 150%), depending on the pool characteristics. To help investors, the Bond Market Association also publishes bimonthly, an estimate of the current prepayment rate, based on a poll of investment banks.

In principle, once the factor has been determined, cash flows of MBS are prepared assuming prepayment of the given percentage of outstanding principal amount. The yields and durations of the PTCs are then reworked on the basis of these revised cash flows.

11.5.2 Negative Convexity

In both falling and rising interest rate scenarios, the investor faces the possibility of the prepayment being different than the prepayment rate assumed at the time of the investment: higher when interest rates are falling and lower when they are rising. Consequently, the **duration of the portfolio falls when market rates are falling and rises in the opposite scenario**: the "contraction" and "extension" risks.

As will be discussed later in Chapter 13, for standard bonds, the price: yield relationship is convex, implying that, for a given change in yield, the price rise is higher than the price fall.

In the case of MBS, because of the exercise or non-exercise of the prepayment option, the situation is exactly the reverse.

- lower price rise (or even price fall), when interest rates are falling; and
- higher price fall when interest rates are rising.

This phenomenon is known as **"negative convexity"**. Note that the terms 'lower price rise' or 'higher price fall' are in comparison with the price volatility estimated at the time of the investment decision. In turn, this is based on the assumed prepayment rate as discussed in paragraph 11.5.1. The actual prepayment rate changes with interest rates.

11.5.3 PTCs Purchased at Discount and Premium

Prepayments have varying impacts on PTCs purchased otherwise than at par. Like other fixed income securities, PTCs would trade at a discount if the coupon is less than the ruling market rates and vice versa.

Consider the impact of prepayments (larger than those assumed when the investment decision was taken) on PTCs purchased at a discount. Since market rates are higher, prepayments would be unlikely. But, to the extent prepayments happen, the **redemption gains (i.e., the difference between purchase price and par value) will be expedited, and improve the yield** —as a higher amount can now be invested at the ruling, higher yields than factored earlier.

Contrarily, larger prepayments on than originally factored, securities purchased at premium, will tend to reduce returns by pre-poning the redemption losses and because reinvestment will now be at lower interest rates.

11.5.4 Interest Rate Risk Mitigation: CMOs

The prepayment risk for the pass through certificates based on a pool of mortgage loans is, as we have seen, a genuine, unavoidable risk in investing in such securities. It, however, can be **mitigated or reduced** for certain classes of investors through more complex structures. These are known as collateralised mortgage obligations (CMOs).

The portfolio of assets backing CMOs can consist of plain vanilla PTCs as also a pool of mortgage loans. The structure of a **CMO converts the cash flows from the underlying assets into different classes of securities** with varying maturities and risk parameters and, obviously, different coupons to reflect the risks. Consider a relatively simple structure:

(i) The CMO comprises three types (or tranches) of securities, A, B and C.

(ii) All cash inflows are first utilised to pay interest on A and B (but not on C) tranches

(iii) The surplus after payment of interest on A and B is then applied to pay the principal amount of "A" securities. When all the "A" class securities are paid off, then the entire cash inflow is applied to serving "B" class securities–interest and principal.

(iv) Only after the entire "A" and "B" tranches are paid off, do any monies come to "C" tranche, firstly for accumulated interest, then for principal.

Clearly, "A" tranche securities are the safest and earliest maturing (therefore with the lowest maturity and interest rate risks), followed by "B" and "C" tranches. Each tranche would therefore have different rating and coupon reflecting their characteristics.

Fixed rate inflows can also be used for creating floating rate tranches through a combination of straight and inverse floaters (see Chapter 9). Inverse floaters can help hedge the interest rate risk on floating rate assets, as their yield goes up when interest rates are falling and vice versa.

11.5.5 Floating Rate PTCs

In India, with the prevalence of floating rate mortgages, floating rate PTCs have been tried out. One lacuna is the lack of a floating rate benchmark for housing loans, acceptable to, and used by, the market.

11.6 Legal Issues

One grey area in the Indian scenario is that, at present, ABS are not recognised as securities under the Securities Contract (Regulation) Act (SCRA), and therefore cannot be listed. However, this is likely to change shortly as the necessary legislation is in the process of being enacted. Even thereafter, some basic, issue-specific points that need attention, will remain (see Box 11.2).

Box 11.2 Extracts from "Structured Obligation" (a publication of CRISIL)

True sale

'True sale' is the single most important issue in any securitisation transaction. A true sale will establish that the assets transferred to the SPV are bankruptcy remote from the Originator's estate.

Since there is no statutory definition of true sale or any judicial interpretation of the same as yet in India, when evaluating a transaction for true sale, CRISIL will examine the following:

- *Extent of recourse to the Originator and risk retained by the Originator in the assets. While, mere recourse to the Originator will not vitiate true sale, it is important to check the extent to which the transferee will have recourse to the Originator. This reflects the risk retained in the assets by the Originator.*

The higher the level of risk retained by the Originator the greater the chances that the assets cannot move off its balance sheet. Therefore, while the transfer of assets to the SPV may be valid, the assets themselves may not be remote from the Originator's estate in bankruptcy.

Although there are diverse case laws on the subject of true sale, CRISIL is of the opinion that in cases where the Originator retains a high level of risk in the assets, the courts are likely to recharacterise the securitisation as secured borrowing by the Originator. Therefore if transactions have unusually high levels of credit enhancement from the Originator CRISIL may regard such transfers as being inconsistent with a true sale.

Option and obligation to repurchase assets

CRISIL will treat an obligation on the part of the Originator to repurchase assets on account of deteriorating credit quality as being inconsistent with a true sale. Accounting guidelines issued by the Council of the Institute of Chartered Accountants of India however, permit the Originator to provide the transferee with a put option for the assets and if the option is structured as an arm's length transaction, distinct from the transfer of the assets, this will not vitiate a true sale.

Where there is a put option, CRISIL will examine the option contract to determine if the same can be construed as a transaction that is distinct from the securitisation.

In most cases the servicer retains the option to purchase the assets when they decline to 10 percent or less than the size of the original pool. This is not inconsistent with a true sale because such a repurchase is not linked to the credit quality of the assets.

Intention of the parties

The intention of the parties to a transaction is often scrutinised by the courts in order to determine a true sale. Therefore it is important that the language used in the transaction documents clearly conveys the intentions of the parties and that the nuances of a transaction do not have the potential to vitiate a true sale. For example, the price at which the assets are purchased is an important consideration for establishing the intention of the parties. An unviable purchase price (if the purchase price received is significantly less than the fair market value of the assets sold) can have the effect of re-characterising a securitisation.

Therefore, CRISIL examines each transaction document to ensure that there are no discrepancies between the terms of the proposed transaction and the execution of the same.

Extent of control retained by the Originator over the assets

In some transactions, the Originator may retain control over the assets even after they have been transferred. For example, the Originator may have a call option on the assets or the transferee may be restricted from further transferring the assets.

CRISIL will acknowledge a transfer to be a true sale only if the transferee gains unrestricted rights to the assets. Covenants restricting the transferee's ownership of the assets will be viewed as inconsistent with a true sale.

Appointment of the Originator as servicer

The appointment of the Originator as the servicer could be inconsistent with a true sale if for example, the servicer indemnifies the transferee because of payment defaults by the obligors or if the Originator takes on the risk of servicing the assets without adequate consideration. CRISIL acknowledges that even if the documents do not evidence an adequate servicer fee the servicer, consideration may be reflected in the purchase price.

It is also important that the transferee be given the right to appoint another servicer if the Originator fails to comply with the terms of the servicing agreement. This will further prove that the Originator has lost control over the transferred assets.

Apart from the due diligence conducted by it, CRISIL also bases its analysis of a transaction on professional opinion. For each transaction CRISIL requires the Originator to obtain a legal opinion from an independent counsel confirming that the transfer of assets is consistent with a true sale. (June 2004)

11.7 Credit Risk for the Investor

The general **experience of default risk on asset or mortgage backed securities, internationally and in India, has been quite satisfactory**. Rating agencies have played a major role in making the instruments conform to the risk parameters of the ratings sought typically, most Originators would like a "AAA" rating for the senior-most tranche, and the rating agencies, based on their analysis of the pool of assets, its historical record and other factors, prescribe the credit enhancements to be put in place by the Originator, for the issue to become eligible for the coveted AAA rating (see Box 11.3).

Box 11.3 Extracts from "Structured Obligation" (a publication of CRISIL)

Credit enhancement

- ***Cash collateral***

  CRISIL examines bankruptcy remoteness in light of the timeliness of payment. In cases where the credit enhancement is in the form of cash collateral, as CRISIL require the cash collateral to be bankruptcy remote from the Originator, that is in case of default the funds in the cash collateral account may be frozen by the trustee and used to pay the investors CRISIL stipulates the following:

> *(i) The cash has to be maintained in a separate account. If the account is a current account then the documents have to expressly state the money lying in the account is being held in trust for the benefit of the trustee. The cash collateral can also be maintained as a fixed deposit, in which case the maturity proceeds of the deposit have to be endorsed in favour of the trustee upfront. The Originator may however be a beneficiary to the residual amounts, if any, in the fixed deposit after payments from the same have been made.*
>
> *(ii) There should be a separate agreement entered into between the account bank, the trustee and the Originator, laying down the mode of operation of the cash collateral account and the rights and liabilities of the respective parties in respect of the account.*
>
> *CRISIL requires that the legal opinion furnished by the Originator also confirms the bankruptcy remoteness of the cash collateral from the Originator.*
>
> ✧ ***Guarantee/corporate undertaking***
>
> *In cases where the credit enhancement is in the form of a guarantee or a corporate undertaking, CRISIL requires that these be unconditional and irrevocable. CRISIL will examine the documents to determine this and also ask for a legal opinion confirming that the guarantee is unconditional and irrevocable. (June 2004)*

11.8 Role of the Structurer/Arranger

If the rating companies play a very important role in evaluating the credit risks and prescribing credit enhancements, **the structurer/arranger also has an important place** in the securitisation process. He analyses the pool cash flows and their characteristics (as to maturity, interest rate—fixed or floating, etc.) and distributes them into tranches (or bundles of PTCs) of varying maturity and/or interest rates, to suit investor appetite. The manager or, more generally, the trustee or investor agent, would also enter into interest rate swaps to convert fixed rate cash flows into floating rates, or vice versa, if required by the investors; bring in inverse floaters if the investors so demand for their own asset liability management etc.

Investment banks often play the structuring role. The result of trying to meet different investors' expectations as to maturity, interest rate risk (and type of interest rates), etc. often is complex structures running into a dozen or more tranches of PTCs with varying parameters.

11.9 Regulatory Requirements

The Reserve Bank has come out with its Guidelines on Securitisation of Standard Assets (i.e. assets other than NPAs or otherwise impaired) in February

2006. The Institute of Chartered Accountants came out with its Guidance Note on Accounting of Securitisation in February 2003. The important provisions under these documents are summarised below.

11.9.1 RBI Guidelines

The guidelines specify the **criteria for "true sale" of assets by the Originator to the SPV**: such true sale is an essential pre-requisite, and involves legal separation of the Originator from the assets, with the purpose of putting them beyond the reach of the Originator or its creditors, even in the event of the bankruptcy of the Originator. This is known as "bankruptcy remoteness" of the transaction and ensures that the cash flows from the securitised assets are available solely for the benefit of the SPV and its creditors, namely the holders of the PTCs. Any restructuring of the debts (i.e. assets) transferred to the SPV, should be done only with the expressed consent of the investors, the providers of credit enhancements and other services.

The Guidelines also lay down **criteria to be met by the SPV**. The SPV should be entirely independent of the Originator, and even name resemblance is prohibited. Any transaction between the Originator and the SPV should be at "arm's length", as between two entirely independent entities. There should be a detailed trust deed specifying the functions of the trustees and their responsibilities towards the holders of the PTCs, with the investors having the right to change the trustee(s).

An option to repurchase performing assets at the end of the securitisation scheme, with residual value not more than 10% of the original amount, can be retained by the Originator.

Credit enhancement can be provided by the Originator and/or third parties. The facility should be limited to a specified amount and duration, and there should be no recourse to the facility provider beyond this. Again, credit enhancement can be provided only at the inception of a transaction. The guidelines also contain criteria for different tranches of the securities issued by the SPV (first loss, second loss, etc.), and regarding liquidity facilities for the SPV.

One accounting rule prescribed in the guidelines is that any **profit or premium earned** by the originator from the sale of assets, **cannot be accounted upfront**, but needs to be amortised over the life of the securities issued by the SPV.

Box 11.4

Securitisation is a process by which assets are sold to a bankruptcy remote special purpose vehicle (SPV) in return for an immediate cash payment. The cash flow from the underlying pool of assets is used to service the securities issued by the SPV. Securitisation, thus, follows a two-stage process. In the first stage, there is sale of single asset or pooling and sale of pool of assets to a ebankruptcy remotei SPV in return for an immediate cash payment. The second stage involves repackaging and selling the security interests representing claims on incoming cash flows from the asset or pool of assets to third party investors by issuance of tradable debt securities.

The salient features of the guidelines issued by the Reserve Bank on securitisation of assets are set out below:

- *The sale should result in immediate legal separation of the originator from the assets which are sold to the new owner, viz. the SPV.*
- *The SPV should meet the specific criteria to enable the originator to treat the assets transferred by it to the SPV as a true sale and apply the prudential guidelines on capital adequacy and other aspects with regard to the securitisation exposures assumed by it. The criteria mainly specifies that: (i) any transaction between the originator and the SPV should be strictly on arm's length basis: (ii) any transction with the SPV should not intentionally provide for absorbing any future losses: (iii) the SPV and the trustee should not resemble in name or imply any connection or relationship with the originator of the assets. In its title or name; and (iv) the SPV should be entirely independent of the originator and the SPV should be bankruptcy remote and non-disretionary.*
- *A bank should hold capital against the credit risk assumed when it provides credit enhancement, either explicitly or implicitly, to a SPV or its investors. Credit enhancement facilities include all arrangements provided to the SPV that could result in a bank absorbing losses of the SPV or its investors. Such facilities may be provided by both originators and third parties.*
- *A liquidity facility is provided to help smoothen the timing differences faced by the SPV between the receipt of cash flows from the underlying assets and the payments to be made to investors. A liquidity facility should meet specific conditions to guard against the possibility of the facility functioning as a form of credit enhancement and/or credit support.*
- *A bank performing the role of a service provider for a proprietary or a third-party securitisation transaction has to ensure certain specific conditions and where these conditions are not met, the service provider may be deemed as providing liquidity facility to the SPV or investors and treated accordingly for capital adequacy purpose.*
- *As the securities issued by SPVs would be in the nature of non-SLR securities, banks investment in these securities would attract all prudential norms applicable to non-SLR investments prescribed by the Reserve Bank form time to time.*
- *The counterparty for the investor in the securities would not be the SPV but the underlying assets in respect of which the cash flows are expected from the obligors/borrowers. These should be taken into consideration while reckoning overall exposures to any particular borrower/borrower group, industry or geographic area for the*

purpose of managing concentration risks and compliance with extant prudential exposure norms, wherever the obligors in the pool constitute 5 percent or more of the receivable in the pool or Rs 5 crore. Whichever is lower.

- *Bank can sell assets to SPV only on a cash basis and the sale consideration should be received not later than the transfer of the asset to the SPV. Hence, any loss arising on account of sale should be accounted accordingly and reflected in the profit and loss account for the period during which the sale is effected. Any profit/premium arising on account of sale should be amortised over the life of the securities issued or to be issued by the SPV.*

Source: Report on Trend and Progress of Banking in India 2005-06

11.9.2 Institute's Guidance Note

One important rule is that the securitised assets can be taken off the books of the Originator **only if the Originator has no control over the assets**. For example, if the creditors of the Originator can have any claim on the securitised assets, or where the SPV cannot transfer the assets, then the Originator will be deemed to have some control over the assets and, in that case, the assets cannot be taken off the Originator's books.

In one important way, the Institute's Guidelines differ from the Reserve Bank's: Under the Institute's Guidelines, the difference between the book value of the securitised assets and the sale price received, needs to be treated as gain or loss and disclosed separately in the profit and loss account.

The Institute's Guidelines also prescribe rules for future flow and revolving securitisation

11.9.3 Other Provisions

The RBI Guidelines and the ICAI Note have also prescribed conditions for underwriting facilities, provisions of services to the SPV, prudential norms for the investor, accounting, disclosure and capital adequacy requirements for the Originator, SPV, and investors.

Internationally, the accounting standards are getting stricter and with the introduction of International Financial Reporting Standards (IFRS) in Europe from the beginning of 2005, cases of securitised assets coming back on the books of the Originator have increased.

Chapter 12

Interest Rate Derivatives: Pricing, Hedging and Valuation

12.1 Introduction

In Chapter 6, we had an overview of the interest rates derivatives currently available in the Indian market. In this chapter we consider the pricing, hedging and valuation of the principal contracts traded in the market: the "price" of a swap is the fixed rate.

12.2 Interest Rate Swaps

As we have noted earlier in Chapter 6, the only interest rate swaps actively traded in the market are **MIBOR** and **MIFOR** based. It is therefore proposed to discuss in this paragraph **only the pricing and hedging of these two swaps**. But the concepts will be applicable for pricing and hedging of other types of swaps as well, when they are actively traded and marketed. Pricing and hedging need to be looked at together as the pricing is based on the cost of hedging plus issues like the desired return on capital, credit premium on the counterparty, etc.

12.2.1 MIBOR-OIS: Elemental Hedge

In such swaps, the floating rate is the overnight MIBOR or the Mumbai Interbank Offered Rate as available on the NSE/FIMMDA sites.

Consider the pricing of a 6 month maturity MIBOR-OIS, pay fixed, receive floating swap. The elemental (or theoretical) hedge will be

- borrow overnight in the interbank market; and
- invest in a 6 month maturity CD.

This portfolio is a hedge for the swap as the "receive floating" pays for the cost of the borrowing, while the income on the CD services the "pay fixed" leg of the swap. Therefore, the fixed rate pricing should, in theory, depend on the ruling CD rate.

It needs to be noted, however, that while the portfolio is a reasonable hedge for the swap, it is not a perfect hedge: the reason is that the floating rate benchmark, namely the overnight MIBOR available on the NSE site, is the "polled" rate at 9.30 in the morning. This may not always agree with the rate at which the bank would be able to borrow in the inter-bank market. In fact, the NSE MIBOR has often differed with the actual rates at which inter-bank money is traded.

For longer maturity OIS (say longer than one year), the first leg will be the same as above but the second will be investment in a corporate or bank bond with 6 monthly coupons—settlement of the interest difference will be six monthly. **The model suggests use of yields on corporate/bank issues as the base for the pricing of the fixed rate leg** and not the corresponding G-Sec or T-bill yields. The reason is simple—counterparties in swaps are corporates or banks and it is not therefore appropriate to price swaps on G-Sec yields. The actual yield differences between G-Secs and corporate or bank (AA or higher rated) bonds (or P1+ CDs) change with demand supply conditions in the market: this is the case in international markets as well. In theory, however, swap prices should be at a premium to G-Sec yields.

A couple of other points are worth noting:

- The hedge for a receive fixed, pay floating swap will be to issue a CD or bond (or short sell another issuer's instrument) and invest the proceeds in the interbank market.
- MIOIS swaps can be priced in the same way, since the floating rate is the mid rate of the MIBOR-OIS swap for the specified period. But, in the market, the overnight MIBOR-OIS, with settlements taking place quarterly for up to one year maturity swaps and six monthly for longer maturities, is the only popular benchmark.

In practice, active banks will not hedge each swap individually, but would **structure the cash flows** resulting from swaps **in the totality of asset: liability management**.

12.2.2 The MIFOR Swap

The features of a MIFOR swap have been described in Chapter 6. The floating rate is an addition of USD LIBOR and the swap cost as obtained from in the USD: INR forex swap market, expressed in % p.a. terms. It thus represents the theoretical cost of raising rupee funds by using USD resources without taking an exchange exposure, i.e. by doing a sell/buy swap. It would be equal to the term inter-bank rates in Mumbai, were the interest parity principle to rule.

Consider a pay 6-month MIFOR, receive fixed three-year swap. The basic, elemental hedge will be

(a) Borrow three-year maturity INR funds, equal to the notional principal of the swap;
(b) Sell the INR notional principal, and buy USD spot at the ruling rate;
(c) Deposit for 6 months at LIBOR;
(d) Sell USD six months forward, principal amount;
(e) Repeat (b), (c) and (d) every six months;
(f) At the end of three years, use rupees generated by USD sale to repay borrowing at (a).

The **fixed rate inflow under the swap can now be priced on the basis of the cost of (a).** The floating MIFOR payment is replicated by (c) and (d) together. This is not, however, a perfect hedge as there are two residual elements this pricing methodology does not take into account. These are:

- interest on rupee funds inflow or outflow, as the case may be, when you exchange cash flows. This arises from
- exchange rate difference on the interest amount. MIFOR is an INR interest rate swap and the floating rate amount thereunder gets determined at the start, while interest on the dollar funds will be realised at end of the period and will need to be converted into INR at the then ruling spot rate. This could therefore be different from the interest at LIBOR on the notional principal, included in MIFOR.

A question could be asked whether this problem can be overcome by selling forward the USD principal **and interest**. The answer is: "not fully or exactly", because then the difference in the rupee amount generated by the forward sale of USD and the notional principal of the swap, will not exactly equal the MIFOR amount. The reason is that **the swap margin included in MIFOR is on the principal amount only**. (Those interested in understanding the arithmetic may like to go through the INR cash flows and calculations in Annexure 12.2 to this chapter.)

A variation with better economics will be possible **if 6-month rupee investments yield more than MIFOR**. In that case, instead of (b), (c) and (d), one could undertake the rupee investment, and use the surplus over

MIFOR to reduce the cost of borrowing as per (a). At the end of 6 months, MIFOR can once again be compared with six-month rupee yields and the more economic option between rupee and dollar market investment, chosen.

For the reverse swap (receive MIFOR, pay fixed), the elemental hedge will be

(a) Borrow USD equal, at the spot rate, to the INR notional principal, for six months at LIBOR;
(b) Buy spot INR by selling the dollars borrowed—the rupee amount is the notional principal;
(c) Invest INR for three years at fixed rate;
(d) Buy six months forward, the USD principal amount borrowed;
(e) Repeat (a), (b) and (d) five times;
(f) At the end of three years, use the principal amount of (c) to pay for the dollar purchase needed to repay the principal amount borrowed.

The MIFOR inflow pays for cost of (a) and forward margin on (d). The fixed rate INR payment will be based on yield on (c). This model also leaves unhedged the same residual risks as in the receive fixed swap, described earlier.

If MIFOR is greater than cost of six-month INR borrowing, then borrow INR instead of (a), (b) and (d), and invest proceeds as per (c). The difference between the MIFOR inflow and the borrowing cost will help quote a higher fixed rupee outflow under the swap.

The above analysis assumes that the bank will be able to borrow or deposit USD at LIBOR. In practice, no Indian bank is really in a position to borrow at LIBOR (it may have to pay a spread above LIBOR), and may receive only the LIBID on its deposit. In either case, the difference with LIBOR will have to be factored in the pricing of the fixed leg. In the case of MIFOR swaps also, no active bank would hedge individual swaps on the lines discussed above. It would manage the exposures as part of the totality of its forward book, and INR and USD assets and liabilities.

12.2.3 Swap Spreads

Prices of MIBOR and MIFOR swaps in the market have often differed from the theoretical models discussed above: in fact, these have sometimes, and for extended periods, ruled below G-Sec yields. (Again, given the elemental or theoretical hedge for the MIBOR and MIFOR swaps, they should be priced similarly. In practice, however, such is not the case, partly because the forward margin in the forex market is not a function of interest differential.) The impression one gets is that pricing is often demand-supply driven—rather than based on models. But, in theory, such variations open up arbitrage opportunities:

- For example, if market price of a MIBOR–OIS is below model price, a portfolio of
  - (i) borrow overnight;
  - (ii) invest in fixed rate paper; and
  - (iii) enter into a pay fixed swap at the market price; will provide an interest-rate-risk-free arbitrage opportunity.
- Similarly, if the market price is higher than the model, then a portfolio of
  - (i) issue (or short sell) fixed rate paper;
  - (ii) invest in overnight inter-bank market; and
  - (iii) enter into a receive fixed swap; will give a risk-free arbitrage opportunity.

One problem with the arbitrage outlined above is that it assumes that the arbitrager will be able to borrow/lend at the NSE-MIBOR which is the floating rate benchmark. This may not be possible as the NSE-MIBOR is a polled rate (see paragraph 7.3.3) at a particular point of time and can differ with the prices at which actual inter-bank transactions can be concluded. Again, in the above discussion, bid offer differences, the ban on short sales, the cost of capital, etc. have not been considered.

As market efficiency improves, however, swap prices will parallel corporate/bank bond yields.

12.2.4 Customer Quotes

There would be two ways of pricing a swap for a customer:

(a) Start with the interbank quote and load, on the fixed rate, an appropriate credit spread (negative if the bank is paying fixed; positive if the bank is receiving fixed) to provide adequate return on capital for the market and credit risks (the latter also depending on the rating of the particular customer).

(b) Another approach, using the zero coupon yield curve, may be particularly appropriate for amortization swaps, i.e. where the notional principal is reduced in a predetermined schedule. This would require a "zero coupon" swap yield curve to be drawn from market prices. This could then be used to price the amortising swap, at market rates, before adding the credit spread as in the earlier case.

Illustrations of the calculations are given in Annexure 12.2.

12.2.5 Unwinding/Reversing an Existing Swap

There are two ways of getting out of an existing swap:

(a) Enter into a reverse swap (i.e. if you are paying fixed rate under the existing swap, receive fix under the reverse swap, the notional principal, floating rate benchmark and cash flow exchange dates remaining the same) with another counterparty, for the balance period of the existing swap. The floating rate flows will cancel each other out and the net cash flow will be the difference in the fixed rate.

In practice, however, the suggested mechanism has a problem, if the unwinding is to be done during the course of an interest period. In that case, the first interest period under the reverse swap will need to be less than the normal 3/6 months period, and prices for such broken period swaps are not generally quoted in the market.

(b) Unwind the existing swap with the same counterparty. This will involve exchanging the present value of the swap (see paragraph 12.6).

The difference between the two is that under (a) both swaps remain outstanding till maturity and capital may have to be provided on both.

Specimen calculations of the cash flows are given in Annexure 12.2 to this chapter.

12.3 Forward Contracts

The general principle is that the forward price is **a function of the spot price, adjusted for the "cost of (or yield on) carry"**. This principle is commonly used in all financial markets. We discuss the forward pricing of interest rates, bonds and swaps, using the principle.

12.3.1 Forward Rate Agreements (FRAs)

As we saw in Chapter 6, a forward rate agreement is a contract between two parties to **exchange interest payments** on an agreed notional principal, for an agreed period, and on an underlying money market instrument or security, **at the contracted rate and the interest rate ruling on maturity of the contract**. To elaborate, the interest payments to be exchanged are:

(a) on an agreed amount (say Rs 50 crore);
(b) for a specified period (say 3 months);
(c) between the contracted rate say (8%) and the rate ruling on maturity of the contract, on the underlying money market instrument or security (CP, CD, T-bill etc.);
(d) the contracted rate payer is referred as the "buyer" or "borrower" under the FRA and the contracted rate receiver is the "lender" or "seller". Typically, the contacted rate payer, i.e. buyer of the FRA, could be a borrower worried about rise in interest rates and wanting to hedge the fluctuation, by paying the fixed rate, i.e. buying the FRA. Contrarily, the receiver of the fixed rate, or the seller of the FRA, would be a depositor worried about a fall in interest rates and desiring to hedge it, by receiving the fixed rate.

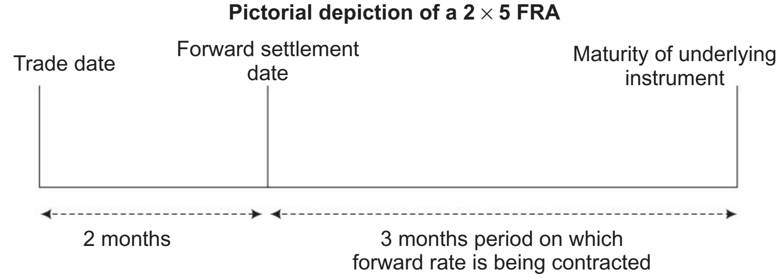
Banks active in the market are of course both buyers and sellers. **It is customary to quote FRA prices as a combination of two months, say 2 × 5**. This implies that the contracted interest rate applies to an instrument on which interest begins to accrue at the end of two months and which matures at the end of five months.

12.3.1.1 Settlement of FRAs

In any FRA, three dates need to be clearly defined:

(i) **the trade date**, or the date on which the agreement is entered into;
(ii) **the forward settlement date**, i.e. the date on which the interest on the underlying instrument starts accruing—for settlement purposes, the actual, ruling rate on this date (the settlement rate) will be used; and
(iii) **the maturity date** of the underlying instrument, or the date on which **the gross amounts of interest** at the contracted and settlement rates would be exchanged—in practice, the present value of the difference is exchanged on the FRA settlement date.

Pictorial depiction of a 2 × 5 FRA



(Another date to be kept in view is the date on which an FRA is being valued. This date will be any day between the trade date and the settlement date. For concepts and calculations underlying valuation, please refer to paragraph 12.6.2.)

The agreement requires that the difference between the agreed (i.e. contracted) rate and the actual rate that may be ruling on the specified date on the agreed notional principal, will be made good by one party to the other on maturity of the underlying instrument. For example, if the contracted six-month term inter-bank rate under an FRA is 9% per annum on a given future date, and the actual rate happens to be 10% per annum on that date, the seller will reimburse to the buyer of the FRA the difference of 1% p.a. on the notional principal for six months; on the other hand, should the term inter-bank rate happen to be 8%, the borrower/buyer will have to pay the difference to the seller. Since interest is payable in arrears, in theory, the amounts are due to be exchanged on maturity of the underlying instrument. **In practice, the actual exchange takes place on the forward settlement date, at the present value of the difference to be paid**. The discounting will generally be done at the same rate as the underlying rate on which the FRA has been contracted.

There are two ways of calculating the amount to be exchanged on the settlement date:

- the more common practice is to calculate the difference in the gross value of interest at the contracted and settlement rates, and then discount it to the settlement date **at the settlement (i.e. actual) rate**.
- in some money markets, an alternate method is used: the amount to be exchanged on the settlement date is the difference in the present values of the notional principal at the contracted and the settlement rates.

There is a small difference in the two amounts. The practice in India is to use the first method above, and this is the way illustrative calculations have been done in the book.

12.3.1.2 Pricing of FRAs

The pricing of an FRA is based on the "yield curve" in the market, and it can be best understood through a synthetic replication of the cash flows in the following manner.

(i) Lock into spot interest rate between trade date and maturity date; and
(ii) Factor in "cost/yield of carry" between trade date and settlement date.

Let us assume that a bank wants to price an FRA on the three-month term interbank rate to rule three months hence (3 × 6). If it is the contracted rate receiver (i.e. seller of the FRA), the price can be determined by considering a portfolio consisting of borrowing six months' money at the ruling rate and placing it for three months. The **cost/yield of the two transactions taken together** allows the calculation of the implied 3 × 6 months forward rate by "bootstrapping" (see Chapter 9). A numerical example will clarify the calculations.

Consider the calculation of the 3-month forward 3-month (i.e. 3 × 6) term inter-bank rate on the basis of the following spot market interest rates, ruling at the time of pricing:

3-month interest rate 5.625/5.6525% p.a.

6-month interest rate 5.75/5.78125 % p.a.

(Note that the two rates are the bid and offered rates in the market: the lower rate is the one at which banks are bidding for deposits, and the higher is the rate at which they are offering deposits, from/to other banks.)

To calculate the implied forward selling rate,

Borrow 6-month money at 5.78125 % p.a.

Deposit it for 3-months at 5.625 % p.a.

(a) Assuming that the FRA is for interest on INR 10 crore, the first step is to calculate the amount you need to borrow. **It should be such as to compound to Rs 10 crore after three months at the deposit rate of 5.625 % p.a.**

(b) The amount to be borrowed is thus INR 9, 86, 13, 251 and you need INR 10,14,63,790 after six months to repay the borrowing at 5.78125 % p.a.

(c) The maturing amount of INR 10 crore, therefore, needs to earn 5.855162% p.a. for three months in order to break even.

(In the above example, interest calculations are based on 90-day quarter and 360-day year.)

If the bank is the seller of the FRA, (i.e. forward rate receiver) it would not price the agreement at less than 5.855162% p.a. It can hedge the price by creating an asset liability gap as above—or use an existing gap.

Let us see what happens if the actual 3-month inter-bank rate after three months is 6.125% p.a. In that case, the seller is due to receive interest for 90 days on Rs 10 crore at 5.855162% p.a. and pay interest at the actual rate of 6.125% p.a. Thus, the seller will

Pay interest on INR 10 crore for three months @ 6.125	INR 15,31,250
Receive interest on INR 10 crore for three months @5.855162 is	INR 14,63,790
Difference payable by the seller is	INR 67,460

Since this will be paid in arrears, that is, at the end of the period, the seller will need a total of INR 10,15,31,250 crore (INR 10,14,63,790 to repay the borrowing + INR 67,460) as proceeds of the rolled over deposit. This is exactly what he will get by rolling over the deposit for 3 months at the ruling rate of 6.125% p.a.

On the other hand, if the actual rate is 4.125% p.a., the seller is due to receive Rs 4,32,540 on maturity of the transaction. This, together with the INR 10 crore now deposited at 4.125% p.a. for 3 months, aggregates to the required sum of INR 10,14,63,790. Whatever the settlement rate, the hedge has worked. In practice, while active banks will price FRAs on the basis of the principles outlined, they will rarely hedge each contract individually: the borrowing/deposit will be incorporated in the overall asset liability book, which will be managed in totality.

If the bank wishes to be the contracted rate payer (i.e. buyer of the FRA), the maximum price can be determined, by a similar logic, by looking at the forward rate implied by

- Borrowing for three months at 5.6525% p.a.; and
- Depositing the funds for six months at 5.75% p.a.

The maximum amount it can afford to pay under the FRA is 5.766019% p.a. This is the forward paying rate.

The two prices (namely receive 5.855162% p.a. and pay 5.7666019% p.a.) constitute the band within which 3 × 6 FRAs will be traded.

It will be seen that in a positive yield curve, i.e. six-month rate higher than the three month rate, the forward rate is higher than the corresponding bid/offer 6-month rate as shown above. But it is lower in a par or negative yield curve scenario. Please see Table 12.1 (figures in % p.a.):

It should be noted that the receive/pay price difference is wider in the forward rates as compared to the spot market.

12.3.1.3 FRA Market in India

Internationally, the most liquid forward rate agreement contract is on the USD LIBOR—the London Interbank Offered Rate. At the time of writing, the 1/3/6 month (i.e. term) inter-bank market in India is not very liquid. In

Table 12.1 FRA Prices

		Bid	Offer		Bid	Offer
–ve Yield curve	3-month	5.625000	5.652500	FRA 3 × 6	5.396244	5.485362
	6-month	5.562500	5.593750			
		Bid	Offer		Bid	Offer
Flat Yield curve	3-month	5.625000	5.656250	FRA 3 × 6	5.515754	5.608629
	6-month	5.625000	5.656250			
		Bid	Offer		Bid	Offer
+ve Yield curve	3-month	5.625000	5.652500	FRA 3 × 6	5.766019	5.855162
	6-month	5.750000	5.781250			

(It will be useful for the reader to do the calculations himself.)

the absence of this benchmark, FRAs are not actively traded. There are transactions with corporate counterparties, which are bilaterally negotiated and priced. The underlying interest rate is generally the 1 year INBMK—or G-Sec yield.

12.3.2 Forward Prices of Bonds

The basic principle of arriving at the forward price of bonds is the same as for currencies. The forward price should reflect today's full price (i.e., quoted price plus accrued interest) and the "cost of carry", i.e., interest on the investment at the current rate for the maturity of the forward contract. Assuming that there are no coupon inflows during the currency of the forward contract, i.e., before it matures, and if,

P_0 = the full price (i.e., "dirty" price, or "clean" price plus accrued interest) of the bond on date zero, i.e., at inception of the forward contract;

r = ruling money market interest rate expressed as a fraction (p.a.);

f = maturity of the forward contract expressed in years; and

P_f = the (full) forward price; then

$$P_f = P_0 \times (1 + r \times f)$$

This equation will need to be modified if

- the contract is on the quoted (i.e. clean) price of the bond; or
- there is a coupon inflow in between.

The modification in the first case is relatively simple: while the equation for the full price remains valid, an adjustment will have to be made to arrive at the quoted price. If

t = period in years from the last coupon date to the maturity of the forward contract and

C = coupon rate (in fraction, p.a.)

Then the forward clean price is at $P_o \times (1 + r \times f) - C \times t$

If there is a coupon inflow $(C/2)$ t_1 years from the inception of the contract ($t_1 < f$), then the basic forward price equation will need to be modified as follows:

$$P_f = (P_o - (C/(2 \times (1 + r \times t_1)))) \times (1 + r \times f)$$

(The term deducted from P_o is the present value of the coupon inflow, from the date of its receipt to the inception of the forward contract.)

This will need a further adjustment if the forward contract is to be on the quoted, not full, price of the bond.

A few points are worth noting:

- Unlike FRAs which are forward contracts on the interest rate of a generic instrument, forward agreements on bond prices are on a specific bond issue.
- Typically, most such forward contracts are for relatively short periods.
- YTMs for the balance life (i.e. after the forward contract settlement date) of the bond, known as the forward yield, can be calculated by using the forward price as the investment on maturity of the forward contract. Such YTM would usually differ from the YTM at the spot price. Again, given two bonds of identical YTM and maturity, but different coupons, their forward yields will not be identical.
- **A fully hedged forward sale of a bond is similar to a reverse repo** (spot buy, forward sale) transaction, with the interest rate at which the cost of carry has been calculated being the repo rate. Therefore, knowing the forward and spot prices of a bond, the implied repo rate can be easily calculated.

12.3.3 Pricing of Forward Swaps

The forward pricing of interest rate swaps also uses **the "spot price adjusted for the cost of carry" principle** discussed earlier. Consider that you are pricing a 3-year MIBOR swap (pay fixed) to begin 6 months from now. The steps involved would be as follows:

(i) Start with the current price of a 3.5 year, pay fixed MIBOR swap, say s_1.

(ii) Consider the ruling price of a 6-month MIBOR swap (receive fixed), say s_2.

(iii) With this combination, the floating rate flows cancel each other out for the first 6 months. Therefore the net outflow would be ($s_1 - s_2$) for a period of 6 months.

(iv) This difference can now be adjusted on a percent per annum basis, for 3 years, against s_1, the 3.5 years swap rate.

(v) The resultant rate say s' is the 6-month forward price of a 3-year, pay fix MIBOR swap.

(Note that the six months maturity swap will have quarterly exchanges, and the 3.5-year swap 6 monthly exchanges of cash flows. The price of the six-month swap will have to be adjusted for this change in the periodicity of interest payments. A numerical example is in Annexure 12.2 to the chapter.)

The same logic can be used for forward prices of MIFOR swaps as well. Consider, for example, that you wish to price a 3-year MIFOR swap (pay fixed) starting 6 months from now. The steps involved would be as follows:

(i) Start with the current price of a 3.5-year, pay fixed MIFOR swap, say s_1.

(ii) Neutralise the first "receive MIFOR" inflow through a combination of (a) borrow 6-month dollars, and (b) do a sell buy/swap in the exchange market. Interest on the USD borrowing and the forward premium on the principal amount will be equal to the "receive MIFOR" amount in the 3.5-year swap at *i*. Ignoring the exchange risk on the dollar interest amount, you are now left with the interest inflow on the rupee funds generated by the sell/buy transaction, say s_2% p.a.

(iii) With this combination, the net outflow would be ($s_1 - s_2$) for a period of 6-months.

(iv) This difference can now be adjusted on a percent per annum basis, for 3 years, against s_1, the 3.5 years swap rate.

(v) The resultant rate say *s*, is the 6-month forward price of a 3-year, pay fix MIFOR swap.

12.4 Forwards and Futures

In substance, futures are exchange traded forward contracts and, therefore, the basic pricing of the two is similar. But even when the underlying instrument and maturity of the contract are the same, there are some differences. These arise because futures are standardized versions of forward contracts, standardized as to maturity and notional principal. Secondly, exchange trading requires deposit of initial and daily mark-to-market margins, as we saw in Chapter 6.

12.4.1 FRAs and Interest Futures

While there are no MIBOR interest rate futures contracts in India, when available, arbitrage between the two instruments is possible, when the futures contract price is outside the FRA band. However, FRAs and interest futures are not synonymous with each other.

The important differences are as follows:

(a) In common with other OTC and exchange traded derivatives, there is a difference in the timing of exchange of cash flows. In the case of futures, margin receipt/payment is on a daily basis, while cash flow exchange is done only once in respect of an FRA. There is thus a timing difference in fund flows, even if the gross amount is identical. This creates what is known as the "convexity" effect (see below).

(b) The other difference is that, apart from the timing of flows, the actual amount to be exchanged in settlement can also differ. The USD LIBOR futures contract on derivatives exchanges assumes a 90-day quarter. On the other hand, settlement of the FRA would be done on the basis of the actual number of days over which the USD LIBOR is applicable which, as a rule, would be different from 90. Therefore, even if the FRA and the futures contract are at the same price and on the same LIBOR, their settlement values are not necessarily identical.

(c) Futures contracts are settled on the date of maturity, while, under an FRA, the value date of the price difference is the end of the period to which the LIBOR is applicable. As we have seen earlier, if settlement has to be done on contract maturity, only the present value, i.e., the price difference discounted at the ruling rate, will be paid.

In short, while similar to each other, an FRA and an interest futures contract are not identical in all respects.

12.4.1.1 The Convexity Effect

We illustrate the convexity effect by considering an example from the US market. One of the most popular futures contract in USD is the 3-month Eurodollar contract. These are futures contracts on the 3-month LIBOR expected to rule on maturity of the contract. On the Chicago Mercantile Exchange, for example, such contracts have maturities extending up to 10 years.

Under the USD 1,000,000 three-month offshore dollar deposit interest futures contract:

(a) The seller undertakes to find a bank, which will accept the buyer's USD 1 mn. 3-month offshore dollar deposit on the maturity date of the contract at the interest rate now agreed.

(b) The buyer undertakes to place the deposit at this rate (irrespective of the market rate ruling on the date of maturity of the contract).

(These definitions are different from meanings of the terms "buyer' and 'seller' used in the OTC derivatives market.)

The price of the contract is quoted as (100—the rate of interest agreed). Thus, a price of 95 means an interest rate of 5% p.a.

A couple of other technical issues should be noted. The contract pricing is based on 90/360 interest rate convention, not on the actual number of days in a given quarter. (In the application of interest based on LIBOR, the convention is actual/360.) Therefore, a change of 0.01 in the price of the USD 1 mn 3-month interest futures contract leads to a change in the value of the contract, i.e., the actual interest amount (as distinct from the rate) contracted, of USD 25. This is the actual change in the interest amount for three months arising from a basis point change in the interest rate on a USD 1 mn deposit calculated as (USD 1,000,000 × 0.01 × 0.01 × 0.25). This amount will also be the change in the margin amount per 1 cent change in the price of the contract, and is referred to as the present value of a basis point (PVBP). **The PVBP of the popular three-month eurodollar futures contract is $ 25. It does not change with passage of time** and to that extent it is different from the PVBP of an FRA with identical price, settlement and maturity dates—see paragraph 12.6.1.

The daily mark-to-market margin receipt/payment in the futures exchange leads to a price distortion referred to as the convexity effect: **the seller of the interest futures contract benefiting more, or losing less, than the buyer, for a given change in interest rates.** To understand this phenomenon, remember that the seller of an interest futures contract gains if interest rates rise (i.e., when the price of the contract falls)—and vice versa. Therefore, if interest rates are rising, he receives cash through the mark-to-market mechanism, which can now fetch higher returns precisely because of the rise in interest rates. In the contrary scenario of falling interest rates, the seller has to deposit additional margin but the cost of the margin is less because interest rates are low. In short, **the interest futures contract seller's gains are more and losses lower, irrespective of whether interest rates go up or down**. The buyer is of course in exactly the opposite situation. The playing field is not quite level!

This phenomenon is referred to as "convexity adjustment" or "convexity effect" and parallels the convexity effect on bond prices (see Chapter 13).

12.4.2 Bond Forwards and Futures

12.4.2.1 Treasury Bond Futures in the United States

Because of the complexities in the forward prices of bonds discussed in paragraph 12.3.2, the treasury bond/note futures contracts traded in the United States have several special features:

- The CBoT contract, for example, is not on a specific bond, but any bond conforming to given specifications (e.g., for the 30-year treasury bond contract, any bond with maturity longer than 15 years on the first day of the delivery month can be delivered).
- The seller of the contract has the right to choose the bond to be delivered (and hence the cheapest-to-deliver, CTD, concept).
- Bonds with a face value of USD 100,000 have to be delivered against one contract.
- There is a "conversion factor" for each bond that can be delivered under the contract, calculated under a complicated formula.
- The conversion factors (and futures prices) are for the quoted, not full, prices of bonds.

12.4.2.2 Bond/T-bill Futures in India

In June 2003, trading on the following interest futures contracts was initiated on the principal stock exchanges in Mumbai:

- A notional 6% coupon bearing government security with a 10-year (balance) maturity at the time the futures contract matures;
- A notional zero coupon government security with a 10-year maturity at the time the futures contract matures;
- A notional treasury bill with a 91-day maturity at the time the futures contract matures.

The theoretical pricing model for the first two contracts may be summarised as follows:

(a) Arrive at ruling ZCYC, from the current term structure.

(b) Based on the ZCYC, calculate today's price of the coupon or zero-coupon bond, as the case may be.

(c) Apply the cost of carry to today's price calculated per (b) above for the period from the date of the transaction to the maturity of the futures contract.

This should be the theoretical price of the futures contract today. In general, the prices of bond futures would be based on the forward price. However, the two are not identical because of the timing difference in the cash flows and the convexity effect, discussed in paragraph 12.4.1.1 while considering the forward and futures contracts on interest rates.

Similarly, for the T-bill contract, one will need to start with the price on trade day of a T-bill, which will have a balance maturity of 91 days on maturity of the futures contract, and apply the cost of carry to this price.

While trading has been initiated, there is no activity in the market because of regulatory restrictions on banks.

12.5 Interest Rate Options

Currently, interest rate options are not traded or available in the INR market in India. However, they are likely to be introduced at a later date, and it would be useful for the reader to have some conceptual understanding of pricing and hedging of interest rate options. Please see Annexure 12.1.

12.6 Valuation of Derivatives

By definition, and ignoring bid offer differences or customer margins, the 'value' of a derivative contract is zero at inception. This is because the pricing is based on the ruling market rates.

The contract, however, **acquires value, negative or positive, as market rates change**: when the contract is "in-the-money", i.e. it has a positive value for one party, it has an equal negative value, i.e. it is "out-of-the-money", for the counterparty. These values can also be looked at as the replacement costs of contracts: if a counterparty fails, the derivative contract will have to be re-entered at the ruling rates and this may involve cost. (It can equally be a gain, but the gain will have to be passed on to the failed counterparty's receiver.) In theory, there will be a claim against the failed counterparty for this amount, but its realisability will hardly be certain.

Valuations are crucially important for monitoring credit exposures, a point discussed in greater detail in paragraph 12.7.

12.6.1 Interest Rate Swaps

Cash flows from an interest rate swap, say pay floating, receive fixed, are exactly identical to the combined cash flows of

- issue of a floating rate bond with coupon equal to the benchmark floating rate; and
- investing the proceeds in a fixed rate bond with coupon equal to the swap rate.

Most IT systems treat interest rate swaps in this fashion.

Therefore, **the value of an interest rate swap** on any day is the difference in the value of these two bonds and **is obviously zero at inception**. One important difference between swap and bond valuations in India, in between interest payment/exchange dates, should however be noted: the day count convention in the G-Sec market is 30/360, while that in the derivatives market is actual/actual. Again, swaps (or other derivative contracts) with customers, do not have a zero value at inception, as the pricing will obviously have a margin over the market rate. This margin is the credit spread, and, therefore, customer contracts should be valued net of unearned credit spreads.

The mathematics of valuing fixed rate bonds have been described in Chapters 8 and 9. For valuing swaps, the only difference will be to use, not the ZCYC, but **the ruling swap rate for the balance maturity of the swap**: the same techniques for interpolation, as used for drawing the ZCYC, can be employed for drawing the swap yield curve. More active banks would generally use a **"zero coupon swap curve" for valuation purposes**; this can be arrived at by bootstrapping and interpolation as in the case of bonds (Chapter 9). For the purpose of interpolation or bootstrapping, a couple of points should be noted. Firstly, as we have seen, for swaps up to one year original maturity, the exchange of cash flows is quarterly; exchange for longer maturity swaps is, however, at half yearly intervals. (In MIFOR swaps up to 1 year, the floating rate is paid quarterly, but the fixed rate payment is done only once, on maturity.) Therefore, the swap prices of the shorter maturity swaps need to be suitably adjusted so that all prices are on identical basis. Secondly, the day count convention in the derivatives market is actual by actual, and not 30/360 as in the G-Sec market.

Specimen calculations are in the annexure to this chapter.

For valuing the floating rate leg, it is enough to discount the notional principal plus the existing floating rate flow, at the ruling floating rate, for the balance period of the current coupon.

Where the floating rate is MIFOR, the discounting rate will be the total, in % p.a. terms of

(a) ruling USD LIBOR for the balance period of the current period, estimated by interpolation if necessary; and
(b) the ruling forward margin for the same period calculated as % p.a. of the spot rate.

Specimen calculations are given in the annexure to this chapter.

12.6.1.1 MIBOR-OIS

The MIBOR overnight indexed swap is also an interest rate swap, periodically exchanging interest at the specified floating rate (in this case the overnight NSE MIBOR), with interest at a fixed rate. There is, however, a difference between MIBOR-OIS and other interest rate swaps: in all **other interest rate swaps, the date of refixation of the floating rate and the date of exchange of cash flow is the same**. On the other hand, as we have seen in Chapter 6, while the overnight MIBOR is refixed every working day, cash flows under the MIBOR-OIS swap are exchanged only periodically, every three months if the original maturity is up to one year and every six months for longer maturity swaps. For this purpose, interest at the ruling MIBOR is added to the notional principal for calculating the following day's interest—this continues until the exchange or settlement of cash flows at the specified periodicity. In other words, the **notional principal of the floating rate leg is not constant through the interest period** but keeps increasing until the exchange of cash flows, on which date it reverts to the original amount.

As we have seen, an interest rate swap is conceptually similar to a portfolio of two bonds, one carrying the floating rate of interest and the other a fixed rate: the portfolio will consist of a "short" position in the bond which parallels the "pay" leg (floating rate bond if the swap is pay floating, receive fixed) and a "long" position in the other bond. We therefore need to value the two bonds and the difference in the value of the two is the present value of the swap. On any valuation date, the value of the MIBOR floating rate bond is **equal to the notional principal plus the interest accrued** up to that date: this is because, this amount of money will enable an exact replication of the cash flows on the floating rate side.

As far as the other leg is concerned, the flows under the fixed rate bond are known. These can be discounted in one of the two following ways, to arrive at the value of the fixed rate bond:

(A) **By interpolation, ascertain the swap rate for the balance life of the swap**. For example, consider that you are valuing a swap which still has say 3 years and 40 days to mature. One can use the day's, i.e. ruling, swap rates for 3 and 4 years and, by interpolation, arrive at the hypothetical swap rate for a 3 year 40 days maturity swap at the rates ruling on the date of valuation. This rate can then be used to calculate the value of the fixed rate bond. Alternately,

(b) **A zero coupon swap yield curve could be drawn from the ruling swap rates, by bootstrapping**, as described in Chapter 9. These rates could then be used for valuing all the flows under the fixed rate bond. Most active players and those running a trading book will prefer this alternative.

12.6.1.2 PVBP of a Swap

The present value of a basis point in the case of a swap, is the estimated change in its value if the swap price (i.e. the fixed rate) changes by 0.01. Calculating PVBPs is very useful for the purpose of calculating "hedge ratios", a point discussed in Chapter 15.

12.6.2 FRAs

Consider the 3 × 6 forward (interest) rate agreement (i.e. a forward contract for the interest rate to rule three months from the date of the contract for the next 3-month period) illustrated in paragraph 12.3. By definition, the "value" of an FRA is zero on the trade date, since it has been arrived at on the basis of the ruling yield curve. For valuing the contract say one month later, one will have to consider the ruling 2 × 5 FRA price which, as a rule, will be different from the original price. **The difference is the current value of the FRA.** If the current price is higher, the contract is "in-the-money" for the buyer, i.e. the party paying the FRA rate and receiving the actual ruling rate on maturity of the contract, and correspondingly "out-of-the-money" for the seller/counterparty. If prices for exact dates are not available, these will have to be estimated by interpolation. The difference accrues on maturity of the underlying instrument. The "value" applicable for settlement on the forward settlement date can be calculated by discounting. If an FRA is to be cancelled or unwound **on the date of valuation**, the settlement date value will have to be further discounted to its present value on the cancellation/unwinding date, at the money market rate applicable to the period between the cancellation date and the settlement date.

It is also useful to calculate the present value of a basis point (PVBP) change in the FRA rate. This represents the change in the settlement date value of an FRA resulting from a 0.01% p.a. change in the FRA rate.

For specimen calculations, please see Annexure 12.2 to this chapter.

12.6.3 "Value" of a Forward Contract on a Bond

Since the forward price is calculated at the ruling bond price and interest rate, the "value" of a forward contract is zero at inception. Between the trade date and the settlement date of the forward contract, the value is the difference between the contract price and the forward price at the time of valuation. The latter would keep changing with changes in the ruling price of the bond as also the cost of carry and so will the "value" of the forward contract. It should also be noted that, calculated as the difference between the contract price and the current forward price, the "value" accrues only on settlement date of the contract; in other words, it is the future value of the contract. If the contract is to be cancelled at the time of valuation, the amount to be paid or received would be the discounted amount of the future value of the contract.

12.6.4 Interest Rate Options

The value of an existing option, bought or sold, is the price at which it can be sold or bought: in other words, it is the market value of an option with identical parameters. In terms of credit risk, however, one difference with the swaps/FRAs should be noted. The buyer of an option clearly has a credit risk on the seller, and this can be quantified as the current value of the option. On the other hand, the seller of the option, once he has recovered the option fee, does not have any credit exposure on the buyer.

For valuing delta hedged options, the change in the value of the option will need to be netted against the change in the value of the delta hedge.

12.7 Credit Exposures on Derivatives: Loan Equivalent Risk (LER)

12.7.1 Regulatory Prescription

The Reserve Bank has prescribed the following alternate methodologies for measuring credit risk exposure on derivative contracts.

The original exposure method

1. Under this method, which is a simpler alternative, the credit risk exposure of a derivative product is calculated at the beginning of the derivative transaction by multiplying the notional principal amount with the prescribed credit conversion factors. The method, however, does not take account of the ongoing market value of a derivative contract, which may vary over time. In order to arrive at the credit

equivalent amount under this method, an FI should apply the following credit conversion factors to the notional principal amounts of each instrument according to the nature of the instrument and its **original** maturity:

Original Maturity	Credit Conversion Factor to be applied to Notional Principal Amount	
	Interest Rate Contract	Exchange Rate Contract
Less than one year	0.5%	2.0%
One year and less than two years	1.0%	5.0% (2% + 3%)
For each additional year	1.0%	3.0%

The Current exposure method

2. Under this method, the credit risk exposure/credit equivalent amount of the derivative products is computed periodically on the basis of the market value of the product to arrive at its current replacement cost. Thus, the credit equivalent of the off-balance sheet interest rate and exchange rate instruments would be the sum of the following tow components:
   (a) the total '**replacement cost**' obtained by "marking-to-market" of all the contracts with positive value (i.e. when the FI has to receive money from the counterparty); and
   (b) an amount for '**potential future exposure**' calculated by multiplying the total notional principal amount of the contract by the following credit conversion factors according to the residual maturity of the contract:

Residual Maturity	Conversion Factor to be applied on Notional Principal Amount	
	Interest Rate Contract	Exchange Rate Contract
Less than one year	Nil	1.0%
One year and over	0.5%	5.0%

Source: RBI master circular on exposure norms dated October 10, 2006.

12.7.2 Maximum Credit Exposure

While the application of credit conversion factors, as above, to the notional principal of derivatives is a rough and ready method for measuring credit exposures, banks active in the market often use more sophisticated methods. In principle, this involves the estimation of the **maximum credit exposure** (i.e. out-of-the-money value for the customer), **through the life of the contract, with a given degree of confidence, from the volatility of the price**—conceptually, this is similar to the Value at Risk (VaR) models (see Chapter 14) to calculate the Potential Future Exposure (PFE). If the bank has a right to terminate a derivative contract before its maturity, clearly the volatility number needs to be calculated for such lower period.

Some banks also use a multiplier, greater than unity, to the LER amount calculated as per either of the methodologies, reflecting the credit rating of the counterparty: the lower the rating, the higher will be the multiplier.

12.7.3 Credit Risk Monitoring

Theoretically, the monitoring of credit exposures should be a continuous exercise so that appropriate actions can be initiated promptly. The RBI requires the mark to market of derivative contracts to be done at least once a month.

The following points may be found useful by banks actively trading derivatives:

(a) Should a separate limit be fixed for all derivatives exposures of a counterparty, or should these be monitored under an overall credit exposure limit for all liabilities of the counterparty?

(b) For weaker counterparties, should the derivatives exposure limit be in two tiers—one cautionary, the second where action like termination of the contracts will have to be initiated?

(c) The nature and content of credit covenants and definition of events of default in the documentation—do they allow the bank to call for additional security or terminate contracts?

(d) Should credit risk be monitored on gross basis or net basis? In other words, should the positive (for the counterparty) MTM valuations of outstanding derivatives be

  (i) ignored (gross) or considered (net) while calculating the replacement cost of all the exposures?

  (ii) netted from the potential future exposures?

(e) Should mark to market valuations of outstanding derivatives be communicated to clients and, if so, at what intervals?

(f) Are the information systems capable of reporting the replacement exposures counterparty-wise for monitoring purposes?

(g) Who should monitor the credit exposures?

12.8 Market Risk Management

There is no need to manage the market, or price, risk on the derivative contracts used to hedge:

- interest rate risk on the gaps between rate sensitive assets and liabilities; or
- derivatives contracts with customers.

The market risk on the trading book however has to be very closely monitored. It is therefore desirable that the trading book is maintained separately from the banking or hedge book.

Active banks manage the market risk by prescribing a value at risk limit: the topic of VaR is described in detail in Chapter 14. The basic principle of risk management is to monitor continuously, or at least daily, the negative value of the trading book against the VaR and cut/hedge trading positions when it threatens to exceed it. Given the calculations involved, it is obviously necessary to employ efficient and tested IT systems to value the book continuously.

Annexure 12.1 Option Pricing and Hedging

12.1.1 Introduction

To start with, we look at some theoretical limits on option prices and a description of the two accepted models: binomial and Black Scholes (BS). It will be useful for the reader to refresh his memory of the basic terms and definitions in paragraph 6.6.

12.1.2 Theoretical Limits for Option Prices

(a) Definitions

$P(x, X, t)$ = price of a call option on underlying asset (currency, equity, commodity, etc.) C2, in units of C1 per unit of C2, where

x = spot rate in units of C1 per unit of C2

X = Strike rate in units of C1 per unit of C2

t = maturity of the option, expressed in years

(b) It is useful to look at the price or value of an American option (exercisable any time up to maturity) as consisting of an intrinsic value, or the profit available on immediate exercise (i.e. $x - X$, where x is greater than X – call option), and time value (i.e. the difference between the price and the intrinsic value, the latter being ≥ 0). Time value is zero on expiry of the option. American style call option contracts are said to be "in the money" where $x > X$, "at the money" where $x = X$, and "out of the money" where $x < X$. It will be evident that only "in the money" American options have an intrinsic value and may have a time value if $P(x, X, t) > x - X$; others have only time value.

For European style options (exercisable only on maturity), the terms "in the money", "at the money", and "out of the money" are used in the relation to the ruling forward rate for the underlying asset for maturity of the option.

(c) Price limits on call options

(i) $P(x, X, t) \geq 0$, never negative—this is self-evident and no explanation is necessary.

(ii) $P(x, X', t) > P(x, X'', t)$ where $X'' > X'$—the former has a higher actual, or potential, intrinsic value than the latter, and hence the higher price.

(iii) $P(x, X, t_1) > P(x, X, t_2)$ where $t_1 > t_2$—the longer the expiry, the higher the price.

(iv) $P(x, X, t) \leq x$ (If not, it will be better to buy the asset; it will have at least some value on expiry—the option may have zero value.)

(v) For an American option, $P(x, X, t) > x - X$ (intrinsic value or the profit on immediate exercise).

(vi) For European options, consider the following table of option and forward contract values, x' being the spot rate on maturity.

Table 12.1

Transaction	Value of transaction when		
	$x' < X$	$x' = X$	$x' > X$
Buy call option	0	0	$x' - X$
Sell put option	$-(X - x')$	0	0
Both together	$x' - X$	$x' - X$	$x' - X$
Sell forward at F	$F - x'$	$F - x'$	$F - x'$
All three together	$F - X$	$F - X$	$F - X$

The combination buy call, sell put (at the same strike price), and forward sale is equal to $F - X$ irrespective of spot rate on maturity. This mathematical certainty can now be used to establish the relationship between call and put prices. In an efficient market, the three transactions taken together should give today a cash flow equal to the present value of $(F - X)$—else arbitrage opportunities will open up and correct the price relationship.

For the three transactions taken together, the cash flows today are as follows:

Buy call: outflow call price

Sell put: inflow put price

Forward sale: 0

Therefore, the difference between the call and put price has to be equal to the present value of $(F - X)$. Again, for European call options:

$P(x, X, t) \geq$ PV of $(F - X)$, since the price of the put option is ≥ 0.

(vii) Also, for given x, X, t, an American option will be priced ≥ a European option, as the former provides greater flexibility for the buyer.

(d) Take another look at (c) (vi) above and consider what happens when $F = X$, i.e., the strike rate is equal to the forward rate. In that case $F - X = 0$ and the prices of the call and put options should be equal.

12.1.3 Binomial and Black Scholes (BS) Models

Both binominal and Black Scholes models calculate option prices and hedge ratios for call options based on expected pay offs from the option: the pay off from a European style call option on an asset is

- Price of the asset on maturity of the option (x') less the strike price (X) if $x' > X$; or
- Zero otherwise (as in that case the option will not be exercised).

The difference in the two models is that the binomial model for call options makes the calculations from likely changes in the price of the asset over a series of discrete time intervals, while BS does so from a continuous distribution.

We now proceed to look at the conceptual framework and features of both the models.

12.1.4 The Binomial Model

The basic principle of calculating option prices under the binominal model is to start with option values at maturity and work backwards to structure a portfolio of short call, long underlying (i.e. the hedge) which has the same value irrespective of the price of the underlying variable. In that case, the portfolio should earn the riskfree rate of return. The process is iterated to arrive at the option price and hedge ratio at inception. We illustrate the model using a currency option.

Consider the following set of numbers for a two period tree. The assumptions are as under.

(a) You are writing a call option on the foreign currency.
(b) The spot rate is 50.
(c) The option matures at the end of two periods.
(d) The option exercise price is 49.
(e) The exchange rate can take only two values at the end of each period – 5% up or 5% down.

	Date 0	End Period 1	End Period 2	Value of Option to Buyer
			55.125	6.125
		52.50		
Exchange rate	50		49.875	0.875
		47.50		
			45.125	0
Interest rates	Per period			
Base currency	6%			
Foreign currency	3%			

We need to start with payoffs on maturity of the option. On the stated assumption, there are three, and only three possible values of the exchange rate: 55.125, 49.875, and 45.125. Given the exercise price of 49, the pay offs are, respectively, 6.125, 0.875 and nil. We now use these to calculate the option value and hedge ratio (Δ, ratio of hedge to notional principal of the option, which is 1 in this case) at the end of period 1 when spot is 52.5. The basic principle is that the change in the value of the option sold, i.e. short position in the option, should be compensated by the change in the value of the long position (hedge) in the underlying. In that case, Δ will have to satisfy the following equation, based on the value of the portfolio being identical irrespective of spot (55.125 or 49.875), and the hedge earning interest of 3%:

$$(55.125 \times \Delta \times 1.03) - 6.125 = (49.875 \times \Delta \times 1.03) - 0.875$$

giving $\Delta = 0.970874$ and closing portfolio value as 49, irrespective of spot. Its PV at the end of period 1 is 49/1.06 = 46.226415. We need (52.5 × 0.970874) or 50.970874 to buy the hedge. This will need to come partly by borrowing the present value of the portfolio (46.226415). The difference 4.744459 will have to be charged as the value of the option to put the hedge in place.

Starting with maturity values of 0.875 and zero, a similar reasoning leads to a hedge ratio of 0.178845 at the end of period 1 and an option value of 0.653164 when spot is 47.5.

The two possible option values at the end of period 1 therefore are 4.744459 (spot 52.5) and 0.653164 (spot 47.5). We can now calculate Δ at inception by equating the two portfolio values.

$$(\Delta \times 1.03 \times 52.5) - 4.744459 = (\Delta \times 1.03 \times 47.5) - 0.653164, \text{ giving}$$

$$\Delta = 0.794426$$

The portfolio value at the end of period 1 is 38.214130. Its PV at inception is 36.051066 (38.214130/1.06), but to buy the hedge, you need 39.721303 (0.794426 × 50). You will therefore need to charge an option fee of 3.670237 (39.721303 – 36.051066) and borrow the PV of the portfolio (36.051066) to buy the hedge at 39.721303.

While the illustration considers only a 2-period maturity of the option, the logic can be extended to any number of periods. Again, the per period up or down charge in the price is a function of the volatility of the underlying variable. The topic of volatility is discussed in some detail in Chapter 14.

12.1.5 The Black-Scholes Model

The most accepted option pricing model is the Black-Scholes Model. Initially introduced for valuing stock options, the model has been adopted for other options as well. The modified Black Scholes model used for currency options is known as "Garman-Kolhagen" model. Just as the normal distribution is the limiting form of the binomial distribution, the Black Scholes Model can in many ways be regarded as the limiting form of the Binomial Model as the number of time periods tends to infinity.

The model was developed by considering a portfolio consisting of a long position in call options and a short sale of the underlying asset—stock, currency, etc. The objective was to develop a model for the value of the option, such that small changes in the spot price of the underlying asset would have a neutral effect on the value of the portfolio. In other words, the change in the value of the option compensates for change in the value of the short position. (To achieve this, there needed to be a proportionality between the quantity of the underlying for which one is long call, and the amount of the short sale.) In that case, the return on the portfolio should be the riskless rate of return. While this is the conceptual framework, the theoretical derivation is quite complicated.

BS also uses the expected payoff from an option, to develop the model for pricing it. The present value of the pay off, discounted at the risk free rate, is the value of the option.

For calculating the expected value of the pay off, BS makes two important assumptions:

- The expected value of the asset is the forward price of the asset (F); and
- The distribution of x' around F is lognormal (see Chapter 14)

According to the Black-Scholes model, the value of a European call option, on an asset with the full premium paid in advance, is

$$P(x, X, t) = (e^{(-i_1 \times t)})\,((F \times N(d_1) - X \times N(d_2)) \quad (12.1)$$

Where

t = time to expiry expressed as a fraction of 1 year;

i_1 = risk free interest rate expressed on a continuously compounding basis. If I_1 is the corresponding periodically compounded rate expressed as a fraction, then $1 + I_1 = e^{i_1}$ or $i_1 = \ln(1 + I_1)$. Please see Chapter 8 for a detailed discussion of continuously compounded rates;

F = forward price of the asset;

$N(\,)$ = cumulative normal density function (i.e., the probability that the final outcome will be less than ( ) standard deviations above the mean.);

$d_1 = (\ln(F/X) + ((SD^2) \times t/2))/(SD \times (t^{0.5}))$;

$d_2 = d_1 - (SD \times (t^{0.5}))$;

SD = a measure of annual volatility of the price of the underlying asset;

ln = natural logarithm (i.e. to the base e).

On the assumptions made, it can be shown that:

(i) $N(d_2)$ is the probability of the option being exercised.

(ii) $F \times N(d_1)$ is the expected value of the variable (x' if $x' > X$; 0 otherwise) on expiry of the option. This variable is similar to, but slightly different from the expected value of the option on its expiry, or its pay off, which is ($x' - X$ if $x' > X$; 0 otherwise).

For calculating the expected value of the option pay off, the strike multiplied by the probability of the option being exercised i.e. ($X \times N(d_2)$), is deducted from $F \times N(d_1)$. The price of the option is the present value of the expected option pay off, giving the price equation.

The Black-Scholes model also gives the hedge ratio as $N(d_1)$. Note that this is the hedge needed on maturity of the option. To elaborate the hedge ratio further, F in the formula, that is the forward price is $x \times e^{(i_2 \times t - i_1 \times t)}$, if interest parity holds in the forward market in the asset. (In the case of bonds and equities, $i_2{*} = 0$ where there are no interim cash flows. Interest parity principle does not apply in most commodity markets.) Therefore,

$$e^{(-i_1 \times t)} \times F \times N(d_1) = x \times e^{(-i_2 \times t)} \times N(d_1)$$

The right hand side gives the cost of the hedge in the spot market, $e^{(-i_1 \times t)} \times N(d_1)$ being the hedge ratio. However, if the hedge is being taken in the forward market, the amount of the hedge will have to be grossed up suitably.

$N(d_1)$ is also referred to as the **option delta**, and is the ratio of the amount of the hedge and the quantity of the underlying on which the option has been written. A corollary for hedged option writers is that they need to keep adjusting the hedge as the spot price of the underlying asset moves, changing the value of d_1 and hence the option delta. For calculating the new hedge ratio, interest should be reckoned for only the balance maturity of the option—and the latest estimate of volatility.

When the spot rate changes by a small amount, the resulting change in the price of the option is reliably compensated by the change in the value of the option **delta**. For larger movements, delta itself will change. **Gamma** is the rate of change of delta, or the second partial differential of the price with reference to the spot rate. **Vega (or kappa)** is the term used to define the change in price as a result of change in volatility—the first differential with reference to SD. Volatility, as already noted, is a major determinant of the price. The other terms in common use are **Theta** (measure of option price change with passage of time) and **Rho** and **Phi** (change in price as a result of change in domestic and foreign currency interest rates).

The change in the hedge percentage, or delta, of the option, is referred to as rebalancing of the hedge to reflect the change in the value of the underlying. In practice, rebalancing or adjustment of the hedge would be done not necessarily continuously, as theory would demand, but at intervals (say, once a day) or when the underlying rate changes by a specified amount. In general, the greater the frequency of rebalancing, the lesser is the cost of the hedge (assuming zero transaction costs). Therefore, in principle, a static hedge strategy would be expensive. In practice, delta hedging is undertaken on a portfolio basis: the portfolio delta is the sum of the deltas of individual options.

12.1.5.1 Assumptions and Limitations

The model has been developed on the basis of several assumptions, many of them not strictly applicable to the real world. For instance, it is assumed that there are no transaction costs (in practice, there will be at least the bid-offer differences), and that there are no taxes. There is also the assumption that instantaneous short selling/borrowing is possible and that market liquidity is such as to allow trades for any amount without moving the price. Again, the model assumes that

- The market is so efficient that there are no arbitrage opportunities;
- The buyer and seller are rational and their sole objective is profitability (a lot of economic theories are based on the rationality of human beings, an assumption unfortunately true only exceptionally); and
- The future distribution of the variable will be the normal distribution.

The two most important limitations of the model are that, in many cases, the relative price change, or the time series of returns from the asset, are not normally distributed, implying that the time series of most prices are not log-normally distributed. This means that extreme prices occur more frequently than predicted by the normal distribution, a phenomenon referred to as "fat tailed" distribution. The other major assumption, which has serious limitations, is that volatility is constant. In practice, it is not and there is no reliable way of forecasting future volatility. (The different models used for calculating volatility are discussed in Chapter 14 in connection with value-at-risk, or VaR.)

The 1992-93 chaos and large movements in the European exchange rates severely tested the mathematics of option pricing. The models could not cope with the sudden and sharp changes in volatility. Again, being based on the probability theory, **the model is useful only when the user undertakes a large number of transactions**—the probability theory is helpless to determine whether the next toss of the coin is going to throw up a head or a tail. It is quite accurate the larger the number of tosses.

Despite the limitations, as of now, the Black-Scholes model remains the most accepted model for calculating option prices.

12.1.6 Some Ground Rules

(a) American style options should not be exercised before maturity: you are better off selling the option and transacting the underlying. This way you capture the full value of the option, i.e., intrinsic value plus the time value. By exercising the option, you will benefit only to the extent of its intrinsic value and forego its time value.

(b) Time value is maximum in the case of at-the-money options and declines as the strike rate moves away on either side.

(c) Option gammas (i.e., rate of change in delta with the price of the underlying) and vegas (i.e., change in price of the option because of change in volatility) can only be hedged in the options market—not in the underlying or forward/futures markets. And, even in the options market, it is difficult to find instruments to hedge these variables at reasonable costs. In practice, therefore, while option deltas are rebalanced periodically, gammas and vegas are monitored rather than hedged. Again, these variables are small for deep in-the-money or out-of-the-money options.

(d) Theta is the rate of change in the value of an option with passage of time—remember, on expiry, time value is zero.

(e) The most important Greek is the delta—the ratio of hedge to the principal amount on which the option has been written, which keeps changing with the price of the underlying. The hedge should be rebalanced at least once a day, more often in volatile markets, and is best done on a portfolio basis. The hedge ratio, or delta, of a portfolio of options on the same underlying is the sum of the hedges of individual options in the portfolio.

(f) What influences change in the hedge ratio most is the change in spot rate for at (or near) the money options, and change in volatility for deep-in-the-money or out-of-the-money options.

12.1.7 Pricing Put and American Style Options

The basic Black-Scholes model is used for pricing European style call options. It can be adapted for pricing put options as follows.

Price of put = $(e^{(-i_1 \times t)}) \times (X \times N(-d_2) - (F \times N(-d_1))$

The hedge ratio is $N(-d_1)$

There is no theoretical model to price American style options. In practice, two approaches are possible:

- As we have seen, in general, it does not make sense to exercise American style options before maturity. This is because an exercise would capture only the intrinsic value, while a sale of the option would yield the full value, inclusive of the time value. Therefore, the Black-Scholes model for pricing European style options could be used for valuing American options as well on the sound assumption that an early exercise is unlikely.
- A modification of the above approach is to compare the price arrived at from the binomial model at each period, with the intrinsic value and, if lower, increase it to cover the intrinsic value. The principle can be applied for Black-Scholes as well.

Exchange traded options are mostly American style and those traded over-the-counter generally European style. This is another reason why

American options are rarely exercised before maturity—they can be easily sold.

12.1.8 Interest Rate Options

We now proceed to look at some special features of interest rate options, which are on three types of underlying variables:

(a) interest rate on an underlying money market instrument like LIBOR;

(b) a specific bond; and

(c) a swap (a "swaption").

As stated above, the BS model was developed initially for pricing and hedging of stock, i.e. equity, options. It has been adopted for currency and commodity options as well.

Its use in interest rate options however presents certain problems as the underlying variables possess certain characteristics which are different from the prices of currencies or equities. Some of the more important differences are as follows:

- interest rates generally display a "mean reversion" tendency, not always discernible in the other asset classes. In other words, the present level of interest rates influences the direction of future changes.
- Bonds have a specific maturity date, and there is a certainty to the price of the bond on that date;
- Therefore, unlike in the case of a currency or equity where volatility increases with time, in the case of bonds, price volatility falls as the maturity date of the bond comes near, and is zero on bond maturity; and
- The bond price is an arithmetical function of interest rates, indeed the entire ZCYC.

All these factors complicate the pricing and hedging of interest rate options—although both the standard models can, and are, used. Bond option prices are also quoted in terms of yield volatilities, which are, of course, easily translatable into price volatilities.

While there is a vast amount of literature on the subject, one general point should be noted: the shorter the maturity of the option as compared to the maturity of the underlying—say a 3-month maturity option on a 10-year bond—the greater the utility of the standard BS model.

Subject to the foregoing general discussion, the special features of the three types of options are outlined in the following paragraphs.

12.1.8.1 Caps and Floors

Options on LIBOR, in the form of caps, can be used to hedge the interest fluctuation risk on a floating rate loan. A cap on LIBOR is essentially a series of European style call options on the LIBOR, maturing on the dates of LIBOR refixation. Therefore, the price or value of a cap would be the total of the prices of the series of options (similarly, of course, for floors). One point to remember is that the number of options involved in a cap would be the number of times LIBOR is due to be refixed during the validity of the cap. Thus, for example, the number of options involved in a two-year cap on the 3-month LIBOR is 7—not 8—because LIBOR for the current period has already been fixed, and there is no uncertainty about it.

As for floors, these can be looked upon as a series of put options on LIBOR. The principle of call-put parity discussed earlier is also applicable in the case of interest rate options in the form of caps and floors. The point to remember is that the "forward rate" in the parity equation is the swap rate. To recapitulate the equation, the pay off from a combination of a cap (bought) and floor (sold) at the same strike rate will equal the value of a swap of the same maturity: as a corollary, if the strike is equal to the swap rate, the cap and floor will have equal values.

One technical difference with the quoted swap rates should be noted. We have seen that cap pricing and pay-offs exclude the current interest period (since LIBOR is already known and there is no uncertainty). In the case of a swap, however, the current interest period is not excluded for the purpose of exchange of cash flows at the end of the interest period. The amount is of course known, since LIBOR has been fixed. The first, known cash flow exchange under the swap for the current interest period, will need to be adjusted in the quoted swap price for the put call parity to apply.

The actual equation for pricing/hedging interest rate options is similar to the one in paragraph 12.1.5 above and based on lognormality of LIBOR and its volatility. Again, the forward rate is the one implied by the term structure of LIBOR rates (See discussion of FRAs in Chapter 12).

The BS model can be used to price an option on LIBOR, in the usual way with the forward rate as the expected value. While the payoff under the option is known on its maturity, it is payable only at the end of the interest period in question: settlement on maturity of the option is the present value of the payoff amount. Therefore, for calculating the price of the option on trade date, we need to consider,

(a) the expected value of the pay off on **maturity of the underlying instrument** (not maturity of the option); and

(b) discount the expected pay off to the trade date.

Again, the rate of discount should be the risk-free rate: the reason is that this is the only rate at which, if the option fee is invested, the amount will compound to the expected value of the pay-off.

Some authors advocate the use of the implied forward rate to discount from the maturity of the underlying to the maturity of the option, and the risk-free rate from maturity of the option to the trade date. But using the risk free rate for the whole period seems advisable for the reason given in the preceding paragraph, namely, on first principles, the fee has to compound to the expected value of the option pay off without any credit risk or capital outlays. Hull uses the risk free rate for the whole period.

There is another way of looking at interest rate options. Consider a call on the 6×9 LIBOR, exercise (i.e. cap) X. The payoff is the same as a put option of the following parameters, on a zero coupon bond with a face value of $1 + (X/4)$ maturing 9 months from the trade date. The parameters of the option are

exercise: 1

maturity: 6 months

If the relevant interest rate on the date of maturity of the option is less than X, the market price will be higher than 1 and the put option will not be exercised; if it is higher, it will be. And the payoff is identical to a call option on the 6×3 LIBOR.

In principle, therefore, valuing caps is similar to valuing a series of options on zero coupon bonds.

12.1.8.2 Option on Bonds

The key problem in pricing of options on bond prices (as in the case of other options as well) is the estimation of volatility—what we need is a measure of the volatility of the bond price on maturity of the option. And, this presents certain peculiar problems in the case of bonds as the assumption of constant volatility is even weaker than in the case of currencies or equities. The reasons are two:

- The mean reversion tendency of interest rates; and
- The known price (i.e. zero volatility) on maturity of the bond. In fact, for a typical bond, volatility increases in the initial period and then goes on falling with balance maturity, until it reaches zero.

The generally used methodology is to consider the forward price of the bond for maturity of the option, as the expected value. As for volatility, two approaches are possible:

- Use volatility of the spot price of a bond with life equal to the time between maturity of the option and maturity of the bond, as in standard BS; or
- Use volatility of the forward price, as suggested in the so-called Black model used for pricing options on futures, on commodities, etc.

Most practitioners prefer the second alternative, at least for long maturity options. Note the difference between spot and forward price volatilities: in the former, the variable used is the same (say the daily return on continuous compounding basis). In the latter, the variable keeps changing every day, as it is the **volatility of the forward price for balance maturity**. Thus if it is the 60×72 forward price volatility on day 0 (for example, for calculating the price of an option on a 6 year bond, maturing at the end of the 5th year), it will be $\left(59\frac{29}{30}\right) \times \left(71\frac{29}{30}\right)$ forward price volatility on the next day. The forward prices and volatilities can be calculated from ZCYCs.

Option strike rates are generally on the clean, i.e. nominal, price of the bond. But the mathematics is based on the full price, which includes accrued interest at the coupon rate, up to the maturity of the option. Therefore, for calculating option price/values, it would be necessary to differentiate between the exercise (i.e. nominal) price X', and the full price to be used for the value of X in the pricing formula: $X = X'$ + accrued interest.

12.1.8.3 Option on Swaps (Swaptions)

As we saw in Chapter 12, swap prices (i.e. the fixed rate) are based on bond yields. Therefore, swaptions can be looked at as options on bond prices, and priced accordingly. If the buyer of the option has the right to receive fixed, it is like call option on the bond; if the buyer has the right to pay, it is the put option. Receive fix of course implies pay floating and vice versa.

What would be the parameters of the bond on which the swaption price is to be based? It should be a par bond with maturity equal to the swap maturity. In other words, for a 3-year maturity option on a 5-year maturity swap, the starting point is an 8-year coupon bond. We can now use the bond option pricing concepts for pricing the swaption.

Annexure 12.2 Derivatives: Pricing and Valuation Arithmetical Examples

In the following paragraphs, we give illustrative calculations covering the pricing and valuation of different interest rate derivatives. The methodology has been simplified for easier understanding, and therefore does not always conform to market practices and rules. The reader's particular attention is invited to the points in paragraph 12.2.8.

12.2.1 Elemental Hedge for a 2-year MIFOR Swap

Receive fixed, Pay MIFOR; Maturity 2 years

The elemental hedge is borrow fixed rate INR equal to the notional principal (borrowing cost is assumed to be the swap price, i.e. the receive fix leg), buy at the spot rate and deposit USD for 6 months and sell USD principal amount forward (interest on the USD deposit and forward margin together will hedge the pay MIFOR leg). The transaction will be rolled over three times at the end of 6, 12 and 18 months respectively. The spot, forward and LIBOR rates will be different at the time of each rollover. The numbers used for illustration are indicated in the calculations shown below. (Note that the fixed rate receipt under swap, and payment to service the borrowing have been ignored as they cancel each other.) At the end of 24 months, the rupee borrowing will be repaid from the proceeds of the dollar deposit, and the transaction squared up.

INITIAL HEDGE

(a) Parameters:

(i)	Notional	INR 100,000.00
(ii)	Spot rate	INR 45.00 per $
(iii)	Forward premium	5.00% p.a.
(iv)	6-month LIBOR	2.00% p.a.
(v)	6-month MIFOR	7.00% p.a.

(b) Cash flows:

(i)	Borrow	INR 100,000.00	for 2 years by issuing bond at say 7.50% p.a.
(ii)	buy	USD 2,222.22	by paying INR 100,000.00 (100,000 = 2,222.22 × 45.00)

(iii)	Invest	USD 2,222.22	for 6 months at LIBOR
(iv)	and sell	USD 2,222.22	forward for 6-months at 5% p.a., i.e. at INR 46.1250 (45.00 × (1 + 0.05/2) = 46.1250)

AFTER 6 MONTHS

(a) Parameters:

(i)	Spot rate	INR 45.50 per $
(ii)	Forward premium	4.00% p.a.
(iii)	6-month LIBOR	2.80% p.a.
(iv)	6-month MIFOR	6.80% p.a.
(v)	Forward Rate	46.4100

(b) Cashflows: cash flows in INR

(i)	Receive under forward contract	102,500.00 (2,222.22 × 46.1250 = 102,500.00)
(ii)	Pay under MIFOR	–3,500.00 (100,000 × (7/(2 × 100))=3,500)
(iii)	$ interest converted at spot rate	+ 1,011.11 (2,222.22 × (2/(2 × 100)) × 45.50 = 1,011.11)
(iv)	Buy USD 2197.8022 equal to notional	–100,000.00 (100,000/45.50 = 2197.8022)
		Net INR 11.11

(v)	deposit	USD 2,197.80	at LIBOR
(vi)	Sell	USD 2,197.80	forward

AFTER 12 MONTHS

(a) Parameters:

(i)	Spot rate	INR 44.50 per $
(ii)	Forward premium	4.50% p.a.
(iii)	6-month LIBOR	3.50% p.a.
(iv)	6-month MIFOR	8.00% p.a.
(v)	Forward Rate	45.5010

(b) Cashflows: cash flows in INR

(i)	Receive under forward contract	102,000.00
(ii)	Pay under MIFOR	–3,400.00

(iii)	$ interest converted at spot rate		+1,369.23
(iv)	Buy USD 2,247.19 equal to notional		–100,000.00
(v)	Surplus/deficit brought forward INR		11.11
			Net INR –19.66
(vi)	Deposit	USD 2,247.19	at LIBOR
(vii)	Sell	USD 2,247.19	forward

AFTER 18 MONTHS

(a) Parameters:

(i)	Spot rate	INR 46.50 per $
(ii)	Forward premium	4.20% p.a.
(iii)	6-month LIBOR	3.75% p.a.
(iv)	6-month MIFOR	7.95% p.a.
(v)	Forward Rate	47.4770

(b) Cashflows: cash flows in INR:

(i)	Receive under forward contract		102,250.00
(ii)	Pay under MIFOR		–4,000.00
(iii)	$ interest converted at spot rate		1,828.65
(iv)	Buy USD 2,150.54 equal to notional		–100,000.00
	Rupee surplus/deficit brought forward		–19.66
			Net INR 58.99
(v)	deposit	USD 2,150.54	at LIBOR
(vi)	Sell	USD 2,150.54	forward

AFTER 24 MONTHS

(a) Parameters:

(i)	Spot rate	INR 45.75 per $
(ii)	Forward premium	4.20% p.a.

(b) Cashflows: cash flows in INR:

(i)	Receive under forward contract	102,100.00
(ii)	Pay under MIFOR	–3,975.00
(iii)	$ interest converted at spot rate	1,844.76
(iv)	repay INR borrowing	–100,000.00
(v)	Rupee surplus/deficit brought forward	58.99
	Net	28.75

(1) Note that there is fluctuating INR surplus or deficit on each rollover. Interest on rupee surplus/deficit has been ignored in the calculations.

(2) There is no perfect hedge for a MIFOR swap.

(3) Selling principal and interest forward also does not provide a perfect hedge as the following calculations in paragraph 12.2.2 show.

12.2.2 Elemental Hedge for a 2-year MIFOR Swap, by Selling Forward Principal + Interest (The same swap as in paragraph 12.2.1)

INITIAL HEDGE

(a) Parameters:

(i)	Notional	INR 100,000.00
(ii)	Spot rate	INR 45.00 per $
(iii)	Forward premium	5.00% p.a.
(iv)	6-month LIBOR	2.00% p.a.
(v)	MIFOR is	7.00% p.a.

(b) Cashflows:

(i)	Borrow	INR 100,000.00	for 2 years by issuing bond at say 7.50% p.a.
(ii)	Buy	USD 2,222.22	by paying INR 100,000.00 (100,000/45.00 = 2,222.22)
(iii)	Invest	USD 2,222.22	for 6 months at LIBOR
(iv)	and sell	USD 2,244.44	forward for 6 months (i.e. principal + interest) at INR 46.1250

$(45.00 \times (1 + 5/(2 \times 100)) = 46.1250)$

$(2{,}222.22 \times (1 + 2/(2 \times 100)) = 2{,}244.44)$

AFTER 6 MONTHS

(a) Parameters:

(i)	Spot rate	INR 45.50 per $
(ii)	Forward premium	4.00% p.a.
(iii)	6-month LIBOR	2.80% p.a.
(iv)	MIFOR is	6.80% p.a.
(v)	Forward Rate	46.4100

(b) Cashflows: cash flows in INR:

(i)	Receive under forward contract	103,525.00 (2,244.44 × 46.1250 = 103,525.00)
(ii)	Pay under MIFOR	–3,500.00 (100,000 × (7/(2 × 100)) = 3,500)
(iii)	Buy USD 2,197.8022 equal to notional	–100,000.00 (100,000.00/45.50 = 2,197.8022)
		Net INR 25.00
	New $ notional =	USD 2,197.80

(iv)	Deposit	USD 2,197.80	at LIBOR
(v)	Sell	USD 2,228.57	forward
		(2,197.8022 × (1 + 2.80/(2 × 100)) = 2,228.5714)	

AFTER 12 MONTHS

(a) Parameters:

(i)	Spot rate	INR 44.50 per $
(ii)	Forward premium	4.50% p.a.
(iii)	6-month LIBOR	3.50% p.a.
(iv)	MIFOR is	8.00% p.a.
(v)	Forward rate	45.5010

(b) Cashflows: cash flows in INR

(i)	Receive under forward contract	103,428.00
(ii)	Pay under MIFOR	–3,400.00
(iii)	Buy USD equal to notional	–100,000.00
(iv)	Rupee surplus/deficit b/f	25.00
		Net INR 53.00
	New $ notional =	USD 2,247.19

(v)	Deposit	USD 2,247.19	at LIBOR
(vi)	Sell	USD 2,286.5168	forward

AFTER 18 MONTHS

(a) Parameters:

(i)	Spot rate	INR 46.50 per $
(ii)	Forward premium	4.20% p.a.
(iii)	6-month LIBOR	3.75% p.a.
(iv)	MIFOR is	7.95% p.a.
(v)	Forward rate	47.4770

(b) Cashflows: cash flows INR

(i)	Receive under forward contract		104,039.3750
(ii)	Pay under MIFOR		–4,000.0000
(iii)	Buy USD equal to notional		–100,000.0000
	Rupee surplus/deficit b/f		53.0000
	Net		INR 92.3750
	New $ notional =		USD 2,150.5376
(iv)	deposit	USD 2,150.5376	at LIBOR
(v)	Sell	USD 2,190.8602	forward

AFTER 24 MONTHS

(a) Parameters:

(i) Spot rate INR 45.75 per $

(b) Cashflows: cash flows in INR

(i)	Receive under forward contract	104,014.3750
(ii)	Pay under MIFOR	–3,975.0000
(iii)	repay INR borrowing	–100,000.0000
(iv)	Rupee surplus/deficit b/f	92.3750
	Net	INR 131.7500

In the cited scenario, there is always a positive cash flow. But, this will not be the case if the forward margin is a discount or if the notional principal is fixed in dollars, as is the case while using MIFOR swaps to hedge risks on cross currency swaps.

12.2.3 MIFOR Swap Cancellation

Notional INR 100

Original swap: receive fixed (7.50%), pay MIFOR (next exchange due in 4 months, current MIFOR coupon outflow, already fixed is 5% p.a.)

Balance maturity 1 year 4 months (i.e. 1.3333 years)

Today's rates

MIFOR swap rate	
Year	**rate (% p.a.)**
1.00	6.00
2.00	7.00
1.33#	6.33

LIBOR and forward margin (%p.a.)		
Month	**LIBOR**	**Forward margin**
3	4.0000	1.5000
6	4.6000	2.0000
4#	4.2000	1.6667

Interpolated rates on 30/360 day basis

Note that as per market practice,

(a) 1-year swap has only one fixed rate flow, and hence the quoted swap rate is, in effect, the "zero coupon" swap rate.

(b) 2-year swap has half yearly cash flows.

(c) There are no interim flows under the 3, 6-month LIBORs and in forward markets.

For canceling the swap, we first need to value it for its balance maturity of 1 year and 4 months, at ruling rates. For this purpose, we have already calculated, by interpolation, the implied 4 month MIFOR and 1.3333 years swap rate above. We can now consider the notional cash flows under the 1.333 year reverse MIFOR swap (pay fix, receive floating) and discount the net flows: subsequent MIFORs (4×10 and 10×16) need not be calculated as flows will cancel each other out—pay floating under the existing swap and receive floating under the (notional) reverse swap. We would also need to calculate the discount factors for 4, 10 and 16 months.

(a) The discount rate for 4 months is 5.8667, and the discount factor is 0.9808.

(b) For the 10 months discount rate, we interpolate the current 1 year (6%) and 6-month (6.6%) rates, giving the 10 months discount rate as 6.2%. The discount factor therefore is 0.9509.

(c) For the 16 months discount rate, we need to consider that the 16 months swap involves exchanges of cash flows at the end respectively of 4, 10 and 16 months. From the 4 and 10 months discount factors, we can now calculate the implied 16 months discount rate. The notional cash flows under the 16-month swap are 2.1111 ($6.3333 \times 4/12$), 3.1667 ($6.3333/2$) and 103.1667. The present value of these cash flows has to be 100 at inception. The PVs of the first two cash flows are, respectively, (2.1111×0.9808), or 2.0706, and (3.1667×0.9509), or 3.0111. Therefore, the PV of the last cash flow has to be ($100 - 2.0706 - 3.0111$) or 94.9183, giving the discount factor for 16 months as ($94.9183/103.1667$) or 0.9200.

We can now use these discount factors to calculate the value of the swap as in the following table.

Cash flows to be exchanged for cancellation, by doing a pay fix, receive floating swap at current rates.

Fixed leg of the swap					
Months	**Original**	**At current swap rates of 6.33**	**Difference**	**Discount factor**	**PV**
4	3.7500	-2.1111*	1.6389	0.9808	1.6075
10	3.7500	–3.1667	0.5833	0.9509	0.5546
16	103.7500	–103.1667	0.5833	0.9200	0.5367
				Total	2.6988

Floating leg of the swap					
Months	**Original**	**At current rates**	**Difference**	**Discount factor**	**PV**
4	–2.5000	1.9556**	–1.5444	0.9808	–0.5340

* While under the original swap INR 3.75 is receivable after 4 months, followed by 6 monthly interest payments, a fresh/offsetting swap will involve the 1st interest payment period of only 4 months, for INR 2.1111 (i.e. 6.3333 × 4/12)

** 5.8667 × 4/12

Cash flow for the floating leg of the reverse swap will also involve a 1st interest period of only 4 months, for INR 1.9556 (i.e. 5.8667 × 4/12). Note that subsequent MIFOR flows need not be considered as they cancel it each other out.

Gain on cancellation = 2.6988 – 0.5340 = INR 2.1648

12.2.4 Valuation of an OIS

The swap (OIS) is receive fix, pay floating

Fixed rate on the swap = 6.25 % p.a.

Remaining maturity = 1 year 5 months, 20 days, or 1.47146 years on 30/360 day basis

Previous interest exchange = 10 days back

Notional principal = 100

Today's OIS rates

Maturity	Rate (% p.a.)
3 months	6.30
6 months	6.50
1 year	6.73
2 years	6.83
3 years	7.03
5 years	7.33

Accrued interest calculation on floating rate leg

Working Day no. since previous interest exchange a	day name b	No. of days for which interest to be applied c	O/N interest rate (% p.a.) d	Notional principal e	Interest f = (d × c/36500) × e	Principal + interest g = c + f
DAY1	Tuesday	1	5.85	100.00000	0.01603	100.01603
DAY2	Wednesday	1	5.89	100.01603	0.01614	100.03217
DAY3	Thursday	1	5.85	100.03217	0.01603	100.04820
DAY4	Friday	3	5.86	100.04820	0.04819	100.09639
DAY5	Monday	1	5.85	100.09639	0.01604	100.11243
DAY6	Tuesday	1	5.85	100.11243	0.01605	100.12848
DAY7	Wednesday	1	5.84	100.12848	0.01602	100.14450
DAY8	Thursday	1	5.82	100.14450	0.01597	100.16046

Value of the floating rate leg of the swap = –100.16046

For valuing the fixed rate leg, we need to calculate, by interpolation and bootstrapping, today's 1.47146 year swap rate, and the discount factors for 0.47146, 0.97146, and 1.47146 years respectively. Note that the 3, 6 months and 1 year swap rates involve only 1 flow on the fixed rate side. In effect, these are "zero coupon" swap rates.

(a) Given the 3 and 6 months rates (i.e. 0.25 and 0.5 years) we can calculate the implied rate for 0.47146, years as $(6.30 + (6.50 - 6.30) \times (0.47146 - 0.25)/0.25)$ or 6.4772. The corresponding discount factor is $(1/(1 + 0.064772 \times 0.47146)$ or 0.970368.

(b) Similarly, the implied rate for 0.97146 years is 6.7169 and the discount factor 0.938745.

(c) For calculating the discount factor for 1.47146 years, we need to assume that cash flow exchanges under a notional swap for this period will take place at the end of 0.47146, 0.97146, and 1.47146 years. By interpolation the swap rate is 6.777146, and the cash flow exchanges are 3.195153, 3.388573 and 103.388573 respectively. The present values of the first two, at the discount rates calculated in (a) and (b), are 3.100473 and 3.181007 respectively. This gives the PV of the last cash flow as (100 – 3.100473 – 3.181007) or 93.71852, giving a discount factor of 0.906469.

We can now use these discount factors to calculate the value of the fixed rate leg.

Time to maturity (yrs)	Inflow	Discount factor	PV
0.47146	3.125	0.970368	3.0324
0.97146	3.125	0.938745	2.9336
1.47146	103.125	0.906469	93.4796
		total	99.4456

Using the valuation of the floating rate leg done earlier, the value of the swap = –100.1605 + 99.4456 = –0.7149

12.2.5 Pricing a Forward Swap

Quote a 3-year MIBOR OIS, starting 2 years from today, receive fix, pay floating

Current OIS rates

Year	Rate (% p.a.)
0.5	6.45
1.0	6.69
2.0	7.00
3.0	7.25
5.0	8.00

The hedge:

Pay fixed under a 5-year swap and receive fixed under a 2-year swap

Note that market price is only one cash flow on the fixed rate side for swaps up to 1 year maturity. Therefore, the discount factors for the 6 months and 1 year cash flows can be readily calculated as (1/(1+0.045/2)) or 0.9688 and (1/1.0669) or 0.9373. For longer maturity cash flows, the discount factors will have to be calculated by

(a) interpolating swap rates where quotes for a particular maturity are not available; and

(b) using bootstrapping procedure. The following table summarises the results:

Period	Swap rates	Discount factors
0.5	6.45%	0.9688
1	6.69%	0.9373
1.5	6.84%	0.9038
2	7.00%	0.8712
2.5	7.13%	0.8390
3	7.25%	0.8069
3.5	7.44%	0.7732
4	7.63%	0.7393
4.5	7.81%	0.7053
5	8.00%	0.6714

Cash flows for fixed rate legs of the swaps, for the initial 2-years (floating rates need not be considered as they cancel each other out).

Maturity (yrs)	2-year swap	5-year swap	Difference	Discount factors	PV1
0.5	3.50	–4.00	–0.50	0.9688	–0.4844
1.0	3.50	–4.00	–0.50	0.9373	–0.4686
1.5	3.50	–4.00	–0.50	0.9038	–0.4519
2.0	3.50	–4.00	–0.50	0.8712	–0.4356
				Total	–1.8405

This shortfall on INR 1.8405 has to be recovered through the forward swap price, over its 3-year life, by quoting a suitably higher price than the current 5-year swap rate. Therefore, the rate for the forward swap needs to be so calculated, by trial and error, that the sum of present values of cash flows (i.e. PV2, shown in the table below) is higher than that of the hedge (i.e. PV1, shown in the table above) to the extent of the shortfall. The calculations are shown below:

Maturity (years)	Discount factors	Cash flows under the 5-year OIS	Cash flows under the forward swap	Difference	PV2
2.5	0.8390	−4.00	4.4059	0.4059	0.3405
3.0	0.8069	−4.00	4.4059	0.4059	0.3275
3.5	0.7732	−4.00	4.4059	0.4059	0.3138
4.0	0.7393	−4.00	4.4059	0.4059	0.3000
4.5	0.7053	−4.00	4.4059	0.4059	0.2862
5.0	0.6714	−4.00	4.4059	0.4059	0.2725
				Total	1.8405

$$PV1 + PV2 = 0$$

Therefore, the rate for a 3-year forward swap, starting 2 years from now is 8.8118% p.a. (4.4059 × 2).

12.2.6 FRA Cancellation

Original FRA 3 × 9 at a rate of 6.4198% p.a.,

Notional principal INR 101.25

Cancellation after 1½-months, i.e. now it is a 1½ × 7½ FRA

Today's interest rates

Maturity	Bid (%p.a.)	Offer (%p.a.)
1 month	4.98	5.00
3 months	5.47	5.49
6 months	5.75	5.77
9 months	6.50	6.52
	Interpolated rates	
1½ months	5.1025	5.1225
7½ months	6.1250	6.1450

1. Under original hedge for the FRA (written by the bank)
   (a) Asset/deposit will mature after 1½ months from today, providing principal plus interest of INR 101.25.
   (b) Liability/borrowing will have to be paid off after 7½ months from today, the amount being INR 104.50 [i.e. 101.25 × (1 + (6.4198/100) × (6/12))].
2. Now the bank needs a 1½ months liability and 7½ months asset at ruling rates such that it cancels/offsets the hedge components in (1) above. Thus,

(a) Borrow 100.6058 @ 5.1225% p.a. for 1½ months. This compounds to 101.25, the amount you receive from the original hedge per 1(a).

(b) Deposit 100.6058 @ 6.1250% p.a. for 7½ months, to fetch 104.4571 (100.6058 × (1+0.06125 × 7.5/12) = 104.4571).

(c) FRA rate implied for buyer of FRA from 2a and 2b is 6.3351% p.a. ((100.4571/101.25 – 1) × 12/6) = 6.3351% p.a.

3. At the end of 7½ months, receive 104.4571 under 2 (b)

   Pay 104.5000 under original hedge

   Shortfall 0.0429

   The present value of this amount needs to be recovered from the buyer of the FRA today. Therefore,

Maturity	Amount	Discount rate	Discount factor	PV
7½ months	0.0429	6.1350 % pa*	0.9631	0.0413

*Mid rate

For cancellation today, INR 0.0413 will have to be recovered. Note that this is the cancellation amount for an FRA with a notional principal of 101.25. Therefore, the cancellation rate is 0.0408%.

4. An alternative way of calculation, is to consider the difference in FRA rates for a period of 6 months and multiply it by the notional principal as shown below:

   (0.063351 – 0.064198) × (6/12) × 101.25 = –0.0429

   The present value of this amount needs to be recovered from the buyer of the FRA today.

12.2.7 Pricing of an Amortising Swap

Consider a 5-year MIBOR OIS IRS with the following amortisation schedule for the notional principal.

Year	Notional principal outstanding at beginning
1	100
2	80
3	60
4	40
5	20

The OIS rates are assumed to be the same as in 12.2.5 and thus the swap rates for unquoted maturities and the discount factors calculated in that example will also be used here.

We can look at the fixed rate leg of the swap as a portfolio of five fixed rate bonds of face value of Rs 20 each, maturing at the end of 1, 2, 3, 4, and 5 years. We need to calculate, by trial and error, the common coupon for all the five bonds such that the total of the discounted values comes to 100. The calculations are shown below:

Year	Principal outstanding	Principal payment	Coupon payment	Principal + interest	Discount factors	Present values
a	b	c	d	e = c + d	f	g = e × f
0.5	100	0	3.7507	3.7507	0.9688	3.6335
1.0	100	20	3.7507	23.7507	0.9373	22.2614
1.5	80	0	3.0006	3.0006	0.9038	2.7120
2.0	80	20	3.0006	23.0006	0.8712	20.0372
2.5	60	0	2.2504	2.2504	0.8390	1.8880
3.0	60	20	2.2504	22.2504	0.8069	17.9538
3.5	40	0	1.5003	1.5003	0.7732	1.1599
4.0	40	20	1.5003	21.5003	0.7393	15.8941
4.5	20	0	0.7501	0.7501	0.7053	0.5291
5.0	20	20	0.7501	20.7501	0.6714	13.9308
					Total	100.0000

This gives the desired swap rate as 7.5014% p.a. (3.7507 × 2).

12.2.8 Some Finer Points

While the hedging and valuation concepts and mathematics have been explained above, practioners need to take note of the following points:

1. The practice in the Indian market is to have quarterly exchanges of floating rate cash flows in respect of swaps up to one year, but the fixed rate is paid only at the end of the swap period. On the other hand, for longer maturity swaps the two cash flows are exchanged half yearly. Therefore, the swap prices—i.e. the fixed rates—of shorter (up to 1 year) and longer maturity swaps are not quite comparable. For interpolation purposes, if both shorter and longer maturity swap prices are used, the former would need to be adjusted for the compounding effect between quarterly and 6-monthly exchanges of cash flows.

2. We have used 30/360 day year for calculation purposes (except for calculating of accrued interest on OIS valuation, paragraph 12.2.4). The derivatives market in India uses the actual/365 day count convention.
3. We have used the discount factors for each maturity arrived at by linear interpolation and bootstrapping of quoted swap prices, for valuing the swaps. On first principles, the valuation amount should be such that, if invested at current interest rates, it should allow a replication of the cash flows. This, however, leads to an anomaly in the current pricing of swaps in the Indian market. As we have discussed in the chapter, in theory, swap prices—i.e. the fixed rate—should rule above the corresponding G-Sec yield because of the counterparty credit risk. Internationally, interest rate swap prices are on par with highly rated corporate paper, i.e. at a premium to sovereign yields. Strictly speaking, therefore, the discounting should be done at the zero coupon yield curve for say AA corporate bonds, and not the zero coupon swap curve. We have not done so because this creates another anomaly in that, at inception, the swap value would not be zero! However, the reader needs to take note of the correct logical basis of the discount rate to be used.
4. There are two ways of doing swap valuations:
   (i) Calculate the cash flows to be exchanged at the ruling prices, for the cash flow exchange dates under the original swap, and an opposite swap at today's prices as we have done in respect of the MIFOR swap (paragraph 12.2.3). The positive or negative cash flows can then be discounted at the appropriate rate to arrive at today's value.
   (ii) The other method is to look at a swap as a portfolio of two bonds, one issued and one purchased; then calculate separately the valuation of the two bonds at the ruling rates. The difference then represents the value of the swap—we have used this methodology in relation to the MIBOR OIS swap (paragraph 12.2.4). (Both methods give the same value.)
5. When market makers are quoting two way prices, the price to be used for valuation etc. should be the appropriate bid or offer rate depending on the transaction. (In the illustrated calculations we have used only one price except in the FRA cancellation illustration.)

Chapter 13

Measuring the Price Risk: Duration and Convexity

13.1 Introduction

As we have already noted, market prices of fixed interest securities depend on ruling interest rates: prices rise when interest rates (or yields) fall, and fall when they go up. Changing yields/interest rates (and hence prices of securities) affect the total return from the investment for the investor. This is obviously true if a security is to be sold before it matures. It is equally true in respect of coupon bearing securities, even if held to maturity: this is because coupon inflows before maturity are required to be invested at the ruling, ever changing interest rates. As we saw in Chapter 8, an implicit assumption underlying YTM calculations is that coupon inflows are invested at YTM: in that situation alone is the realized yield of a coupon bearing security held to maturity equal to its YTM.

There is also another problem in respect of investments which are required to be "marked to market", i.e. valued at market prices periodically. The difference affects the net asset value of the portfolio and also sometimes the profit and loss account of the investor if the valuation changes need to pass through it. The "price risk" is therefore important to managers of debt security portfolios.

We discuss the issues of varying returns and price volatility arising from changes in market rates, in the following paragraphs.

13.2 Time Horizon Returns: Macaulay Duration

13.2.1 Components of Total Return from a Fixed Income Security

We have already seen that the total return from a coupon bond, even if held to maturity, is equal to the YTM only when all coupon inflows are also invested at the YTM (see Eq. (8.4)): this requires the yield curve to be flat and unchanged up to investment maturity, hardly a realistic assumption. At any interim (i.e. pre-maturity) time horizon, the total return is even more uncertain as it will consist of

(a) the ruling full price of the bond;
(b) the coupon inflows;
(c) interest on (b) (which depends on interest rates ruling when the inflows materialise and the periods for which they are invested).

Table 13.1 illustrates the importance of the last factor to total returns for a security held to maturity.

Table 13.1 Composition of Total Return

(Same security as in Table 8.3)

Price	–70.00	–80.00	–90.00	–100.00	–110.00	–120.00	–130.00
YTM*	0.0850	0.0714	0.0599	0.0500	0.0413	0.0336	0.0267
Total return to maturity*	188.13	161.03	138.24	118.29	100.30	83.72	68.21
Composed of price change	30.00	20.00	10.00	0.00	–10.00	–20.00	–30.00
Coupon inflows	80.00	80.00	80.00	80.00	80.00	80.00	80.00
Interest on inflows invested at YTM	78.13	61.03	48.24	38.29	30.30	23.72	18.21
Interest on inflows as a percentage of total return	41.53	37.90	34.90	32.37	30.21	28.33	26.70

* YTM is per period. The total return has been calculated by compounding the investment at YTM, and deducting the original investment/price therefrom.

It will be noted that higher the YTM, **higher is the dependence on the interest on interest component** as a proportion of the total return and vice versa. And this interest on coupon inflows depends on future interest rates (i.e. interest rates ruling when coupon inflows occur), which are unknown at the time of the investment. The other components—i.e. price change to maturity and coupon inflows—are known at the time the investment decision is made.

13.2.2 Macaulay Duration

Of the three components of total return, **for any given time horizon before maturity, only the second factor (i.e. coupon inflows) is certain. The other two are uncertain but have opposite influence on the total return:** if interest rates go up after investment, price (the first factor) falls but the third factor, i.e. interest on coupon inflows, increases, and vice-versa. Can they neutralise each other before maturity of the security?

Consider Table 13.2 which has been prepared on the assumption that yield on the security falls by 2% **per interest period** immediately after the security has been purchased at Rs 70 (YTM 8.50% per period).

It will be seen that after the fall in interest rates, the total returns are higher up to the 10^{th} period, and become negative thereafter. Somewhere in the course of the 11^{th} period, the total returns would be unaffected by the change in interest rates.

For calculating this time horizon at which total returns are immune to interest rate changes, Frederick Macaulay introduced the concept of "duration" of a fixed income security, as distinct from its maturity. This considers a coupon bond as a portfolio of zero coupons, each representing one inflow. **The Macaulay duration is the weighted average maturity of the zero coupon bonds representing the inflows, the weights being the present values of those inflows as a proportion of the full price of the coupon bond.**

$$\text{Thus, Macaulay duration } D = \sum_{i=1}^{n} \frac{\left[i \times \dfrac{C_i}{(1+\text{YTM})^i} \right]}{\text{Price}} \qquad (13.1)$$

Note that i is the maturity in periods of the i^{th} inflow; its multiplicant is

$$\frac{C_i/(1+\text{YTM})^i}{\text{Price}}$$

The numerator in the multiplicant is the present value of the inflow, and the multiplicant is the proportion, or weight, of that present value in the price of the security.

Table 13.2 Impact of Change in Interest Rate on Total Returns

(Same Security as in Table 8.3)

		No change in interest rate			Interest rate falls by 0.02 per period			Net change
	Invest-ment –70.00	Price 70.00	Interest on interest	Total return	Price	Interest on interest	Total return	
1	5.00	70.95	0.00	75.95	85.91	0.00	90.91	14.96
2	5.00	71.98	0.42	82.40	86.50	0.32	96.82	14.42
3	5.00	73.09	1.31	89.41	87.12	1.00	103.11	13.71
4	5.00	74.31	2.70	97.00	87.78	2.04	109.81	12.81
5	5.00	75.62	4.63	105.25	88.48	3.47	116.95	11.70
6	5.00	77.05	7.14	114.19	89.23	5.32	124.55	10.36
7	5.00	78.59	10.30	123.89	90.03	7.61	132.64	8.75
8	5.00	80.27	14.15	134.42	90.88	10.38	141.26	6.84
9	5.00	82.09	18.75	145.85	91.78	13.65	150.44	4.59
10	5.00	84.07	24.17	158.24	92.75	17.47	160.21	1.97
11	5.00	86.22	30.47	171.69	93.77	21.85	170.62	–1.06
12	5.00	88.54	37.73	186.28	94.87	26.84	181.71	–4.56
13	5.00	91.07	46.04	202.11	96.03	32.49	193.52	–8.59
14	5.00	93.80	55.48	219.28	97.27	38.82	206.09	–13.19
15	5.00	96.78	66.14	237.91	98.59	45.89	219.49	–18.43
16	105.00	100.00	78.13	258.13	100.00	53.75	233.75	–24.39

YTM % 8.50

Notes:

(a) The first two columns describe the security's cash flows.

(b) The next three calculate returns, on each coupon date, assuming reinvestment of inflows **at the original YTM** and a flat and unchanged yield curve.

(c) The subsequent three calculate prices, interest on interest and total returns assuming that interest rate falls by 2% **per interest period**, immediately after the investment has been made, and remains unchanged to maturity.

(d) The last column shows the difference in returns.

The Macaulay duration is expressed in periods, is less than maturity for coupon bonds, and is equal to maturity for a zero-coupon bond. At the Macaulay duration of an investment, **calculated when a yield change occurs**, the total returns from a fixed income investment are

(a) unaffected by the change, if small;

(b) higher, if the change is large, whether upward or downward, than what they would have been in the absence of the change.

For proof of the formula for Macaulay duration, please refer to Annexure 13.1.

The actual calculation of the Macaulay duration for a specimen security is shown in Table 13.3.

Table 13.3 Macaulay Duration Calculation

Security:	Face value	Rs 100
	Price	Rs 83.20
	Coupon	5
	Interest periods to maturity	14
	YTM 6.91% per interest period	

I	C_i	$I \times C_i$	$I \times C_i/(1 + YTM)^I$
1	5.00	5.00	4.68
2	5.00	10.00	8.75
3	5.00	15.00	12.28
4	5.00	20.00	15.31
5	5.00	25.00	17.90
6	5.00	30.00	20.09
7	5.00	35.00	21.92
8	5.00	40.00	23.44
9	5.00	45.00	24.66
10	5.00	50.00	25.63
11	5.00	55.00	26.37
12	5.00	60.00	26.91
13	5.00	65.00	27.27
14	105.00	1470.00	576.79
YTM (%)	6.91	Total	831.99
Macaulay duration	9.9999		

It will be useful for the reader to calculate the duration of the security analysed in Table 13.2—it is 10.37 periods.

Table 13.4 illustrates the change in total returns of the above security at its Macaulay duration (10 periods), under a variety of changes in interest rates occurring immediately after its purchase (in each case the returns are higher).

Note that **whatever the change in yields, the total returns at duration are higher than what they would have been** without a change in YTM (.0691) as shown in Table 13.4. It may be noted that the total **realised returns to maturity go up, if interest rates have gone up after investment (and down if interest rates have fallen)**.

Table 13.4 Macaulay Duration : 10 Periods

(Same Security as in Table 13.3)

	Change at duration in		
YTM (%)	**Price**	**Interest on interest**	**Total returns**
3.91	10.45	–9.01	1.44
4.41	8.61	–7.61	1.00
4.91	6.80	–6.17	0.64
5.41	5.04	–4.69	0.36
5.91	3.33	–3.17	0.16
6.41	1.64	–1.60	0.04
6.91	0.00	0.00	0.00
7.41	–1.60	1.64	0.04
7.91	–3.17	3.33	0.16
8.41	–4.71	5.07	0.36
8.91	–6.21	6.85	0.64
9.41	–7.67	8.68	1.00
9.91	–9.11	10.55	1.44
10.41	–10.51	12.48	1.97

The Macaulay durations of securities with identical maturities and YTMs, but different coupon rates (and prices), are obviously different. Securities C and D in paragraph 8.4.2 have Macaulay durations of 13.0853 and 14.4738 interest periods respectively.

A closer inspection of the formula and methodology for calculating suggests that duration

(i) increases with bond maturity but is less than balance maturity for coupon bonds;

(ii) for given YTM and maturity, duration is lower for high coupon, higher for low coupon bonds and **equal to balance maturity for zero coupon securities**;

(iii) for given maturity and coupon, is lower for high YTM (low price) and higher for low YTM bonds.

13.2.2.1 Calculation in between Coupon Dates

The formula needs to be modified as follows for calculations of duration in between coupon dates

$$D = \sum_{i=1}^{n} \frac{(i-1+w) \times C_i/(1+\text{YTM})^{(i-1+w)}}{\text{Price}} \qquad (13.2)$$

where w is the fraction of the interest period between date of calculation and next coupon inflow.

13.2.2.2 Duration Drift

Duration, like the price of a security, keeps changing with passage of time even if interest rates are unchanged. This is referred to as "**duration drift**". **The changes are not, however, linear**, i.e. not proportionate to the passage of time, as Table 13.5 shows.

Table 13.5 Change in Duration with Passage of Time

No change in yields

Coupon 5.00 per half year

Maturity 8 years

	Price	Duration in (interest periods)
Price now	70.00	10.3728
2 years later	74.31	8.8087
4 years later	80.27	6.6212
6 years later	88.54	3.7037
8 years later	100.00	0.0000

Note that duration has fallen by 1.5641 periods in the first two years, but by 2.9175 periods between the 4th and 6th years.

13.2.3 Portfolio Duration

From the duration of individual securities, the duration of a portfolio can also be readily calculated by weighting the duration of each security by its full price (and face value). Algebraically, the Macaulay duration of a portfolio of n securities

$$= \frac{\left(\sum_{i=1}^{n} D_i \times p_i \times f_i\right)}{\left(\sum_{i=1}^{n} p_i \times f_i\right)} \qquad (13.3)$$

where

D_i = duration of i^{th} security;

p_i = full market price of i^{th} security as percentage of face value;

f_i = maturity value of i^{th} security in the portfolio.

13.2.4 Immunising Portfolios from Interest Rate Risks

Portfolio durations can be used to "immunise" the total returns from a portfolio of fixed income securities, from changes in interest rates: "total returns" means coupon inflows, return on such inflows, and changes in bond prices. For such immunization strategies, the time horizon of the investor needs to be specified. In principle, **if the duration of an investment portfolio is kept equal to the time horizon of the investor, he does not need to worry about changes in** interest rates and their effect on the total return from his portfolio. Remember, however, that since duration keeps changing with passage of time, **a dynamic management of the portfolio is essential** to ensure that duration equals the time horizon (which could be say 10 years on a rolling basis, or a specific date), on an ongoing basis.

Portfolio rebalancing becomes necessary as the duration change is equal to the passage of time only in the case of zero coupon bonds: therefore, no rebalancing will be necessary only if

(a) The time horizon is specified in terms of a date; and

(b) The investment is in the form of a zero coupon bond maturing at the specified time horizon.

In general, however, rebalancing of the portfolio would be necessary to keep the duration of the portfolio equal to the time horizon. Two situations arise:

- If the time horizon is a prescribed date, with passage of time, the duration of the unchanged portfolio will become larger than the balance time horizon, and the portfolio duration will need to be reduced by making short dated investments;
- On the other hand, if the time horizon is a constant period on a rolling basis, then, with passage of time, the duration of the unchanged portfolio will become smaller than the specified time horizon and the portfolio duration will need to be increased by making longer maturity investments.

In theory, such rebalancing needs to be done whenever a cash inflow takes place. In practice, results within tolerable limits can be achieved by much less frequent rebalancing. Quite often, judicious investment of coupon inflows itself can achieve the desired objective, actual switching of existing securities for fresh ones being used only when necessary.

13.3 Price Volatility

An **estimation of the likely price change** is obviously important for management of fixed interest securities and portfolios which are required to be marked to market (i.e. valued at market prices) periodically.

There are two ways in which the price risk can be estimated:

(a) by assuming a certain change in yields; or

(b) empirically, on past price behaviour.

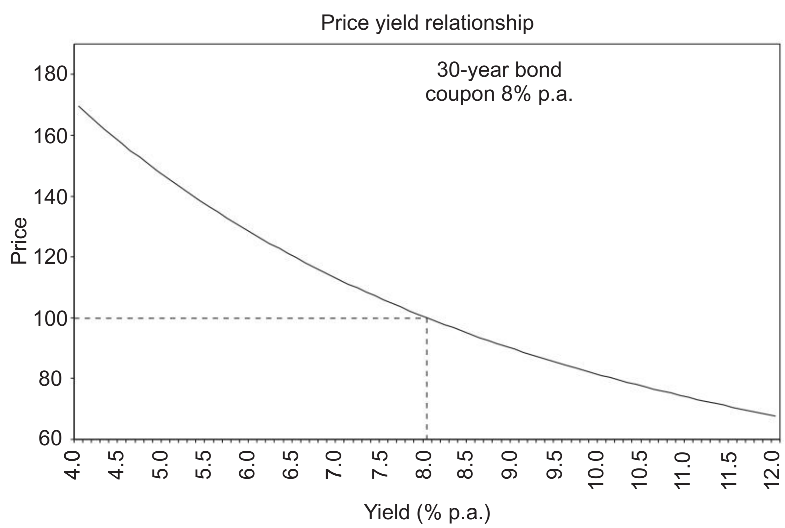
The former approach is based on calculating the **duration and convexity** of a security and is discussed in this paragraph; we look at the latter approach, based on **Value at Risk (VaR)**, in the next chapter.

In India, commercial banks and primary dealers' portfolios of debt securities are subject to capital requirement on the basis of the measured price risk.

13.3.1 Price Yield Curve

The shape of the price: yield curve is convex as the following graph shows.

Graph 13.1



Note the difference between straight-line and convex shapes. Where the price yield relationship to be a straight line, for a given change in yield, the rise and fall in price would have been equal. However, as we have seen in paragraph 8.3, for the same change in yield (of 1%), the price rise is more than the price fall. This is the effect of the convexity of the shape of the price yield curve: it implies that **the fall in price resulting from a given rise in the yield is always less than the rise in price resulting from an equal fall in the yield.** (Incidentally, this is the reason why, at the Macaulay duration, the total returns are equal to **or higher than** what they otherwise would have been, whether interest rates go up or down.)

13.3.2 Volatility Calculations

For calculating the **price volatility of a security, defined as price change in percentage terms for a unit change in yields,** one needs to use a branch of mathematics called differential calculus. As explained in Annexure 13.1, **the percentage change** in the price of a fixed interest security arising from a change in yield can be estimated by using the following equation:

$$= \frac{dp}{d\,\text{YTM}} \times \frac{d'\,\text{YTM}}{p} + \frac{d^2 p}{d\,\text{YTM}^2} \times \frac{d'\,\text{YTM}^2}{2 \times p} \tag{13.4}$$

where

$\frac{dp}{d\,\text{YTM}}$ and $\frac{d^2 p}{d\,\text{YTM}^2}$ are respectively the first and second differentials of the price (p) with reference to YTM; and d' YTM is the change in YTM. Expressing YTM by r, the multiplicants of $d'r$ and $(d'r)^2$ namely

$$\frac{dp}{dr} \times \frac{1}{p} \text{ and } \frac{d^2 p}{dr^2} \times \frac{1}{p}$$

are referred to respectively as **the modified duration, and convexity of a security.** The modified duration and convexity are measures of a security's price volatility.

Given that

$$p = \sum_{i=1}^{n} \frac{C_i}{(1+r)^i} \quad \text{(vide Eq. (8.1))}$$

it can be shown that (see Annexure 13.1)

$$\frac{dp}{dr} = \sum_{i=1}^{n} -i \times \frac{C_i}{(1+r)^{(i+1)}} \tag{13.5}$$

and $$\frac{d^2 p}{dr^2} = \sum_{i=1}^{n} i \times (i+1) \times \frac{C_i}{(1+r)^{(i+2)}} \tag{13.6}$$

It will be seen from Eq. (13.4) that $(dp/dr) \times (1/p)$, i.e. the modified duration, is very similar to the Macaulay duration defined earlier. In fact,

$$\text{Macaulay duration} = -1 \times (1 + r) \times (\text{modified duration}) \tag{13.7}$$

Note that for the relationship to hold, the Macaulay and modified durations should be expressed in interest periods, not years. Again, the **per period YTM** should be used and not the bond equivalent yield.

From Eqs. (13.4), (13.5) and (13.6).

(a) If $d'r$ is positive, the effect of the first term is negative—price falls if interest rate rises and vice versa.

(b) For any $d'r$, whether positive or negative, the effect of the second term is positive, but much smaller than the effect of the first term.

The end result therefore is that, for a given change in yield, **the fall in price (if yield rises) is less than the price rise (if yield falls)**—hence the convex shape of the price: YTM curve.

Table 13.6 gives specimen calculations of modified duration and convexity.

From Eq. (13.4), the percentage change in price is

$$\frac{d'p}{p} = \text{modified duration} \times \text{change in YTM} + \left[\text{convexity} \times \left(\frac{\text{change in YTM}}{2}\right)^2\right]$$

Substituting actual figures, assuming a rise of 1% in yield

$$\begin{aligned} d'p/dp &= (-9.35 \times 0.01) + (115.92 \times 0.0001/2) \\ &= -0.0935 + 0.0058 \\ &= -0.0877 \end{aligned}$$

The estimated percentage fall in price is therefore 9.35% using only the modified duration, and 8.77% using both modified duration and convexity. Given the base price (83.20), the estimates of new prices are 75.42 and 75.90 respectively. The actual price directly calculated from the revised yield of

Table 13.6 Modified Duration, Convexity and Volatility

Fourteen Interest Payments

Price	83.20
Coupon	5.00
YTM	6.91%

Inflows			Modified Duration		Convexity		
I	C_i	$i \times C_i$	$(1 + YTM)^{(i+1)}$	$i \times C_i/(1 + YTM)^{(i+1)}$	$i \times (i+1) \times C_i$	$(1 + YTM)^{(i+2)}$	$i \times (i+1) \times C_i/(1 + YTM)^{(i+2)}$
1	5.00	5.00	1.14	4.37	10	1.22	8.18
2	5.00	10.00	1.22	8.18	30	1.31	22.96
3	5.00	15.00	1.31	11.48	60	1.40	42.96
4	5.00	20.00	1.40	14.32	100	1.49	66.97
5	5.00	25.00	1.49	16.74	150	1.60	93.96
6	5.00	30.00	1.60	18.79	210	1.71	123.04
7	5.00	35.00	1.71	20.51	280	1.82	153.45
8	5.00	40.00	1.82	21.92	360	1.95	184.54
9	5.00	45.00	1.95	23.07	450	2.09	215.76
10	5.00	50.00	2.09	23.97	550	2.23	246.66
11	5.00	55.00	2.23	24.67	660	2.38	276.86
12	5.00	60.00	2.38	25.17	780	2.55	306.05
13	5.00	65.00	2.55	25.50	910	2.72	333.98
14	105.00	1470.00	2.72	539.51	22050	2.91	7569.52
Sum				778.21			9644.91
Sum/Price				9.35			115.92
Modified duration				–9.35	Convexity		115.92

7.91% is 75.88, very close to the estimated price using both modified duration and convexity.

Clearly, using modified duration and convexity gives a better estimate of the price change than modified duration alone. In the Indian market, however, few participants are presently using convexity.

13.3.3 Calculations in between Interest Periods

The formulas need to be modified as follows when calculating modified duration and convexity in between interest periods. Assuming w to be the fraction of the period between the calculation date and next coupon inflow.

$$\text{Modified duration} = \frac{dp}{dr} = \sum_{i=1}^{n} -(i-1+w) \times \frac{C_i}{(1+r)^{(i+w)}} \qquad (13.8)$$

$$\text{and Convexity} = \frac{d^2 p}{dr^2} = \sum_{i=1}^{n} -(i-1+w) \times (i+w) \times \frac{C_i}{(1+r)^{(i+1+w)}} \qquad (13.9)$$

13.3.4 PVBP

The concept of "present value per basis point (PVBP)" of a bond, sometimes also referred to as PV01, is very useful in measuring and, particularly, hedging, price risks. PVBP is an estimate of the **absolute** change in the price of a bond, resulting from a 0.01% change in the yield (i.e., say, from 5.73% to 5.74% p.a.). From the mathematics of modified duration, it would be readily apparent that

$$\text{PVBP} = \text{modified duration} \times 0.0001 \times \text{Price}$$

(Note that 0.01% is 0.0001)

13.3.5 Effective Duration: Option Embedded Bonds

Effective duration and convexity are measures used for measuring price risk on bonds whose **prices are affected by variables other than yields or interest rates,** for example, bonds with embedded options. As we have seen in Chapter 11, the prices of option embedded bonds are affected also by the change in the probability of exercise of the option. The effective duration of such bonds is therefore different from the modified duration of option-free bonds.

13.4 Duration of a Floating Rate Bond

The duration of a floating rate bond with no contracted premium over the reference rate is the remaining period till the next refixation. While this is a good enough definition for most practical purposes, when the coupon incorporates a margin over the reference rate, a more rigorous approach leads to a slight modification.

A floating rate bond carrying a margin, typically premium, over the reference rate, can be looked at as a portfolio of two bonds:

- A floating rate bond with coupon equal to the reference rate; and
- A fixed rate bond with coupon equal to the contracted premium over the benchmark rate.

The duration of the first bond can be calculated as described in the previous paragraph; that of the second in the usual way for fixed income securities. The duration of the floating rate bond with coupon set at a premium to the reference rate can then be calculated as the duration of a portfolio of two bonds.

This methodology gives a somewhat higher duration than calculated ignoring the premium over the reference rate.

13.5 Duration and Continuously Compounding Rates

There are two ways of looking at the difference between Macaulay and modified durations. We have seen that the latter multiplied by the change in yield gives a good, first order estimate of the proportionate change in the price of a fixed income security. In other words,

$d'p/p = -\text{MD} \times d'\,\text{YTM}$, where $d'p$ is the estimated change in price, MD the modified duration, YTM is yield to maturity and d' YTM is the change in YTM.

Given that

$\text{MD} = D/(1 + \text{YTM})$, where D is the Macaulay duration, the equation can be recast as

$$d'p/p = -D \times (d'\,\text{YTM}/(1 + \text{YTM})) \tag{13.10}$$

Given this relationship, if one is using continuously compounded rates, it is not necessary to calculate modified duration to estimate the change in price, as the following discussion shows.

Let "YTMc" be the continuously compounded rate equivalent to the periodically compounding rate "YTM". In that case,

$$e^{\text{YTMc}} = 1 + \text{YTM} \tag{13.11}$$

Let d' YTM be the change in YTM and d' YTMc the corresponding change in *c*. Therefore

$$e^{(\text{YTMc} + d'\ \text{YTMc})} = 1 + \text{YTM} + d'\ \text{YTM} \tag{13.12}$$

Dividing Eq. (13.12) by Eq. (13.11), we get

$$e^{(\text{YTMc} + d'\ \text{YTMc})}/e^{\text{YTMc}} = (1 + \text{YTM} + d'\ \text{YTM})/(1 + \text{YTM})).$$

Simplifying,

$$e^{d'\ \text{YTMc}} = 1 + (d'\ \text{YTM}/(1 + \text{YTM}))$$

Therefore, $(d'\ \text{YTM}/(1 + \text{YTM})) = (e^{d'\ \text{YTMc}}) - 1$.

Substituting in Eq. (13.10),

$$d'p/p = -D \times (e^{(d'\ \text{YTMc})} - 1) \tag{13.13}$$

13.6 Price Volatility Approach for Measuring Price Risk

From the price volatility of an individual security, based on its modified duration and convexity, it is possible to calculate the price volatility of a portfolio of securities. However, there are two major limitations to this approach:

(a) The likely price risk can be measured only by **assuming a certain (likely) adverse change in yield (say 1%). The actual change could be different.**

(b) The more important limitation is that the calculations assume **a parallel shift in the yield curve**: in other words, that the existing and post-change yield curves are parallel to each other. In practice, this assumption is not realistic: chances are that yields for different maturities may change in varying and erratic ways, changing the shape of the yield curve. The estimate of price change may therefore turn out to be wrong.

13.7 Excel Spreadsheet

The popular Excel spreadsheet has functions to calculate Macaulay and modified durations by inputting the parameters of the security.

Annexure 13.1 Mathematical Derivation of Formulas

13.1 Differential Calculus: Basic Formulae

Consider a variable y whose value is an algebraic function of another variable x. (In this case, y, is the dependent variable and x is the independent variable). For example, $y = x^2$. Obviously, the value of y will change with the value of x. It is customary to describe the general algebraic relationship between y and x by using the notation $y = f(x)$, read as y is a "function" of x.

Differential calculus calculates the change in the value of the dependent variable y, **for small changes in the value of x,** the independent variable, as the latter tends to zero. It is customary to denote the changes as dy and dx. If dy is the change in value of y, then the basic rules of differential calculus are

(a) If $y = x^n$, then $\frac{dy}{dx} = n \times (x^{(n-1)})$.

(b) If $y = \frac{y_1}{y_2}$ where y_1 and y_2 are functions of x, then

$$\frac{dy}{dx} = \frac{\left[\left\{y_2 \times \left(\frac{dy_1}{dx}\right)\right\} - \left\{y_1 \times \left(\frac{dy_2}{dx}\right)\right\}\right]}{(y_2)^2}$$

(c) If $y = f_1(x_1)$ and $x_1 = f_2(x_2)$ then

$$\frac{dy}{dx_2} = \left(\frac{dy}{dx_1}\right) \times \left(\frac{dx_1}{dx_2}\right)$$

(d) If $y = y_1 + y_2 + ... + y_n$ where $y_1, y_2, ..., y_n$ are functions of x, then

$$\frac{dy}{dx} = \frac{dy_1}{dx} + \frac{dy_2}{dx} + ... + \frac{dy_n}{dx}$$

If y is not a function of x, say a constant, then $\frac{dy}{dx} = 0$.

These basic formulas give the first differential of y with reference to x. the second differential (d^2y/dx^2) is the change in dy/dx for small changes in the value of x, and so on.

13.2 Taylor Expansion

If $f(r)$ is a "function" of r, i.e. the value of $f(r)$ depends on the value of r (for example, the price of a fixed income security depends on the ruling interest rates), and if $d'r$ is the change in the value of r, then, by the well-known Taylor expansion;

$$f(r + d'r) = \left[f'(r) \times \frac{d'r}{1!}\right] + \left[f''(r) \times \frac{(d'r)^2}{2!}\right] + \ldots$$

where $f'(r) = \dfrac{d[f(r)]}{dr}$ and f'', f''' etc. are higher order differentials.

The equation can be recast as

$$f(r + d'r) = f(r) \times \left[1 + \left\{f'(r) \times \frac{d'r}{1! \times f(r)}\right\}\right] + \left[f''(r) \times \frac{(d'r)^2}{2! \times f(r)}\right] + \ldots$$

Therefore,

$$\frac{f(r + d'r)}{f(r)} = \left[1 + f'(r) \times \frac{d'r}{1! \times f(r)}\right] + \left[f''(r) \times \frac{(d'r)^2}{2! \times f(r)}\right] + \ldots$$

and

$$\frac{[f(r + d'r) - f(r)]}{f(r)} = \left[f'(r) \times \frac{d'r}{1! \times f(r)}\right] + \left[f''(r) \times \frac{(d'r)^2}{2! \times f(r)}\right] + \ldots$$

If r = YTM and $f(r)$ = full price p, the left hand side of the equation is the percentage change in the price of the security, for a change $d'r$ in the yield.

Thus,

$$\frac{d'p}{p} = \left[\left(\frac{dp}{p}\right) \times \left(\frac{d'r}{p}\right)\right] + \left[\left(\frac{d^2 p}{dr^2}\right) \times \left(\frac{d'r^2}{2 \times p}\right)\right] \qquad \text{(A13.1)}$$

where $d'p$ is the estimated price change following a $d'r$ change in yield.

13.3 Macaulay Duration

Let r = YTM

d = duration in interest periods, when interest rate changes by dr

D = Integer part of d

n = number of interest payments after interest change

c = coupon

If price change is to neutralise the changed returns on coupon inflows, d will have to satisfy the following equation:

$$\sum_{i=1}^{D} c \times [\{(1+r)^{(d-i)}\} - \{(1+r+dr)^{(d-i)}\}]$$

(i.e. the difference between the compounded amounts of coupon inflows up to duration at old and new rates)

$$= \left[\sum_{i=1}^{D}\left\{\frac{c \times (i-d)}{(1+r)^{(i-d+1)}}\right\} - \left\{\frac{100 \times (n-d)}{(1+r)^{(n-d+1)}}\right\}\right] \times dr,$$

(i.e. the change in price at duration by the dp/dr formula)

Since dr is small, we can ignore its higher powers and using the binomial theorem, simplify the left hand side of the equation as follows:

$$\left[\sum_{i=1}^{D} c \times \{-(d-i) \times (1+r)^{(d-i-1)}\} \times dr\right]$$

$$\text{or, } \left[\sum_{i=1}^{D} \frac{c \times (i-d)}{\{(1+r)^{(i-d+1)}}\right] \times dr = \left[\sum_{i=(D+1)}^{n} \frac{-c \times (i-d)}{\{(1+r)^{(i-d+1)}\}} \times dr\right] - \left[\frac{100 \times (n-d)}{\{(1+r)^{(n-d+1)}\}} \times dr\right]$$

$$\text{or, } \left[\sum_{i=1}^{D} \frac{c \times (i-d)}{\{(1+r)^{(i-d+1)}\}}\right] = \left[\frac{100 \times (d-n)}{\{(1+r)^{(n-d+1)}\}}\right]$$

Multiplying both sides by $(1 + r)^{(1-d)}$

$$\sum_{i=1}^{D} \frac{c \times (i-d)}{(1+r)^{i}} = \frac{100 \times (d-n)}{(1+r)^{n}}$$

$$\text{Therefore, } d \times \left[\sum_{i=1}^{D} \frac{c}{(1+r)^{i}} + \frac{100}{(1+r)^{n}}\right]$$

$$= \left[\sum_{i=1}^{D} \frac{i}{(1+r)^i} + \frac{100 \times n}{(1+r)^n} \right]$$

or, $$d \times \text{price} = \sum_{i=1}^{D} \frac{i \times C_i}{(1+r)^i}$$

or, $$d = \sum_{i=1}^{D} \frac{i \times C_i/(1+r)^i}{\text{Price}}$$

which is the formula for the Macaulay duration.

13.4 Modified Duration: The First Differential: $\frac{dP}{d\text{YTM}}$

Consider the price formula.

$$\text{Full price } P = \left[\sum_{i=1}^{n} \frac{C_i}{\{(1+\text{YTM})^{(i-1+w)}\}} \right]$$

where C_i is the ith inflow; w is the fraction of the interest period from the settlement day to the next interest payment date; and YTM is the yield to maturity.

Consider one term in the summation,

$$y_i = \frac{C_i}{[(1+\text{YTM})^{(i-1+w)}]}$$

In this term, and using the terminology of rule b in paragraph 1, $Y_1 = C_i$, $Y_2 = [(1 + \text{YTM})^{(i-1+w)}]$.

Again, using the terminology of rule *c*, ibid, $x_1 = (1 + \text{YTM})$, and $x_2 =$ YTM

Therefore, $$\frac{dy}{d\,\text{YTM}} = \frac{dy}{d(1+\text{YTM})} \times \frac{d(1+\text{YTM})}{d\,\text{YTM}}$$

The second term has a value of unity. Therefore

$$\frac{dy}{d\,\text{YTM}} = \frac{dy}{d(1+\text{YTM})}$$

Again $\dfrac{dC_i}{d\,\text{YTM}} = 0$, C_i being a constant. Combining rules a, b and c, therefore,

$$\frac{dy_i}{d\,\text{YTM}} = \frac{[0 - \{C_i \times (i-1+w) \times (1+\text{YTM})^{(i-2+w)}\} \times 1)]}{[(1+\text{YTM})^{2(i-1+w)}]}$$

Using rule d,

$$\frac{dy}{d\,\text{YTM}} = \sum_{i=1}^{n} \frac{dy_i}{d\,\text{YTM}}$$

$$= \sum_{i=1}^{n} \frac{-(i-1+w) \times C_i}{(1+\text{YTM})^{(i+w)}}$$

13.5 The Second Differential

The starting point will be the formula for $dP/d\,\text{YTM}$. By using the same logic, the differential of any one term will be: $\dfrac{d^2P}{d\,\text{YTM}^2}$

$$\frac{0 + [(i-1+w) \times C_i \times (i+w) \times \{(1\ +\text{YTM})^{(i+w-1)}\}]}{[(1+\text{YTM})^{2(i+w)}]}$$

$$= \frac{(i-1+w) \times (i+w) \times C_i}{(1+\text{YTM})^{(i+w+1)}}$$

By the fourth rule, $d^2P/d\,\text{YTM}^2$

$$= \sum_{i=1}^{n} \frac{(i-1+w) \times (i+w) \times C_i}{(1+\text{YTM})^{(i+w+1)}}$$

Chapter 14

Measuring the Price Risk: VaR Approach

14.1 Introduction and Definition

14.1.1 Risk and Uncertainty

Literature on risk management makes **a distinction between risk and uncertainty**. While exposure to assets whose value keeps changing creates price risk, i.e. uncertainty about the return or outcome, the difference between risk and uncertainty comes from whether the probability of different outcomes can be reasonably predicted or not: **"risk" is used in relation to returns whose probability distribution is predictable**. Where such is not the case, the returns can be said to be "uncertain". It is self-evident that probability can be calculated only in respect of repetitive events, or those which can be observed under identical conditions. To give a non-technical example, nobody can predict the exact amount of rainfall in Mumbai next year. There is a y % "risk" that it will be below x cms, leading to the lakes not getting filled up fully, and water supply having to be cut. On the other hand, there is "uncertainty" about whether Mumbai will experience a repetition of the July 26, 2005, floods. The first statement is based on the frequency distribution of the annual rainfall in Mumbai, for which historical data are available; the second statement is not susceptible to such analysis.

In this sense, the returns from most financial assets—equities, currencies, bonds, etc.—entail a risk and the Value at Risk (VaR) calculations are the accepted methodology for measuring such risks.

14.1.2 Definition

VaR is defined as the potential loss in the market value of a portfolio, if the portfolio is **kept unchanged for a specified period**, the loss being estimated with a **given degree of confidence or probability**.

Two important, "user-defined" parameters are part of the definition and should be noted: the period for which the portfolio is assumed to be kept unchanged (the holding period), and the degree of confidence. Higher the value of these parameters, more conservative will be the VaR measure. In principle, the holding period is also related to the liquidity of the market for the underlying asset. The feasibility of an orderly liquidation of the asset or portfolio (**"orderly" means at market prices**) depends on market liquidity: less liquid the market in the underlying instrument, higher should be the holding period. Orderly liquidation is important since assets are held at market prices. Banking regulations also prescribe the holding period for calculating VaR and the capital charge for market risk.

14.1.3 Calculating Value at Risk

There are three methodologies for calculating VaR:

- historical simulation
- using parameter based models
- Monte Carlo simulation

We proceed to discuss the three methodologies in the following paragraphs.

14.2 Historical Simulation

In principle, VaR can be calculated by using historical data, without assuming that returns conform to a particular distribution. Consider that you are calculating the VaR of a portfolio consisting of various elements: equity investments, currency exposures, bonds, etc. The data you need would be the prices (say daily) of each of these variables over say the last 100 days: obviously, a change in the value of any of the variable affects the value of the portfolio. We will first look at the calculations of a 1-day VaR. One methodology could be as follows:

(a) Calculate the daily **percentage change** in each of the variables: so you have 100 sets of historical changes.

(b) Take today's actual portfolio and estimate the likely change in the value of each element in it, and hence the portfolio, **under each of the** 100 sets of percentage changes.

(c) The 5th worst change in the value of the portfolio is the portfolio VaR with 95% confidence level.

(d) The next day, drop the first day values in the tabulated data; add one more day's data. Then repeat (b) and (c) using today's portfolio.

For calculating VaR for a longer holding period, there would be two approaches:

(e) Multiply the one day VaR by the square root of the number of days in the holding period. Alternatively,

(f) From the price data, calculate the price change in percentage terms, for each of the variables, over the desired holding period. For example, instead of calculating the price change from day 1 to day 2, calculate the price change from day 1 to day 6, day 2 to day 7, etc. for estimating the 5 day VaR.

One major limitation of the suggested approach is that, when an extreme observation goes out of the sequence being followed for arriving at the VaR, the measure will show a sudden fall.

14.3 Evolution of Parameter-based Models VaR

While qualitative appreciation of risk in financial markets has been in existence for a long time, the first attempt to quantify it by using probability distribution and other statistical concepts, was the enunciation of the modern portfolio theory in the early 1950s. This analysed the risks and rewards in equity portfolios through the volatility of equity prices, as measured by the standard deviation of price changes. The capital asset pricing model (CAPM) is a corollary of the portfolio theory.

The next major step in the acceptance of risk measurement through models, was the **publication, by J.P. Morgan, of RiskMetrics,** a document detailing Morgan's methodology and models. While RiskMetrics was published in 1994, the methodology was being used by J.P. Morgan internally since much earlier: the model was initially known as earnings-at-risk (hence the acronym DEAR, or daily earnings-at-risk). The model-based VaR methodology received the stamp of regulatory approval in 1996 when BIS published its "Amendment to the Capital Accord to Incorporate Market Risks" prescribing capital norms for market risks, based on VaR. Since then, model-based VaR has found near universal acceptance as a tool for measuring risks.

The generally accepted methodology is based on the properties of a "normal" distribution, the familiar bell-shaped curve to which most variables in real life—from heights and weights of adults in Mumbai to annual rainfall—conform. It assumes that returns from investments are random variables with a defined expected/average value and standard deviation. The latter measures the volatility of the expected return, i.e. the likely "risk", or deviation from expected value. Once the expected (or mean) value and standard deviation of a normal distribution are known, it is easy to calculate the probability of its actual value being below (or above) a particular level: contrarily, given probability (or confidence level), we can estimate the level below (or above) which the value of the variable is unlikely to go. Thus, for example, if the heights of adults in Mumbai are normally distributed, we could argue with, say, 99% confidence, that the height of the next person is unlikely to exceed 6 feet! The same logic can be used to estimate the maximum loss on an exposure, with a given degree of confidence.

Readers not familiar with the concept of normal distribution and its parameters may like to refer to Annexure 14.1 before proceeding further.

14.3.1 Model-based VaRs

At the heart of VaR models is the assumption of lognormality of the periodic returns: in other words that the logarithms of returns are normally distributed with a mean zero. The logarithms used are the so-called "natural" logarithms, i.e. to the base *e* ("ln" function in the Excel spreadsheet) which we have already come across while discussing continuously compounded rates (see Chapter 8). The other parameter of a normal distribution that needs to be discussed is the standard deviation, often denoted by σ.

14.3.1.1 The Variable Used

The volatility of a price is the source of market risk (and, of course, rewards), and the accepted measure of volatility is the standard deviation of the price change.

The variable used for calculating the price change is generally **the relative price change over a standard time interval**, typically a day. If P_t is today's closing price and P_{t-1} is yesterday's closing price, then the price change is $(P_t - P_{t-1})$. As a fraction of yesterday's close, the change is $(P_t - P_{t-1})/P_{t-1}$. It can be considered as the relative price change, or the rate of return. (In fact, we have used this measure while describing the methodology for historical simulation.) Let us define it as V_t.

Now, (P_t/P_{t-1})

$$= 1 + (P_t/P_{t-1}) - 1, \text{ i.e.}$$

$$= 1 + ((P_t - P_{t-1})/P_{t-1}), \text{ i.e.}$$
$$= 1 + V_t.$$

While discussing the concept of continuously compounding rates, we have seen that

If $1 + V_t = e^{v_t}$, then v_t is the continuously compounded rate of return on the asset.

Therefore $\quad v_t = \ln(1 + V_t)$, or
$$= \ln(P_t/P_{t-1}).$$

This is the variable used for measuring volatility through its standard deviation. The assumption is that the variable v_t is normally distributed—in other words that V_t is lognormally distributed.

14.3.1.2 Why Logarithms?

Why use $\ln(P_t/P_{t-1})$ rather than the variable $(P_t - P_{t-1})/P_{t-1}$, i.e. V_t? One reason is that, at its theoretical lowest, P_t can have a zero value, and at its theoretical highest, the value can be infinity. Given this, the range of values over which $(P_t - P_{t-1})/P_{t-1}$ can vary is minus 1 to infinity. If the concepts underlying the normal distribution are to be used, the theoretical range of values for the variable needs to be between minus infinity to plus infinity. Hence the use of $\ln(P_t/P_{t-1})$, which has a range of values that can conform to normality, and is the continuously compounded rate of return. As we have seen in Chapter 8, continuously compounded rates of return have several advantages over discretely, or periodically, compounded rates of return.

14.3.1.3 Measuring Volatility

The standard deviation of this variable, calculated from daily price changes over, say, 90/180 days, would represent a measure of daily volatility of the returns. The annual volatility is calculated by multiplying this number by the square root of 252 (i.e., $252^{0.5}$), the number of working days in a year. It is customary to report volatility on an annualised basis.

While, using historical data, the standard deviation of past returns can be calculated, in practice, what is needed is an estimate of the volatility of future returns. This presents several problems because

- Volatility of returns in financial markets is not constant (a property known as "heteroscedasticity"); and
- If volatility is high on a given day or time period, it is likely to be high on the subsequent day as well: the same applies to low volatility also. To elucidate, the observed values of daily volatility do not display the

characteristic of successive values being uncorrelated, random, stochastic, which is one of the properties of normal distributions. There is a strong positive correlation between volatilities on successive days, a property described as "auto-regression". In short, the assumption of uncorrelated (i.e. "identically and independently distributed") returns is not supported by market behaviour.

14.3.1.4 ARCH, GARCH and EWMA Models

Various models of estimating future volatility are used to overcome the problems of heteroscedasticity and auto-regression: incidentally, this is one of the most researched topics in financial economics. Some of the better known models are

- The autoregressive conditional heteroscedasticity (ARCH) based, or generalised ARCH (i.e. GARCH) models.
- The exponentially weighted moving average (EWMA), where the weights attached to the variable v_t vary exponentially. The latest observation has the maximum weight, the immediate previous one the second highest, and so on.

ARCH models estimate today's volatility (σ_t^2) using a constant (α_0) and the actually observed, most recent returns. If only the latest return is used, the model is known as ARCH(1); if more than one most recent returns (p) are used, the model is known as ARCH(p).

Mathematically, an ARCH(p) model will be

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \times v_{t-i}^2 \tag{14.1}$$

(ARCH(1) will use $p = 1$)

The various constants in the formula, designated by αs, are estimated by using regression analysis of past data to arrive at the "best fit" with the future changes. Their total is unity.

GARCH (p, q) uses not only the recent, actually observed returns (on say p days or time periods) but also the recent q estimates of volatility of returns.

Mathematically, a GARCH (p, q) model will be

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \times v_{t-i}^2 + \sum_{j=1}^{q} \alpha_j \times \sigma_{t-j-p}^2 \tag{14.2}$$

A simpler, GARCH (1, 1) model uses only the most recent actual return and estimate of volatility, i.e.

$$\sigma_t^2 = \alpha_0 + \alpha_1 \times \sigma_{t-1}^2 + \alpha_2 \times v_{t-1}^2 \tag{14.3}$$

Once again, the parameters (αs) are estimated by regression analysis. EWMA is a simplified form of GARCH(1, 1) with $\alpha_0 = 0$ and $\alpha_1 = \lambda$. (Since the total of the αs has to be 1, this gives $\alpha_2 = (1 - \lambda)$.)

The model is

$$\sigma_t^2 = \lambda \sigma_{t-1}^2 + (1 - \lambda) \times v_{t-1}^2 \tag{14.4}$$

Box 14.1

Modelling historical volatility and generating volatility forecasts

We assume that historical interest rate volatility can be well represented by the following asymmetric GARCH(1,1) model (see Engle and Ng (1993)):

$$r_t = \mu + \Phi \cdot r_{t-1} + \varepsilon_t$$
$$\varepsilon_t | I_{t-1} \sim N(0, \sigma_t^2)$$
$$\sigma_t^2 = \omega + \alpha \cdot \varepsilon_{t-1}^2 + \beta \cdot \sigma_{t-1}^2 + \gamma \cdot \max(0, \varepsilon_{t-1}^2)$$

where r_t denotes the logarithmic daily rates of change of a swap rate and α_t^2 is its daily conditional variance; I_{t-1} is the information set, i.e. the past history of the interest rate series. In a first step, the model was estimated for the one- and five-year swap rates of the United States and the euro area. To reproduce as closely as possible the expectations of economic agents at time t, the estimation was performed on expanding samples, the shortest of which starts on 23 January 1997 and ends on 15 October 1998 (450 daily observations). In this way volatility forecasts rely only on information available when forecasts were made. For each day we retain the parameters of the GARCH model, $\theta_t = (\mu, \Phi, \omega, \alpha, \beta, \gamma)$, the time series of forecast errors (ε_t) and the historical volatilities (σ_t).

In a second step we use the information retained to produce, for each calendar day after 15 October 1998, forecasts of the historical volatility over various horizons. Each day we generate 2,000 future paths of the interest rate and its volatility, for each of the two interest rates (one- and five-year) and for two forecast horizons, six and 24 months. For each of these horizons we compute the expected volatility by averaging first across time-to-expiration and finally across the 2,000 replications. This value is then compared, for each calendar day, to the implied volatility for the same swap rate and the same horizon. It is important to average volatility across time-to-expiration because implied volatility is an average volatility expected by a risk neutral investor over the life of the option.[1]

The structure of the simulation scheme is pretty much the same as the asymmetric GARCH(1,1) described above. The only difference is due to the distributional assumption placed on the standardised forecast errors ($\varepsilon_t / \sigma_1 = z_t$). The implicit GARCH assumption that z_t are independently and identically normally distributed is rejected, due to the presence of asymmetry in excess of zero and kurtosis in excess of three. To reproduce these features we directly employ the estimated z_t in the simulation. For each calendar day, we randomly select an element of z_t and then loop over the following two equations, up to a two-year horizon:

$$\sigma^2_{t+1} = \omega + \alpha\cdot(\sigma_t\cdot Z_t)^2 + \beta\cdot\sigma^2_t + \gamma\cdot \max(0, -(\sigma_t\cdot Z_t))^2$$

$$r_{t+1} = \mu + \phi\cdot r_t + \sigma_t + \sigma_{t+1}\cdot Z_t$$

Given that in each calendar day we have 2,000 values for the expected volatility of each interest rate over the two forecast horizons, we can recover the distribution function of such expected volatilities. From this we calculate two measures of dispersion of the volatility forecasts, the standard deviation and the 2.5 and the 97.5 percentiles, both allowing us to build a confidence interval for the expected volatility.[2]

[1]As an example, in each working day, the expected six-month historical volatility is the average across replications (2,000) of the average volatility simulated in the six months after that specific day. Hence, comparing the time-t implied volatility to the time-t historical volatility (and not to the average historical volatility between t+1 and t+t, t being the time-to-expiration of the swaption) defines a compensation for risk which rests on the assumption of a random walk in volatility, which has been strongly rejected by many applications of the GARCH methodology.

[2]The volatility of volatility, i.e. uncertainty about future volatility, is the variable that should lead economic agents to adjust the swaptions price relative to what they would do by looking at the volatility forecast only. Swaptions are priced according to the Black (1976) model, whereby traders insert the expected volatility into a pricing formula similar to that of Black and Scholes (1973). However, given that volatility is time-varying, they will be more uncertain about this volatility when the volatility of volatility is very high and they will therefore increase the price of the swaption relative to the central forecast of the volatility when the confidence interval is wider.

Source: BIS Quarterly Review, September 2005

The basic difference between EWMA and GARCH models is that the latter give a weight to a (constant) long-term volatility in the calculation. In other words, the GARCH model incorporates mean reversion of the returns—EWMA does not. One advantage of the EWMA model is that, for ongoing revisions of volatility calculations, data requirements are limited.

"λ" (pronounced "lambda") is known as the decay factor. RiskMetrics, the methodology and dataset originally developed by J.P. Morgan for measurement of risk, uses a λ value of 0.94, and claims that this gives the best estimate of the realised variance on the subsequent 25 days.

With $\lambda = 0.94$, the weights for older values decay rapidly: data older than 100 days has practically zero weight.

In India, FIMMDA uses the EWMA model for calculating the volatility of bond prices. In fact, EWMA is perhaps the most commonly used model, because of its simplicity.

It is beyond the scope of this book to go into the technical details of all these models and their variations. The interested reader should refer to specialised books (like "Value at Risk" by Philippe Jorion, "Fundamentals of

Risk Measurement" by Chris Marrison) and research papers on the subject: www.gloriamundi.org has a large collection.

14.3.1.5 Variance/Covariance

In theory, σ could be calculated for a given portfolio of assets, by analysis of actual past returns on the portfolio, and then using one of the models. However, in practice, this is not a feasible proposition as the actual portfolio will keep changing.

Therefore, in practice, σ, the standard deviation, or σ^2, the variance, is separately calculated for the returns on each element in the portfolio (a bond, a currency pair, the share price of a company), as also the covariance of the returns with each of the other elements (see Annexure 14.1 for a discussion of the concept). The variance/covariance matrix can then be used to calculate the standard deviation or variance of the portfolio returns. The formula is

$$\sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_{i,j}^2 \tag{14.5}$$

where σ_p is the portfolio standard deviation for a portfolio of n assets; $\sigma_{i,j}$ is the covariance of returns on assets i and j; ($\sigma_{i,i}$ is the variance of the i^{th} asset return); and w_i is the weight of the asset i in the portfolio's market value.

14.3.2 The VaR Number

Once we have measured the standard deviation of the daily returns from a portfolio of assets, we can now proceed to calculate the Value at Risk. Recall that, for this purpose, we need to define the holding period and the degree of confidence in the measure we are aiming at. We can then calculate VaR using the assumption of lognormality of the returns, by using its following properties:

- For calculating the standard deviation for the holding period, say 10 days, σ_{ph}, we need to multiply the daily standard deviation σ_p, by $\sqrt{10}$; if the latter has been expressed on annualized basis, as is customary, the multiplicant will be the fraction of one year which the holding period represents (10/252 if daily standard deviation has been converted to the annual number by using the number of working days).
- For the degree of confidence, typically 95% or 99%, we would need to multiply the holding period portfolio standard deviation, $\sigma_{ph,}$ by the appropriate factor. For instance, since 90% of the values of a normally

distributed variable fall within –/+ 1.65 standard deviations of the mean, if one uses 1.65 σ_{pb}, as the Value at Risk, it is likely that, over a period and on an average, the value of the portfolio **will not change adversely** more than this number on 19 of 20 days. (Remember that we need to consider only movements on the adverse side, i.e. only half the price changes exceeding –/+ 1.65 σ_{pb}. Hence, the 95%, i.e. 19/20, degree of confidence.) If a more conservative VaR number is desired, one could use 2.33 σ_{pb}, which would mean that 99% of the days, the adverse change in the value of the portfolio would not exceed the VaR. For example, for Primary Dealers using internal risk-based (VaR) models, RBI has prescribed a 15-day holding period and 99% confidence level.

The complications do not end here; note that the number has been calculated for the variable $\ln(P_t/P_{t-1})$. We now need to convert it into its absolute value which is $((e^{2.33\,\sigma_{pb}}) - 1)$.

14.4 Monte Carlo Simulation

This involves simulating the behaviour of variables using stochastic techniques based on random numbers. Stochastic processes have non-deterministic, random outcomes. In theory, Monte Carlo simulation is the best way to estimate value at risk, because it makes the least assumptions about the probability distribution of future outcomes, or the correlations between different elements of a portfolio. The larger the number of random changes used (millions?), the greater the reliability of the simulation. Since a very large number of simulations are needed, the method may require extensive use of computers and computer time.

14.5 Testing the VaR Models

14.5.1 Back Testing

Back testing of the risk measurement models is important. For this purpose, it needs to be remembered that the VaR measure calculates the maximum loss on **a given portfolio,** with a given degree of confidence. Back testing would therefore require that the VaR is calculated on a portfolio of assets and liabilities at a specified time of the day—say end of day. While the actual portfolio would surely undergo a change in the course of the next day's trading, the portfolio valuation to be used for testing should be that of the unchanged portfolio of the previous day. The process should be repeated every day. If the change in the value does not exceed VaR on most days ("most" depends on the degree of confidence used in calculating the number), this is a validation of the model. Note that even if the change is positive, but exceeds VaR on a disproportionate number of days, this too is evidence that the model needs review. (Under the symmetry of the normal distribution, VaR should be exceeded on either side, positive or negative, equally frequently.) Such back testing has become an important element for the banking supervisor's comfort with the model used.

These days major banks active in proprietary trading disclose in their annual accounts the actual number of days during the year on which losses in excess of the value at risk measure were incurred.

14.5.2 Stress Testing

Stress testing of models used to measure risks is another important element of the risk management framework. Stress testing involves estimating the effect of extreme market conditions on the value of the portfolio. Examples of such extreme conditions would be, say, a major bond market default, a sharp fall in equity prices, etc. The estimated impact of such events helps determine the economic capital needed for the portfolio: economic capital is a measure designed to calculate the equity capital needed to absorb unexpected losses. Those interested in studying the subject in greater detail may like to refer to various BIS publications on the topic including "Stress Testing by Large Financial Institutions: Current Practice and Aggregation Issues" (April 2000), and "A survey of stress tests and current practice at major financial institutions" (April 2001). The Reserve Bank has also come out with recommended stress testing models recently.

14.5.3 Independent Verification

A third element of using VaR is independent verification of the model. This is extremely important, as the calculations are done inside the 'black box' of the IT system and if any error has crept in the algorithms used, the output from the system will also be wrong. (The author himself has come across errors in the VaR calculation model used by a Primary Dealer.)

The verification of the model, the back testing and stress testing procedures should be done by experts other than these involved in the development of the model.

Box 14.2 Qualitative Standards

It is important that supervisory authorities are able to assure themselves that banks using models have market risk management systems that are conceptually sound and implemented with integrity. Accordingly, the supervisory authority will specify a number of qualitative criteria that banks would have to meet before they are permitted to use a models based approach. The extent to which banks meet the qualitative criteria may influence the level at which supervisory authorities will set the multiplication factor referred to in Section B.4 (j) below. Only those banks whose models are in full compliance with the qualitative criteria will be eligible for application of the minimum multiplication factor. The qualitative criteria include:

- *(a) The bank should have an independent risk control unit that is responsible for the design and implementation of the bank's risk management system. The unit should produce and analyse daily reports on the output of the bank's risk measurement model, including an evaluation of the relationship between measures of risk exposure and trading limits. This unit must be independent from business trading units and should report directly to senior management of the bank.*
- *(b) The unit should conduct a regular backtesting programme, i.e. an ex-post comparison of the risk measure generated by the model against actual daily changes in portfolio value over longer periods of time, as well as hypothetical changes based on static positions.*
- *(c) Board of directors and senior management should be actively involved in the risk control process and must regard risk control as an essential aspect of the business to which significant resources need to be devoted.[47] In this regard, the daily reports prepared by the independent risk control unit must be reviewed by a level of management with sufficient seniority and authority to enforce both reductions of positions taken by individual traders and reductions in the bank's overall risk exposure.*
- *(d) The bank's internal risk measurement model must be closely integrated into the day-to-day risk management process of the bank. Its output should accordingly be an integral part of the process of planning, monitoring and controlling the bank's market risk profile.*
  - ✧ *The risk measurement system should be used in conjunction with internal trading and exposure limits. In this regard, trading limits should be related to the bank's risk measurement model in a manner that is consistent over time and that is well understood by both traders and senior management.*
- *(e) A routine and rigorous programme of stress testing[48] should be in place as a supplement to the risk analysis based on the day-to-day output of the bank's risk measurement model. The results of stress testing should be reviewed periodically by senior management and should be reflected in the policies and limits set by management and the board of directors. Where stress tests reveal particular vulnerability to a given set of circumstances, prompt steps should be taken to manage those risks appropriately (e.g. by hedging against that outcome or reducing the size of the bank's exposures).*
- *(f) Banks should have a routine in place for ensuring compliance with a documented set of internal policies, controls and procedures concerning the operation of the risk*

measurement system. The bank's risk measurement system must be well documented, for example, through a risk management manual that describes the basic principles of the risk management system and that provides an explanation of the empirical techniques used to measure market risk.

(g) An independent review of the risk measurement system should be carried out regularly in the bank's own internal auditing process. This review should include both the activities of the business trading units and of the independent risk control unit. A review of the overall risk management process should take place at regular intervals (ideally not less than once a year) and should specifically address, at a minimum:

- *the adequacy of the documentation of the risk management system and process;*
- *the organisation of the risk control unit;*
- *the integration of market risk measures into daily risk management;*
- *the approval process for risk pricing models and valuation systems used by front and back-office personnel;*
- *the validation of any significant change in the risk measurement process;*
- *the scope of market risks captured by the risk measurement model;*
- *the integrity of the management information system;*
- *the accuracy and completeness of position data;*
- *the verification of the consistency, timeliness and reliability of data sources used to run internal models, including the independence of such data sources;*
- *the accuracy and appropriateness of volatility and correlation assumptions;*
- *the accuracy of valuation and risk transformation calculations;*
- *the verification of the model's accuracy through frequent backtesting as described in (b) above and in the following document: Supervisory Framework for the Use of Backtesting in Conjunction with the Internal Models Approach to Market Risk Capital Requirements.*

[47] *The report,* Risk Management Guidelines for Derivatives, *issued by the Basle Committee in July 1994 further discusses the responsibilities of the board of directors and senior management.*

[48] *Though banks will have some discretion as to how they conduct stress tests, their supervisory authorities will wish to see that they follow the general lines set out in Section B.5.*

Source: Amendent to the Capital Accord — To Incorporate Market Risks (January 1996, updated to April 1998)

14.6 Limitations of VaR

Whatever the sophistication of the methodology used for developing VaR models, there are certain inherent limitations to its reliability for accurately predicating future losses:

(a) Firstly, calculations are made from past data. Future behaviour of the market may not necessarily display the same distribution.

(b) Secondly, the assumption of log-normal distribution of daily returns, on which the VaR number is based, is not always valid. Empirical analysis suggests that market variables exhibit "positive kurtosis". This implies that the actual distribution has a higher peak and fatter tails, than a normal distribution with the same mean and variance. The effect is that the probability of very large and very small moves is larger than that predicted by the normal distribution. Correspondingly, there are lower probabilities of moderate moves.

(c) Thirdly, market prices often display trends in a particular direction, i.e., today's change is not unrelated to yesterday's, a phenomenon referred to as auto-regression. In such cases, the volatility over a longer period can be much higher than estimated by $\sigma\sqrt{t}$. In trending markets, the expected value of the returns would also differ from zero (the efficient market or random walk hypothesis). This phenomenon is known as skewness, or in simple language, asymmetry of the distribution.

(d) Fourthly, illiquidity in the market for particular securities means that liquidation of a position may not be possible at market prices. An illiquidity premium may have to be paid, thus increasing the loss. The use of holding periods is aimed at mitigating this problem: it should be such as to allow an orderly liquidation of the portfolio. But market liquidity itself is not constant and this limitation should be kept in view.

While such limitations are inherent to parametric VaR models, the fact is that they have generally been found useful and reliable, and banking regulators too are allowing VaR-based internal risk measurement models to be used for determining capital adequacy.

Annexure 14.1 Some Statistical Concepts

14.1.1 Probability Distributions

One analytical method used by statisticians is the preparation of "frequency distributions" of observed data. These tabulate the various values of the variable under observation, indicating the observed frequency of each. For instance, the variable may be the height of adults in the city of Mumbai, the height being measured to the nearest centimeter. The frequency distribution would tabulate the number of adults against their height.

While frequency distributions are prepared on the basis of actual observations, probability distributions can be looked upon as theoretical distribution of the frequencies of the different values of the variable.

Amongst the probability distributions most frequently observed in real life is the so-called "normal distribution", which has the familiar bell shaped curve. It plots the values of the variable on the x-axis, in a continuous fashion; the expected frequency with which that value would occur is plotted on the y-axis. The cited example of the heights of adults in Mumbai, would conform to the normal distribution—except that the change in heights would be on a continuous, and not full centimeter, basis, as in the case of a frequency distribution. Many other variables—the annual rainfall for example—also conform to normality. One major assumption underlying a normal distribution is that successive values of the variable are independent and random.

14.1.2 The Normal Distribution

If y denotes the frequency of observation and x the value of the variable, the equation of a normal distribution is as follows:

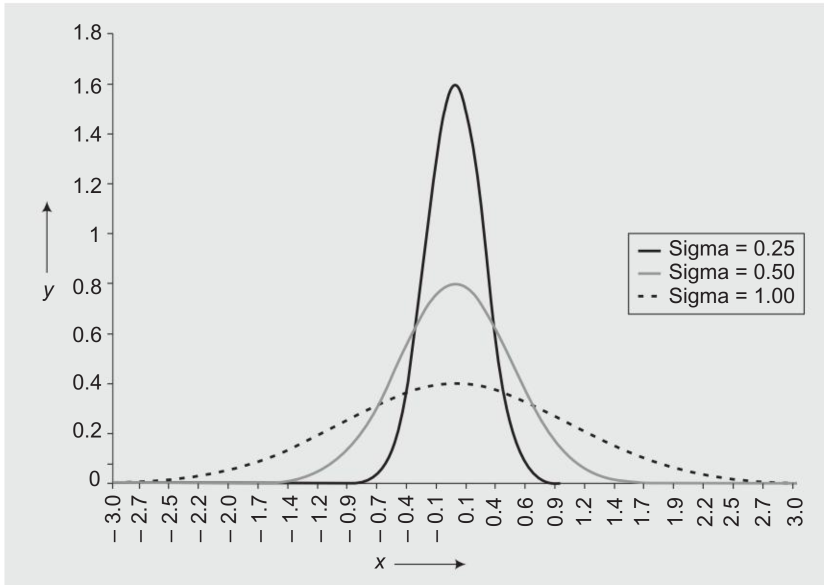
$$Y = \frac{1}{\sigma\sqrt{2\pi}} \times e^{-\frac{1}{2}\frac{(x-\mu)^2}{\sigma}}$$

where μ (pronounced as 'mew') is the mean of the x values and σ (pronounced as 'sigma') is its standard deviation, i.e.

$$\sigma = \frac{1}{n}\sqrt{\sum_{i=1}^{n}(x_i - \mu)^2}$$

It will be noticed that two parameters, namely mew and sigma, determine the shape of the normal distribution curve. The following graph shows three shapes, all with mew = zero, but with different values of sigma as shown in the graph.

Graph 14.1.1 Normal Distribution



It will be noticed that the distribution is symmetrical, with both the arms, in theory, extending to infinity—in other words, the range of the *x* values is from $-\infty$ to $+\infty$ — and the maximum number of values being at the mean. Also, when a variable conforms to normality, 68% of the observed values fall within a range of $\mu \pm \sigma$, and 95% within a range of $\mu \pm 2\sigma$. Therefore, if a variable conforms to normality, the range of its future values can be estimated with the desired degree of confidence. For example if $\mu = 3$ and $\sigma = 0.5$, we can say with 95% confidence, that the value of *x* will lie between 2 and 4. This property is very useful in calculating the Value at Risk.

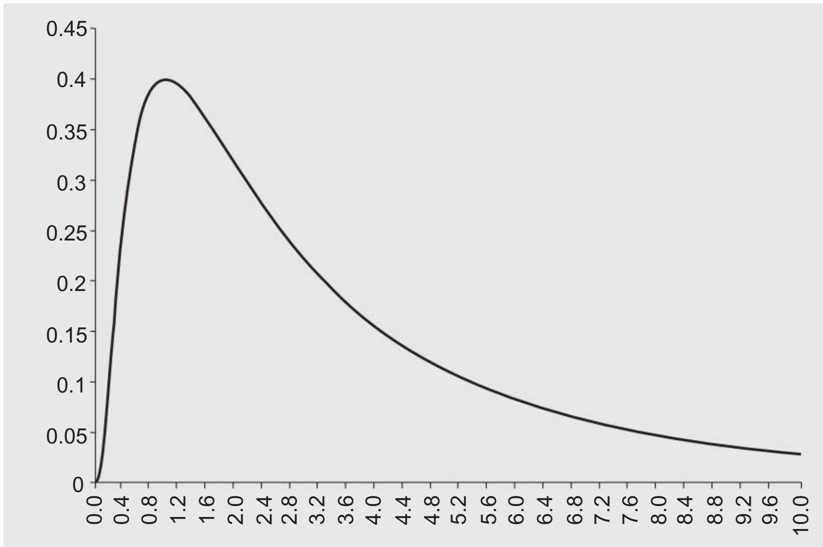
14.1.3 Lognormality

A variable is said to be 'lognormally' distributed if its natural logarithm, i.e. to the base *e*, conforms to normality. In that case, the variable itself conforms to a 'lognormal distribution', whose shape is as shown in Graph 14.1.2.

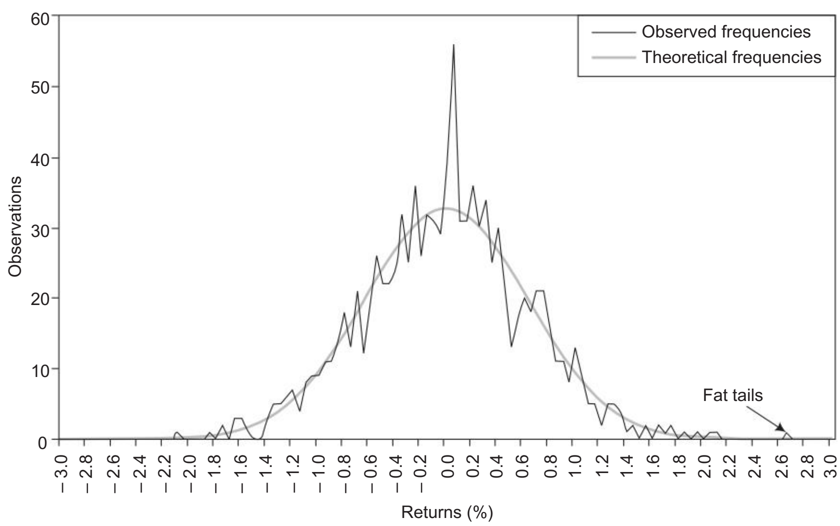
14.1.4 Empirical Evidence

Do the rates of return in financial markets, conform to normality, which is the assumption underlying many of the VaR measures? The following findings (Graphs 14.1.3 and 14.1.4) are interesting:

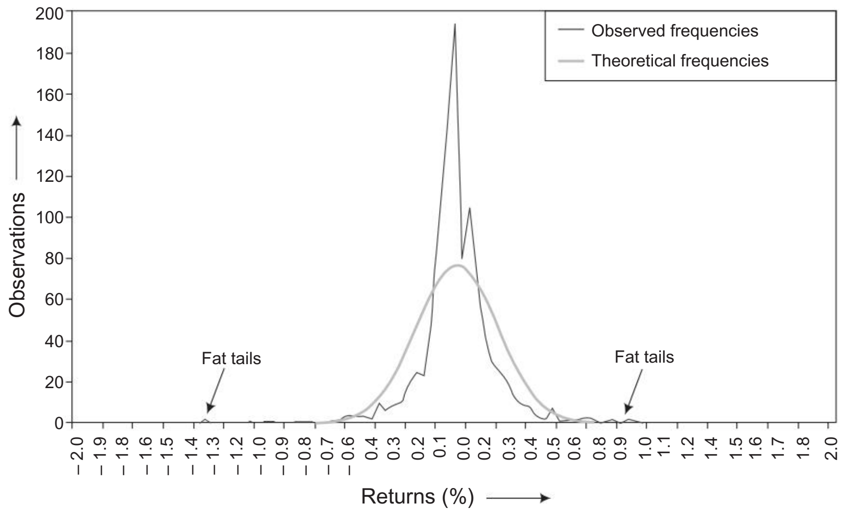
Graph 14.1.2 Lognormal Distribution



Graph 14.1.3 Distribution of Returns (ln Xt/Xt – 1) in USD: EUR Market Jan 02 to Apr 06



Graph 14.1.4 Distribution of Returns (In Xt/Xt – 1) in INR: USD Market Jan 02 to Apr 06



Statisticians have developed tests to determine whether a particular distribution conforms to normality.

14.1.5 Standard Normal Distribution

A normal distribution with $\mu = 0$ and $\sigma = 1$ is known as the standard normal distribution. Any normal distribution can be converted to a standard normal distribution, by defining a new variable $x' = (x - \mu)/\sigma$.

14.1.6 Portfolio Variance

By definition, a portfolio consists of more than one variable or asset. In practice, those using VaR measures for managing the price risk, are more interested in the variability of the value of the portfolio, as distinct from the variability of the value of an individual asset in the portfolio. It can be shown that the expected value of a portfolio is the sum of the expected values of the elements in it. On the other hand, the variance of the rate of return from the portfolio is not the arithmetical sum of the variances of the elements.

Mathematically, if x_1 and x_2 are the two elements of a portfolio and V denotes the portfolio variance. Then,

$$V(x_1 + x_2) = V(x_1) + V(x_2) + 2\,\text{cov}(x_1, x_2)$$

The last term is the "covariance" between the two variables x_1 and x_2, and is a measure of the relationship between the movement of the values of the two variables. It is calculated as

$$\text{cov}(x_1, x_2) = \frac{1}{n}\sum_{i=1}^{n} (x_{1,j} - m_1) \times (x_{2,i} - \mu_2)$$

Since the absolute values of either or both the bracketed variables can be positive or negative, the covariance number too can be positive or negative. In general terms, if the two variables tend to move in the same direction (for example, the shares of two IT companies going up or down on the same day), covariance will have a positive value, and, therefore, the variance of the portfolio will be higher than the sum of the variances of the two individual elements. On the other hand, if the two variables tend to move in opposite directions, the covariance term will be negative and the variance of the portfolio will be less than the sum of the variances of the two elements.

Where a portfolio consists of more than two variables or assets, for calculating the portfolio variance, the variance/covariance matrix of the bilateral covariances amongst each pair of variables, is used.

14.1.7 Coefficient of Correlation

Coefficient of correlation is also a measure of the strength and direction of a linear relationship between two variables. Note that it relates only to linear relationship and the coefficient may show zero value where the relationship is not linear, for example, where one variable is the square of another variable.

The coefficient of correlation is calculated by the following formula and it can be shown that the absolute value is between –1 to +1.

$$\rho_{x_1, x_2} = \frac{\text{Cov}(x_1, x_2)}{\sigma_{x_1} \times \sigma_{x_2}}$$

where σ is the standard deviation.

A value of –1 evidences perfect negative correlation in the sense that the two variables will move in opposite directions by the same proportion. Similarly, a value of +1 means perfect positive correlation, and 0 signifies that the changes in values are totally independent of each other. Note that even a strong positive correlation is not necessarily indicative of a cause and effect relationship between the two variables.

Chapter 15

Debt Securities Portfolios: Management, Classification and Valuation

15.1 Introduction

Banks and financial institutions often hold 25, 30 or even higher percentage of their assets in debt securities. The proportion in respect of primary dealers and residual non-banking finance companies is even higher. While a significant proportion of the investment portfolio of commercial banks, for example, consists of debt securities held in compliance of statutory/regulatory requirements, principally the statutory liquidity ratio, the balance is in the nature of discretionary holdings for the purpose of earning returns. Thus, the driving forces behind the two parts are different: statutory compliance in one case, and returns in the other.

Again, it should be noted that, since there are only a limited number of floating rate G-Secs, most of the investment in debt securities is in the form of fixed interest paper.

15.1.1 Risks in Investment Portfolios

Some of the principal risks in portfolios of debt securities which need to be managed include

(a) Price (i.e. interest rate) risk on G-Secs;

(b) Price and credit risks on debt securities of other issuers;

(c) Operations risk for the entire portfolio.

15.1.2 Active and Passive Management

Management of the investment portfolio, could be undertaken in two different ways.

(a) passive; or

(b) active

The former would imply

- **making investments principally for meeting regulatory prescriptions**, to have liquid assets and for investment of surplus funds;
- generally, **holding on to the debt securities until they mature**.

On the other hand, active management would require constant 'churning' of at least a portion of the portfolio, **taking views on future interest rates or yield changes**, and speculating on price movements.

The first approach is more regulation/compliance driven and the second converts **management of debt securities into a profit centre**. Each has different implications in terms of the risk management, accounting and regulatory issues involved, and appropriate policies need to be framed to cover these.

15.1.3 Managing Debt Securities Portfolios

We cover the various issues in this and the following chapters as follows.

15.2 Passive Management of the Portfolio

15.3 Active Management of the Portfolio

15.4 Functioning of Financial Markets

15.5 Classification of the Investment Portfolio

15.6 Valuation of Securities

15.7 Performance Evaluation of the Trading Portfolio

15.8 Discretionary Non-SLR Investments—Credit Risk and Other Issues

15.9 Investment Portfolio of Corporate Entities

In Chapter 16, we look at management of price risk and capital ratios; Chapter 17 discusses operations risk and Chapter 18 some issues in accounting.

15.2 Passive Management of the Portfolio

Passive management of the debt securities portfolio looks at such investments principally from a regulatory or compliance angle, and not as a profit centre. It would also require, in effect, the portfolio to be held to maturity.

Consciously or unconsciously, such a policy assumes that markets are efficient—in other words, the current prices of bonds properly reflect all the known information and it is difficult, if not impossible, to make profits by actively trading securities. While we discuss the concept of efficient markets in some detail in paragraph 15.2.1 below, even relatively passive management of portfolios will need to be done within certain defined parameters like duration, current yield v/s yield to maturity, fiscal efficiency, etc., points discussed later.

15.2.1 Efficient Markets

The topic of how/why prices in financial markets move has puzzled and intrigued academics and participants for a century and more. For the latter in particular, the prediction of future prices remains vitally important: on that depends their ability to make trading profits. If prediction with any degree of accuracy or consistency is not feasible, one would have to assume an equal probability of a price rise or fall and, following from this, that **today's price is the best forecaster of tomorrow's**: the random walk model.

The first statement and test of the random walk model was developed by Louis Bachelier in his paper "Theory of Speculation", back in 1900. Not much work got done on the subject until the second half of the twentieth century, when computers became available and facilitated/allowed empirical analysis, on a scale and depth impossible earlier. Much of the work was initially based on changes in equity and commodity prices; the insights developed and conclusions reached are also relevant to other financial markets. In short, **the question is whether markets are too "efficient" to be predictable**.

Professor Eugene Fama of the University of Chicago coined the term "efficient market" in his doctoral thesis in the 1960s. (In terms of market participants, perhaps a bigger stir was created by Burton Malkiel's "*A Random Walk Down Wall Street*", first published in 1973). Fama further developed the concept and summarised the work on the subject in a paper "Efficient Capital Markets: A Review of the Theory and Empirical Work", prepared as background for a meeting of the American Association of Finance in 1969. Incidentally, Malkiel chaired the meeting. The paper was published in the Journal of Finance, Volume 25, Issue 2, 1970. In it, Fama defines an efficient market as follows: *"A market in which prices always 'fully reflect' available information is called 'efficient'"*. What are the conditions precedent for market efficiency? Fama prescribes the following as being sufficient — but goes on to argue that they are not strictly necessary. *"Consider a market in which (i) there are no transactions costs in trading securities, (ii) all available information is costlessly available to all* *market participants, and (iii) all agree on the implications of current information for the current price and distributions of future prices of each security. In such a market, the current price of a security obviously "fully reflects" all available information.*

………………

"But though transactions costs, information that is not freely available to all investors, and disagreement among investors about the implications of given information are not necessarily sources of market inefficiency, they are potential sources. And all three exist to some extent in real world markets."

In efficient markets, by definition, prices are expected to change to incorporate almost instantaneously all relevant information. Thus, market efficiency is about price changes, not the prices themselves—but it can be argued that today's price is the sum of all past changes, and should, therefore, reflect fundamental values. The efficient market hypothesis also argues that, should demand-supply imbalances carry prices away from the fundamental value of the asset, more knowledgeable and expert players will step in to bring prices back to the correct level by arbitraging (between actual and "correct" values). At the heart of market efficiency is the concept that financial markets possessing the three attributes listed by Fama, quickly and correctly incorporate all fundamentals into the prices; therefore, market prices are the best evaluations of all information, making it difficult, if not impossible, to spot mispricing with any degree of consistency. Given modern communication, information and trading systems, the first two conditions of market efficiency are substantially met, at least in respect of liquid securities.

It is Fama's third condition, admittedly not a necessary one, which raises more questions: agreement on the implications of current information for the distribution of future prices. To be sure, the term used is "distribution" of future prices, not the future price itself (Agreement about the latter, in its most extreme form, would preclude all trading!) and "distribution" of a variable implies a range of values and a probability for each value. Unless there are differences about at least the probabilities, one would not see the buyer and seller agreeing on a price, which is what a market is about!

There are two corollaries flowing from the concept of market efficiency:

- It is "news" which alone moves markets; and
- The price adjustment is so fast ("efficient") that one cannot anticipate the future price movement, which, therefore, follows the random walk: in other words, there is an equal probability of the price going up or down and that, therefore, the current price is the best forecast of the future price.

Perhaps the **weakest assumption underlying the theory is that when prices move away from fundamentals, contrarians will step in** and correct the aberrations (in other words, the familiar "reversion to mean" principle will come into play). The reason is that too many of the actual participants in the market are trend followers, happy to run with the crowd. As Keynes said, "it is much better for one's reputation to fail conventionally than to succeed unconventionally"!

Such issues apart, if you are a believer in market efficiency, you would follow a passive investment strategy.

15.2.2 Duration Targeting

Even passive management **strategies need to be backed by quantification of the targeted duration**. This may be based on considerations of asset: liability management for a bank, insurance company or other financial intermediary; any relevant conditions in the offer document of a debt fund; or how much interest rate risk the investor is comfortable with. In theory, there could be an unlimited number of portfolios which would give the desired duration. Therefore, one would need to have some more precise idea of the strategy to be followed for choosing the portfolio. Broadly, there are two strategies:

- **The laddered or staggered, maturity strategy**. This requires a policy determined maximum maturity, with the portfolio spread more or less evenly across the years. In other words, the face value of bonds maturing every year is kept roughly equal. The advantage of such a model is that the yield is not over-dependent on the current market yields. In general, the portfolio yield will be lower than market at the time of high interest rates and higher when interest rates are low. As most market movements evidence, interest rates have a mean reversion property and such a portfolio would tend to give the mean yield, year after year, irrespective of the ruling market yields.
- **The barbell strategy** involves a significant proportion of the portfolio—say 30 to 40% in the short-term, say up to 2 years maturity, and an equal proportion at the long-end, say in excess of 10 years. The former part of the portfolio provides the liquidity and helps reduce the market risk for the portfolio; the latter gives higher yields.

Either portfolio could be so constructed as to have the desired duration. It should be noted, however, that the duration of a portfolio keeps changing with passage of time and therefore the portfolio would need to be rebalanced periodically: choosing appropriate maturity for fresh investments will mitigate the need for selling existing debt securities and buying others. It will be useful to specify the duration as a range rather than a fixed number to avoid frequent rebalancing.

15.2.3 Convexity

From the discussion in Chapter 13, it will be recalled that, for a given duration, larger the convexity of the portfolio, the better off one is: lower price fall when yields rise, and higher price rise in the opposite scenario, compared to a portfolio with identical duration but lower convexity. Clearly, therefore, for a given duration, even a passive investor would be **well advised to maximize convexity**.

15.2.4 Fiscal Efficiency

Fiscal efficiency of the portfolio could also be an objective of portfolio management. To give an example, consider two bonds having the same maturity and YTM, one priced at par and the other at a discount. Obviously, since the YTM is identical, the second bond would have a lower coupon and current yield as compared to the first bond. On the other hand, its after tax YTM could be higher than that of the par bond because a portion of the return, namely the difference between the purchase price and the par value, accrues and is taxed only on maturity of the bond. Therefore, there is a case for selling the par bond and buying the bond quoted at a discount in order to maximize the after tax earnings. There is, however, a price to be paid, namely, the current income from the investment is likely to be lower in percentage terms, under current accounting norms for banks. The question is whether this fits in with the overall portfolio management objective and strategy.

15.2.5 Current Yield v/s Yield-to-maturity

In general, for a portfolio manager with a long term perspective, current yields are not all that relevant—he would be trying to optimize the portfolio's valuation and yield-to-maturity rather than the current yield. On the other hand, given the present regulatory prescriptions about the valuation of securities (see paragraph 15.6), increases in value of securities do not get reflected in the accounts. They get accounted only when the security is actually sold or matures. Until that point of time, the income being reported broadly reflects the current yield and this may **tempt some managers to overemphasise current yield,** even at the cost of yield-to-maturity. (Regulatory changes for accounting, presently under consideration, would eliminate some of the existing anomalies.)

In the author's view, however, the objective should be to maximize the after tax yield-to-maturity and convexity of a portfolio within the policy prescribed duration constraint. This may require that management accounts, prepared on the basis of full mark-to-market, are used for judging the performance, and not the reported numbers complying with the regulatory norms. **Changes in accounting regulations to bring them nearer international practices on the subject, are however, likely to be introduced soon.**

15.3 Active Management of the Portfolio

The objective of active management of the debt securities portfolio is **to earn profits by selling and buying securities**, of course ensuring that the portfolio complies with the regulatory and/or policy prescriptions. The active managers believe that the market often is inefficient in the short or even medium term, that some securities are mispriced, and that they can spot them. In considering yield changes, they believe that the actual future spot rates would differ from the forward rates implied by the term structure, and that they have a better idea of on which side of the forward rate, the future spot rate would lie. Their trading strategies would depend on this judgment.

In principle, of course, **even active managers need to believe in market efficiency**, at least in the long term, because many of the trading strategies are dependent on the principle of mean reversion, or prices reverting to historical (or average) relationships in the fundamentals at a later date. Clearly, active management strategies are riskier than passive management in that, should the judgment of the manager about future yield/price go wrong, losses would be incurred. Therefore, the strategy would be justified only if it results into extra profits over and above what could have been earned from a passive management. It follows that proper management accounting, performance evaluation and reporting systems need to be put in place for regularly monitoring results from the trading activity.

In this paragraph, we discuss some of the trading strategies commonly used. These could be classified under different factors that affect bond prices:

(a) Expectations about the level of interest rates, nominal and real;

(b) Expectations about the shape of the G-Sec yield curve (flat, steep, etc.);

(c) Yield spreads between say AAA bonds and G-Secs, between AAA and lower rated bonds, etc., in absolute and percentage terms; and

(d) Riding the yield curve.

15.3.1 Expectations about Interest Rates

The basic **theory of real and nominal interest rates** was propounded by Irving Fisher. Fisher argued that the realized "real" interest rate can be calculated by subtracting the actual inflation rate from the nominal interest rate; as for the future, investors add the expected rate of inflation to the desired real rate to calculate the needed nominal interest rate. Fisher also hypothesized that the real desired interest rate is a function of both demand: supply of money for different time horizons and the productivity of capital.

The general experience in most bond markets is that while the central bank can, and does, control the interest rate at the short end of the market, longer term bond yields depend on inflation expectations of the investor. In turn, the central bank's monetary and interest rate policy would be governed by the need to keep inflation within targeted levels or, sometimes, to counteract upward or downward pressures on the exchange rate. In fact, in India, the experience of the last decade or so suggests that the single largest influence on domestic interest rate has been the downward or upward pressure on the exchange rate. To cite a few examples,

(a) In 1995-96, both nominal and real interest rates went to abnormally high levels, following the strong downward pressure on the rupee's exchange rate.

(b) Again in 1999, when the rupee came under pressure, the bank rate was increased by two full percentage points at one stroke;

(c) The relatively low level of both nominal and real interest rates seen in recent years is at least partly the result of the large capital inflows putting upward pressure on the exchange rate, and necessitating central bank intervention in the market buying dollars and releasing rupees.

For more detailed discussion of the interactions between money and exchange market in India, please see paragraph 15.3.1.1 below.

While **realized real interest rates** vary, they also **have a mean reversion tendency** and this could be used to build expectations about the future nominal interest rates and take trading decisions based thereon. In fact, expectations about future interest rates or yields, is the single strongest influence on trading decisions. A portfolio manager expecting yields to go up, would take steps to bring down the duration/maturity of the portfolio, even at the cost of reducing current earnings and hope to increase it after his expectations have been fulfilled and prices fall. If expectations are belied, an opportunity loss has been incurred by the deliberate lowering of the portfolio maturity. On the other hand, high (by historical standards) real interest rates, would be a buy signal in the hope that mean reversion would lead to a fall of both real and nominal rates, increasing prices. (It should however not be forgotten that high real rates also increase the default risk on corporate bonds.)

15.3.1.1 Interactions between Money and Exchange Markets

(It may be difficult for the reader to understand some parts of the discussion in this paragraph without a basic knowledge of the foreign exchange market, and he may like to skip to paragraph 15.3.2. However, every dealer in the money and exchange market will find the discussion useful.)

After the gradual opening up of the economy to international capital flows, and relaxation of exchange controls, perhaps the single largest influence on the demand: supply of money in the rupee market, has been the flows in the foreign exchange market. As of now, the integration of the two markets is not as strong as internationally, where it is manifested in the interest parity principle equating forward margin in the exchange market with interest differential between the two currencies. But there are other strong connections between the two markets in India as well. Indeed, in the author's opinion, in recent years, the strongest single driver of interest rates in the domestic market has been the exchange market.

This influence comes through various avenues:

(a) Arbitrage between interest differential and forward exchange margin.
(b) Corporate sector's preference for rupee or foreign currency borrowing, affecting the demand for rupee funds.
(c) The exchange rate policy followed by RBI and its repercussions on money supply and monetary policy.

Another interesting feature of the interaction between the two markets is worth noting, namely, that the foreign exchange market supplies some of the benchmarks used in rupee interest rate derivatives.

(a) Arbitrage

In international currency markets, the integration with the money markets comes through parity between the forward margin (i.e., difference between spot and forward rates) and the interest differential between the two currencies. With the gradual relaxation and liberalization of exchange controls in India in recent years, for example on investments/borrowings by banks in foreign markets, a similar parity between the forward margin and interest differentials is gradually developing. This arises through banks' arbitrage operations. The arbitrage is between

- Rupee interest rate for a given maturity; and
- USD interest rates for the same maturity plus the forward margin in % p.a. terms.

For instance, if a bank is a borrower in the money market, it will compare the cost with the alternative of selling dollars and buying them back for a later delivery. The dollar sale would fetch rupees which otherwise would have had to be borrowed. The cost of this alternative is

- Loss of interest on the dollars; plus
- The forward margin in % p.a. terms

If this is lower than the interest the bank would otherwise have to pay in the money market, it obviously benefits by going through the swapped dollar route. Indeed, it could swap more dollars than it needs to meet its funding requirements, become a lender in the money market and earn the difference. In an efficient market, such arbitrage opportunities would be rare, since arbitrage itself would eliminate the difference. Arbitrage opportunities can arise in the reverse direction as well, i.e. when INR money market interest rates are lower. In that situation, borrowing from (or not lending in) the local market, buying dollars and selling them forward, will be a profitable operation.

The interest parity principle is seen most closely at the short end of the interbank money market. The cash: spot forward margin tracks the difference between the overnight interbank rates in Mumbai and New York very closely. The term interbank money market (one, three and six months) in India is not very liquid at present and, generally, interest parity does not rule for longer maturities. Once it develops, we may see a far closer relationship between one-, three- and six-month interbank interest rates, the corresponding USD interest rates and the forward margin in % p.a. for these periods.

There is, however, a serious limitation on such arbitrage, namely, the amount of dollars banks can deposit in, or borrow from, international markets. There are limits imposed by exchange control, and, once reached, demand/supply from/by end-users, and not interest differential, determines the forward margin. The following Table 15.1 of rates ruling on 31.7.06 is illustrative of the points made above.

Table 15.1 LIBOR, MIBOR and Forward Margin (31.7.06)

	1 month	3 months	6 months	12 months
(a) USD LIBOR	5.39	5.47	5.51	5.54
(b) Forward Premium	0.70	0.80	1.02	1.12
(c) Total (a + b)	6.09	6.27	6.53	6.66
(d) NSE MIBOR*	6.27	6.68	—	—

* 6 and 12 months not quoted on that day.

(b) Corporate Funding Choices

As the restrictions on supplier/buyer credit on imports and availability of export credit in foreign currency, have been liberalised, the corporate sector has a choice to finance international trade in either dollars (or another foreign currency) or dollars and rupees. Typically, when the forward margin in the exchange market is less than the difference between the marginal cost of rupee funding to an importer and the cost of supplier/buyer credit in dollars (or another foreign currency), the importer would obviously prefer to use the latter. Such opportunities arise because, as we have seen in the previous paragraph, the forward margin in India does not always follow, or negate the interest differential. For many companies, the marginal cost of funding could be the interest rate on the cash credit account; suppliers or buyers credit in dollars may be available at a far lower rate of interest. If this difference exceeds the forward margin on the dollar (plus other incidental costs of dollar credit like bank commission, stamp duties, etc.) it is obviously in the interest of the importer to use dollar credit rather than bank borrowing in rupees. This reduces the demand for rupee funds. Contrarily, if the rupee is under downward pressure and the forward margin flares up, the preferred currency of borrowing may change to rupees. There is a similar logic to the choice of the financing currency for exports, and this too affects the demand for rupee funds from the banking system.

If this is true of working capital finance, it is also true of medium term loans. Interest differential between foreign currency and rupee loans is a key factor in corporate preference for the currency of funding.

In short, the spot and forward rates in the exchange market can, and do, affect the demand for rupee funds from the banking system, and therefore interest rates.

(c) RBI

Some issues in the RBI's intervention in the exchange market and the implications for money supply and its sterilisation have been discussed in paragraph 2.4.

15.3.2 Yield Curves

Another major influence on the trading decisions is the flatness or steepness of the yield curve, in other words, how do yield differences between say one and ten-year maturity bonds differ? A question that should be specifically raised and answered is whether the extra price risk on the longer term bond is adequately compensated by the yield spread. The shape of the yield curve could be used to decide on the duration/maturity of the portfolio. One way of tracking the yield differences is to compare the current differences with the long term average: once again, **the expectation or belief is that the yield difference would revert to mean over a period** and this property can be used to take trading decisions.

A standard methodology for looking at the current spreads in relation to the historical numbers is to look at not only the average yield spread, but also the historical standard deviation of the variations in yield spreads. **If the actual yield spread is higher or lower than, say, one standard deviation from the mean**, this could be a pointer to the possibility of the spread starting to move towards the mean level.

To be sure, the possibility of reversion to mean of yield spreads is only one factor that an active fund/portfolio manager would use. **Prospects for economic growth** is also a major factor influencing yield spreads and curves. Fast economic growth, unmatched by an expansive monetary policy, may lead to a steeper yield curve: on the other hand, prospects of slowdown lead to a flatter yield curve. To give a recent example, towards the end of 2005, long term bond yields had remained unchanged in the US market despite nine successive hikes in the Fed funds rate engineered by the monetary authority. The result was a practically flat yield curve with the 10-year treasury yield actually marginally lower than the two-year yield. This flatness was being seen as predicting a slowdown in the economy rather than as presaging higher long term bond yields. Incidentally, the so-called "fed model" compares the 10-year govt. bond yield with the prospective earnings yield in the equity market, i.e. the ratio of the current year's forecasted earnings and the equity price. (This is the inverse of the more familiar price earnings – P/E – ratio.)

Signals from the yield curve are particularly strong when prices reflect unusually large or small spreads between different maturities. The following table shows the wide variation in yield spreads in the Indian market during the last seven years.

15.3.3 Yield Spreads

Yield spreads refer to the premia non-sovereign issuers like state governments, corporates, etc., pay over the G-Sec yields for corresponding maturities. These keep fluctuating with the demand: supply dynamics for instruments with different ratings. Here again, there is a historical relationship between the yields and, sometimes, the spreads are much narrower, or wider, than suggested by yield spread volatility around the historical average. These

Table 15.2 Bond Yield Spreads

	5 years–1 year			10 years–1 year		
	Minimum	Maximum	Average	Minimum	Maximum	Average
1999	0.67	1.05	0.84	1.28	1.83	1.53
2000	–032	1.06	0.59	0.32	1.79	1.25
2001	–0.20	1.96	0.63	0.74	2.99	1.75
2002	–0.03	1.09	0.60	0.23	1.75	1.25
2003	–0.98	0.97	0.21	–0.85	1.39	0.59
2004	–1.20	1.69	0.25	0.88	1.97	0.68
2005	0.35	1.34	90.54	0.86	1.69	125.97

often present trading opportunities. For instance, if the spreads are too narrow, this is an indication that the lower rated securities are over-priced relative to the higher rated securities (or G-Secs). In that situation, selling (or shorting) lower rated paper and investing in securities carrying higher ratings, is a potentially profitable strategy: for the yield spreads to revert to the historical average, the yield of the higher rated bonds has to fall **relative to that** of the lower rated paper. In other words, **the price of the former has to go up relative to the latter**. Note that the important point is **relative, not absolute, price change**. (Thus, in a rising interest rate scenario, the prices of both may fall in absolute terms.) When this occurs, the higher rated bond could be sold, and the lower rated one bought back.

15.3.4 Riding the Yield Curve ("Rolling Down the Yield Curve")

One of the most common strategies for improving yield, when the curve is positive or upward sloping, is purchasing longer dated securities, and selling them before maturity: as we discuss below, this strategy would give **higher yields than available on investments for the shorter term**. To elaborate the strategy, consider the following illustration.

(a) The time horizon for investment is 3 months;

(b) One option is to invest in a T-bill of 3-month (balance) maturity, yielding say 4% p.a.;

(c) In a normal, positive yield curve, longer maturity investments would yield higher. Therefore the other option would be to make the investment in a T-bill with 6-months (balance) maturity, yielding say 4.5% p.a., and selling the investment at the end of 3 months.

(d) In the absence of any change in market yields during these 3 months, the latter strategy, which is known as "riding the yield curve" would give a return of more than 4% p.a., namely the return on a straight 3-month T-bill.

The reason is that, firstly, the yield on the longer-term investment itself is higher (4.5%). Secondly, at the end of 3 months from date zero, the 6 months T-bill would be priced to yield 4% p.a. over its balance life, which is now 3 months. Since this yield is assumed to be 4%, the effective yield on the 6-month investment sold at the end of 3 months, would be significantly higher as follows.

Assuming that 3 months is an exact quarter of a year,

(a) the 3-month T-bill would be priced at 99.0099, to yield 4% p.a.

(b) Similarly, a 6-month T-bill would be priced at 97.7995, to yield 4.5% p.a.

(c) In the illustration, you would buy the 6-month bill at 97.7995, hold it for 3 months and then sell it at 99.0099. The annualized yield on this investment (over 3 months) is 4.9505%, much higher than the 4% yield on a 3-month T-bill: 4.9505, incidentally, is the 3×6 forward rate implied by the term structure.

Clearly, the strategy of riding the yield curve has improved the yield quite significantly. The improvement would be even higher in a falling interest rate scenario where, for example, the yield on the 3-month T-bill may fall to say 3.75% by the time the investment is sold. On the other hand, the risk in the strategy is that yields may go up during the period in which the amount stays invested. If that happens, the strategy could reduce the effective yield, or even bring it below the yield of 4% available on date zero on a straight 90 day T-bill. Can we quantify the rise in interest rates which will equate the yields from a straight 3-month investment, and one in a 6-month investment sold after 3 months?

If the buy 6-month, sell after 3-month strategy is also to yield a return of 4% p.a., the selling price should be 98.7775 (97.7995×1.01) – this price implies a yield of 4.9505% p.a. for the balance three months, which is the 3×6 months forward rate at the inception of the transaction. In short, the strategy of riding the yield curve will work and improve yields **provided the future spot rates do not exceed today's forward rates**. In other words, while riding the yield curve, you are taking a bet that **future yield will be lower than the forward rates implied by the term structure** of interest rates. The principle is applicable also in the longer-term bond market but the risks are higher.

15.3.5 Trading Performance

The practice is to maintain the trading book at clean, not full, prices, and judge the performance by the change in the value of the portfolio. In the author's view, this suffers from one weakness: the change in accrued interest distorts the performance. If the coupon is more than the YTM, the clean price will fall even when there is no rise in yields, and vice versa. It would therefore be best if trading performance is judged on the basis of full, and not clean, prices. For a more detailed discussion of the issues involved, please see paragraph 15.7 below.

15.3.6 Evaluation of Switches

As would have been noticed, many of the trading or yield improvement (or duration targeting) strategies involve switching of securities, i.e. selling (or shorting) one category, and buying, or going long, in another. Therefore a rigorous evaluation of switches is important. A rigorous approach would compare the existing cash flow stream (i.e. on the security to be sold) with that from the new security purchased **using the exact sale proceeds of the sold security**. The YTM's of the two cash flow streams **on the full market price** of the security can be compared, along with the change in the Macaulay duration and price volatility which the switch will entail, before taking the decision.

15.3.7 Financial Market Research Cell

Banks and other investors engaged in active management of the debt securities portfolio, will find it useful to create a small research cell as part of the treasury. This would be independent of the dealers and manned by mathematicians/statisticians fully conversant with the debt (and derivatives) markets, with some grounding in macroeconomics. It should be the job of the cell to analyse the macroeconomic environment and its possible impact on the bond market; prepare, and continuously review, debt market strategy; spot any mispricings; explore arbitrage opportunities between money and forex markets, etc. The cell should be actively involved in the trading operation.

15.4 Functioning of Financial Markets

While some of the trading strategies usually employed by participants are described above, some pointers about the actual price behaviour in markets need to be noted.

15.4.1 Reversion to Mean

Many of the trading strategies based on nominal or real interest rates and yield spreads depend on their success on **the assumption of reversion to mean**. While the principle of mean reversion has been observed in most markets, the big unknown is the level of diversion from the mean from which the pendulum will start swinging the other way! Even the most sophisticated players cannot predict this and sometimes the results can be disastrous. The classic example is that of Long Term Capital Management, a New York based hedge fund (with which, incidentally, a couple of Nobel Laureates were associated); LTCM took huge bets on narrowing of the yield spreads between corporate bonds and government paper. The yield differences were high by historical standards, but a Russian default in 1998 led to **a "flight to quality" and the spreads widened further**, instead of narrowing. Not only was LTCM wiped out but it was so highly leveraged that its collapse posed a systemic risk and the Federal Reserve had to sponsor a bailout of LTCM.

15.4.2 Market Psychology and Behavioural Finance

John Kenneth Galbraith coined the phrase **"conventional wisdom"** to describe opinions held by a large majority of the market participants, whether well founded or not. **Repeated often enough, and quoted in the media, such conventional wisdom gains validity** and it becomes more difficult for a participant to take an opposite, contrarion view. Believing what is generally believed to be correct, can be risky in financial terms, but is quite safe from the angle of ones reputation as Keynes pointed out (see paragraph 15.2.1). Indeed, market psychology and how people take financial decisions has led to a whole new discipline known as "behavioural finance". Many researches and experiments in behavioural finance suggest that **human beings approach to financial risk is not very rational**. One of the most quoted experiments is that participants are offered a 50-50 chance of gaining Rs 11 or losing Rs 10. Logic would suggest that the chance should be accepted since the game has a positive pay off. ((0.5 × Rs 11) – (0.5 × Rs 10)). Yet, a large majority of the people refuse to take the chance: apparently people feel the pain of a loss more than the pleasure of a slightly higher gain! This of course does not apply when the gains are much more than the likely loss—consider the enormous popularity of lotteries the world over despite the fact that, as a group, those who buy lottery tickets invariably lose much more than the winner earns!

A few other examples are worth quoting:

- **Issue of bonus shares** or a stock split often leads to an appreciation of the price. By any yardstick, such corporate actions add nothing to the company's value and should have no impact on the price—were investors to be rational!
- **Investors like dividend paying stock** although gains by way of capital appreciation than through dividends is more tax efficient in most countries of the world. Rationally, therefore, for a given PE ratio (and other fundamentals) investors should prefer companies which do not pay dividends!
- Other manifestations of irrational behaviour include the unwillingness to accept losses by reversing positions but cashing profits too early: both of these **go against the basic principles of risk management** which call for cutting losses and allowing profits to ride;
- the sunk cost effect (most people would rather spend an additional Rs 10 million completing an uneconomic project than write off Rs 100 million already invested, now itself);
- the herd instinct;
- varying answers to the same substantive question depending on how it is framed, etc.

One striking example of irrational pricing is the Royal Dutch/Shell case. The company had a strange structure. While operating as a single business, cash flows were distributed between the U.K. and Dutch corporate entities in 60:40 ratio. By any logic, the market capitalization of the two companies should have been proportionate. In practice, it has often differed widely. Such examples can be multiplied.

Market participants often **confuse hopes and desires with expectations**. Some common pitfalls include the **tendency to extrapolate existing trends**, overlooking the validity of the underlying rationale; allowing wishful thinking to influence decisions unduly, etc. There is no substitute to an enquiring mind willing to put conventional wisdom to the test of commonsense and logic. If one needs to guard against such behaviour, one should also never forget what John Maynard Keynes said: "*markets can remain irrational longer than you can remain solvent*." (Incidentally, Lord Keynes was also a successful speculator.)

While many of the examples cited here are from the equity market, bond markets are no less prone to irrational behaviour, the herd instinct, and other quirks of human agents and their decisions.

15.5 Classification of the Investment Portfolio

The generally accepted practice the world over is for financial intermediaries like banks to classify investment portfolios in three categories:

- Held to maturity (HTM);
- Available for sale (AFS); and
- Held for trading (HFT)

So is the case in India where the RBI regulates the classification of investment portfolios of banks, financial institutions and Primary Dealers. (Note that the classifications for disclosure at the investment portfolio in published accounts are different: see below.) Banks are required to decide (and record) the category of the investment at the time of acquisition.

The object of the categorisation is to **define the purpose and holding periods** of the different segments **and prescribe varying mark-to-market valuation norms**: mark-to-market means valuing the securities at their market prices for the purpose of finalizing the accounts. The change in valuation affects the reported profits.

This categorisation into HTM, AFS and HFT is for internal and valuation purposes. In published accounts of banks and financial institutions, however, the investments are disclosed by type of security: (a) Government securities, (b) Other approved securities, (c) Shares, (d) Debentures & Bonds, (e) Subsidiaries/joint ventures and (f) Others (CP, Mutual Fund Units, etc.).

Debt securities acquired with the intention to hold them up to maturity are categorised as Held to Maturity. So are strategic or other long term investments in equities. On the other hand, securities acquired with the intention to trade by taking advantage of the short-term price/interest rate movements are categorised as Held for Trading. Securities which do not fall within either of the above categories are classified under Available for Sale. While there is a limit on the amount of securities that can be held in the HTM category, banks have freedom to decide on the extent of holdings under Available for Sale and Held for Trading categories, but HFT securities have to be sold within 90 days. The spirit of the regulatory provisions is that while the investments in compliance of statutory requirements, SLR for example, and strategic investments in equities, in subsidiaries for example, can be part of the HTM category, others, i.e. discretionary investments, need to be kept in either the AFS and HFT categories. While the classification category of a particular investment has to be decided at the time of purchase, some flexibility is currently permitted for changing the category. As we shall see in the next paragraph 15.6, these categories have different valuation norms. (The rules for categorisation, valuation, and accounting are currently under review; the likely changes are indicated in Chapter 18.)

15.5.1 Some Issues in Portfolio Classification

Given the requirement of sale of securities in the HFT portfolio, it is obvious that the securities **should be those which have a liquid and ready market**. The evaluation of trading performance also needs to be done very rigorously, a point discussed earlier.

The AFS portfolio consists of what remains after earmarking securities in the HFT and HTM segments. We therefore need to look at the considerations to be kept in view while designating securities as part of the HTM portfolio. Regulations limit inter-se changes to/from the HTM portfolio to once a year. Such transfers to/from the HTM portfolio have to be done at the acquisition cost/book value/market value on the date of transfer, whichever is the least, and the depreciation, if any, on such transfer should be fully provided for. To be sure, fresh purchases from the market can always be taken to the HTM portfolio at any time provided, of course, the overall size of the HTM portfolio is within the prescribed limit.

In principle, the securities to be held to maturity should be such as are either illiquid or of long maturity and held for yield purposes alone. It should be noted however that merely designating a security as HTM does not avoid the economic or opportunity loss arising from rising interest rates: it merely spreads the economic/opportunity loss through the life of the security instead of being accounted upfront.

Clearly, the largest vulnerability to provisioning for mark-to-market losses arises from the AFS portfolio. Regulations require this exercise to be done at least once a quarter. While the market value of every security in the portfolio will be calculated, the need for provision would arise only if there is a net depreciation of the AFS portfolio as a whole under any of the six classifications (a) Government securities, (b) Other approved securities, (c) Shares, (d) Debentures and Bonds, (e) Subsidiaries/joint ventures and (f) Others (CP, Mutual Fund Units, etc.). In other words, within one classification, the appreciation of some securities can be netted against the depreciation of other securities for the purposes of provisioning.

15.6 Valuation of Securities

15.6.1 Mark-to-market: Economic Logic

The question of prudent policies for managing portfolios of debt securities is of crucial importance to banks and other investors, particularly when such portfolios form a significant proportion of the total assets. The management of the portfolio is important not only from the income or yield perspective, but equally from the impact of mark-to-market valuations on the reported net profit. In India, after practically eight years of continually falling yields, interest rates hardened in fiscal 2004-05, and investors, including particularly banks and primary dealers, have had to take a significant hit in their profit and loss account statements.

The economic logic of providing for mark-to-market losses on valuations of fixed interest securities, arises from the fact that it **recognizes an opportunity loss**: for example, if an investor has locked into a low coupon security, he cannot take advantage of any subsequent rises in interest rates. The mark-to-market valuation, in effect, crystallises this opportunity loss upfront. On the other hand, in a falling interest rate scenario, the rising prices reflect opportunity gains on the security.

There is another way to look at the issue of mark-to-market. Consider the basic economic logic for the statutory liquidity ratio of banks: it is that a bank should have a minimum amount of liquid investments to meet any unforeseen or disproportionate withdrawal of deposits. (While this is the basic underlying logic, the author cannot recall any instance in recent banking history of a commercial bank being allowed to sell SLR portfolios, taking them below the prescribed ratio, in order to meet a run on deposits—to that extent, the statutory "liquidity" remains a theoretical resource.) From this angle, it is obviously necessary that such securities be carried in the books **at their currently realizable values** (i.e. market rates) as only such amounts will be available for meeting depositor liabilities. But, in practice, many banks classify the bulk of the SLR portfolio in the HTM category, thus escaping the mark to market discipline.

To be sure, the economic logic of mark-to-market is not as crystal clear as the above discussion would suggest. Consider, for example, a financial intermediary with just one asset and one liability on its books. Let us assume that there is a 5-year fixed rate deposit carrying interest at 8% p.a. and the proceeds have been invested in a 5-year government security at say 9% p.a. Evidently, this financial intermediary carries no interest rate (or, indeed, credit) risks and, ignoring operational costs, should report a steady 1% profit year after year (ignoring income on the equity of the intermediary). Consider, however, what would happen if market interest rates go up and the price of the security, which is the only asset, falls by say 3%: in that year, the intermediary would report a loss since only the asset would be marked-to-market, but not the liability. It can be argued that this "loss", arising from the mark-to-market of only one side of the balance sheet, does not give a "true and fair" picture of the results for the year. (The loss would of course be recouped in subsequent years.)

Arguing from first principles would suggest that the provisioning arising from changes in interest rates should apply to the totality of the assets and liabilities of a financial intermediary, and not just those parts, like the government securities, which have a secondary market. Incidentally, this problem also exists in respect of valuation of derivatives transactions entered into as portfolio hedges, under both US FAS 133 and IAS 39.

Whatever the economic logic, current regulatory prescriptions require a significant proportion of the investment portfolio to be marked-to-market and the portfolio loss, if any, provided in the books of account.

15.6.2 Regulatory Norms

(a) Investments categorised as Held to Maturity are not required to be marked to market and are carried at acquisition cost unless it is more than the face value; in the latter case the premium is amortised over the period remaining to maturity on a straight line basis.

(b) Individual scrips in the Available for Sale category are required to be marked to market at quarterly or at more frequent intervals, and the depreciation/appreciation aggregated separately for each disclosure classification (see paragraph 15.5) Classification-wise net depreciation needs to be provided for but net appreciation ignored.

(c) Individual scrips in the Held for Trading category are required to be marked to market at monthly or at more frequent intervals and provided for as in the case of those in the Available for Sale category. There is a dichotomy in the valuation prescription for the HFT category: for banks, as in the case of the AFS category, book values of individual securities remain unchanged after marking to market; for financial institutions, they are required to be changed.

15.6.3 Valuation Basis: SLR Securities

(a) The 'market value' of G-Sec investments included in the Available for Sale and Held for Trading categories would be the market price of the scrip as available from the trades/quotes on SGL account transactions, price list of RBI, prices declared by Primary Dealers Association of India (PDAI) jointly with the Fixed Income Money Market and Derivatives Association of India (FIMMDA) periodically.

(b) Unquoted G-Secs are also valued using YTMs given by FIMMDA.

(c) State Government and other approved securities are valued applying the YTM method by marking it up by 25 basis points above the yields of the Central Government Securities of equivalent maturity put out by PDAI/ FIMMDA periodically.

(d) Treasury bills are valued at the carrying cost.

(e) The implications of the valuation norms may be summarized as follows:

  (i) Investments in the HTM category do not need to be marked to market for accounting purposes. This of course does not mean that such investments are free of interest rate risks; only that any losses do not need to be recognised in the books of account. HTM securities are as susceptible to economic, as distinct from accounting, losses as the other categories.

  (ii) While securities in the AFS category need to be marked to market, only the aggregate loss in a category needs to be provided; on the other if the category aggregate is a gain, it should be ignored. To elaborate, consider the AFS portion of the accounting category "debentures and bonds". Let us assume that there are 10 instruments 6 of which have a higher market value than the book value, and the remaining 4 show losses on the same basis. If the aggregate profit on the first 6 is less than the loss on the remaining 4, only the net category loss will have to be provided in the accounts. If there is a net gain, it should be ignored.

  (iii) Investments in the HFT classification need to be individually marked to market. In the case of both AFS and HFT, however, the mark to market does not lead to a change in the book values (for banks).

15.6.4 Repo Accounting Guidelines

Market participants are allowed to undertake repos from any of the three categories of investments viz., Held for Trading, Available for Sale and Held to Maturity. (The second leg of the transaction has to be in the same category.) The basic principle in accounting for a repo is to consider it as a combination of outright sale and outright purchase. Therefore, securities sold under repos are excluded from the investment account of the seller, while the securities bought under reverse repo are included in the investment account of the buyer. The buyer can include the approved securities acquired under a reverse repo transaction, as part of the buyer's Statutory Liquidity Ratio (SLR) investments, during the period of the repo. The first leg of the repo should be contracted at the prevailing market price and the accrued interest. (In case the interest payment date of the security offered under repo falls within the repo period, the coupon received by the buyer of the security should be passed on to the seller on the date of receipt.) While the buyer will book the accrued interest during the period of the repo, the seller will not accrue the coupon during that period. In the case of discounted instruments like treasury bills, however, the seller will continue to accrue the discount at the original discount rate during the period of the repo.

15.6.5 Likely Changes

The RBI is likely to introduce major changes in the categorisation and valuation norms shortly, to bring them in alignment with international practices. The exact details are not however known at the time of writing, but the general principles are discussed in Chapter 18.

15.7 Performance Evaluation of the Trading Portfolio

All the regulation-prescribed and accounting valuations are done at the quoted prices. However, one prerequisite of a rigorous evaluation of treasury's trading activity in government securities is separation of the change in valuation of the portfolio between

(i) change because of external reasons like monetary policy; and

(ii) change because of managerial actions or trading.

Some treasuries evaluate performance on the basis of changes in the quoted, or clean, prices which are used for mark-to-market purposes. One weakness of this system is that clean prices would rise even without a change in the YTM, if coupon is less than YTM—and vice versa. This would tend to inflate (or deflate) the trading performance without any contribution of the trader. Therefore, the author prefers the use of full values. This will require a proper management accounting and performance evaluation systems for the trading portfolio somewhat on the following lines:

(a) To start with, active trading could be limited to a relatively small number of liquid securities, segregated from the current portfolio. The holdings of each security earmarked for active trading should be such that they can be easily traded in the current liquidity conditions in the market. The securities and holdings should be specified. A value at risk or, preferably, daily earnings at risk limit should be imposed on the portfolio.

(b) The trader would be free, within the DEAR limit, to

  (i) switch securities, i.e. selling some of the existing ones and buying others;

  (ii) remain in cash, i.e. sell securities and keep funds in the overnight market subject to fulfilling regulatory requirements; or

  (iii) leverage the portfolio by borrowing in the overnight market and buying securities. Leveraging should be limited to a specific amount or percentage of the portfolio value, or controlled through the VaR.

  The earnings/expenses on call money would be part of the trader's notional profit and loss account. The borrowings/placements in the call market could be with the central treasury itself at the going market rate.

(c) The portfolio is handed over to the trader at its full market value on date zero—full value comprising the quoted price and the accrued interest.

(d) Coupon inflows on the securities in the active trading portfolio should be added to it with freedom to the trader to invest them in the securities or call money market.

(e) The performance evaluation will compare the full mark to market value of the trading portfolio at the time of evaluation, **with what it would have been had the portfolio remained unchanged**, with coupon inflows re-invested in the same security.

15.8 Discretionary Non-SLR Investments—Credit Risk and Other Issues

15.8.1 Objectives

Non-SLR investments are purely discretionary as far as bank or other financial intermediaries are concerned. The objectives of making such investments can be:

(a) investment of surplus funds at times when acceptable loan demand is weak;

(b) improving earnings through higher returns than available in the government securities market; or

(c) liquidity.

These objectives are not mutually exclusive and most non-SLR investments may get done with a combination of more than one objective. For example, investments in commercial paper not only give higher yields than T-bills but are also liquid.

15.8.2 Earnings or RoC

The issue of increasing earnings needs to be looked at from two different perspectives:

(a) yield; and

(b) return on capital.

Consider the case of a bank which has fulfilled the SLR requirements and has surplus funds which, if invested in CPs or CDs, would give a slightly higher yield than T-bills. Should the bank therefore invest surplus funds in such paper if the yield is only marginally higher than T-bills? Such investments have higher capital charge than T-bills. Therefore, the answer to the question of making such investments would be affirmative if the bank has surplus capital (or the extra return gives an adequate return on equity), and negative if the bank's capital is under strain. In the latter case, it may be better to invest the surpluses in T-bills, foregoing the extra yield. However, if the bank has more than adequate capital, the investments could be considered on a marginal extra yield basis, even without considering the question of return on capital.

This point is all the more important in the case of long-term investments in, say, corporate bonds/debentures. As we shall see in the next chapter, such investments carry a higher capital charge than an equal amount of corporate loan: this is because investments in corporate/bank bonds are subject to separate capital charges for credit and market risks (in contrast, a loan would be subject to a capital charge relating only to the credit risk). Since such investments are of a relatively longer-term nature, and since the corporate bond market is less liquid, the issue of adequate return on capital needs to be seriously considered before making the investment decision. While the coupon on corporate bonds will be largely determined by the credit rating assigned to the instrument, banks need to do their own credit analysis even in respect of rated issues.

In the author's view, smaller banks may find it advisable to make investments in corporate debt paper (and equities) through the medium of mutual funds, rather than doing them directly, for the following reasons:

(a) diversified portfolio;
(b) dedicated fund management staff;
(c) liquidity; and
(d) fiscal efficiency.

The asset management company/fund would be selected taking into account the following:

(i) the general reputation of the asset management company.
(ii) the ranking of the fund or other similar funds managed by the AMC as available in the latest studies of CRISIL or other respected organizations
(iii) the entry/exit loads and other costs.

15.8.3 Valuations of Non-SLR Securities

(a) While some old non-SLR investments can continue to be held in the HTM category, the remaining have to form part of the AFS or HFT segments and, therefore, subject to mark-to-market treatment. Again, banks are precluded from investing in unrated paper.
(b) Corporate debentures/bonds are valued on YTM basis. The YTM is arrived at by adding to the YTM of G-Secs of corresponding maturity, a premium to reflect the rating of the bond. FIMMDA publishes the rating spreads, but the minimum needs to be 0.50%.
(c) Investments in mutual funds need to be valued at stock market price (for closed-end funds), or repurchase price for open-ended funds. If neither is available, the funds NAV (net asset value) should be used. Debt funds themselves value debt securities as per CRISIL valuations.
(d) Commercial paper is valued at carrying cost.

15.9 Investment Portfolio of Corporate Entities

Cash-rich companies have also become large investors in debt securities. They too need to be lay down the basic parameters and policies for managing the portfolios. Some of the points to be covered:

(a) The objective—investment of surplus funds, meeting a definite future liability, availability of liquid resources for capex or acquisitions, etc.;

(b) Parameters and constraints like type and ratings of investments, portfolio duration, etc.;
(c) Active or passive management strategy;
(d) Valuations and MIS, etc.

15.9.1 Immunisation Strategy

In theory if one is managing a fixed interest portfolio whose objective is to meet a definite liability at a later date, this could be achieved by:

(i) Equating the present value (or the total of present values if there are more than one liabilities which are to be met through the investment portfolio) of the liability(ies) with the present value of the investment portfolio; and
(ii) Matching the Macaulay duration of the liability and investment portfolios.

If this were done, the proceeds of the investment portfolio should be enough to pay off the liability(ies) irrespective of any changes in interest rates. While this is so in theory, certain limitations of the duration based, interest rate change-immunised strategy need to be taken into account:

- The strategy would work only if there is a parallel shift in yields across the yield curve. A parallel, that is equal change in yields for different maturities, is implicit to the use of duration based immunisation;
- The second limitation comes from the fact that the duration of any portfolio changes every day, and by less than the passage of time.

Therefore the portfolio would need to be rebalanced periodically as discussed in paragraph 13.2.4.

Chapter 16

Price and Credit Risk Management Capital Charge

16.1 Introduction

While much of the following discussion is from the viewpoint of banks, the concepts would be found applicable to management of debt securities portfolios by other investors as well. Traditionally, banking was far more concerned with and conscious of managing credit risks. Over recent decades, however, as exchange and interest rates have become more volatile, and as banks have become more dependent on trading income to bolster their profits, **management of price risk has assumed great importance**.

The other driving force on the subject has been the **evolution of banking regulation**, starting with introduction of capital norms for credit risk (Basle I), the 1996 amendment to cover regulatory capital for managing market/price risks, and the recent introduction of Basle II which also covers capital charge for operational risks. These developments have been important catalysts in the development of the principles and practice of risk management. Indeed, modern risk management concepts promise to transform the business of banking. Apart from price and credit risks in the management of investment and derivatives portfolios, banks also face operations risk, a topic we will discuss in the next chapter.

The market/price and credit risks in the portfolio of debt securities and interest rate derivatives may be summarised as follows:

(a) The prices of all debt securities and values of interest rate derivatives change with **market interest rates**;

(b) The prices of debt securities issued by non-sovereign issuers are also affected by changes in **the credit rating** of the issuer, as also changes in the premia over G-Sec yields which different rating categories attract;

(c) There are also **settlement risks**, which is a particular type of credit risk, in over-the-counter transactions not settled through a clearing corporation which guarantees settlements.

16.1.1 Risk Management: General Principles

Management of market or price risk is a three-tier process—**risk identification, risk measurement and risk control**. We have already identified earlier the different risks integral to portfolios of debt securities and interest rate derivatives. Risk measurement consists of choosing the appropriate method for measuring the price risk—duration or Value at Risk, concepts which we have discussed respectively in Chapters 13 and 14. Risk control has two elements—firstly fixing a limit on the aggregate risk and, secondly, introducing appropriate systems, procedures and information systems to monitor that the risk limits are being observed.

A critical issue, particularly in discretionary (i.e. non-statutory) investment in debt securities and in the derivatives market, is the question of pricing of the products. In principle, the pricing should be such as to give adequate returns for the price and credit risks.

16.1.2 Capital Charge

Increasingly, under the leadership of the Basle Committee on Banking Supervision, national regulators are imposing tighter regulatory norms in the form of capital charges for the different risks. At this stage, it will be useful to distinguish between accounting, regulatory and economic capital. Accounting capital is the reserves and capital, net of intangible assets, as available from the published accounts. Regulatory capital is the capital charge mandated by the banking regulator for different types of businesses. Increasingly important is the concept of "economic" capital: this is the capital needed to absorb losses that may be incurred from the various risks being assumed by the financial intermediary in the pursuit of its profit objective. It can be argued that the evolution of concepts underlying regulatory capital norms has been driven by the objective of **bringing regulatory capital nearer economic capital**. The recent introduction of Basle II norms is another step in this direction.

16.1.3 Scheme of the Chapter

In paragraphs 16.2 and 16.3 we look at some issues in the measurement and control of price and credit risks respectively. Paragraph 16.4 would discuss regulatory capital charges for price and credit risks in the debt securities and interest rate derivatives portfolios. In paragraph 16.5 we take an overview of the capital asset pricing model and the cost of capital.

As stated earlier, operations risks would be discussed in the next chapter.

16.2 Market/Price Risk Management

16.2.1 Risk Identification

Both the debt securities and interest rate derivatives portfolios are subject to price risk: the prices of the securities/contracts keep changing with market interest rates. Nevertheless, it will be useful to discuss some issues and finer points involved.

(a) *Accounting v/s Economic Risks*

(i) As we have seen in Chapter 15, the debt securities portfolio is separated between held-to-maturity (HTM), available for sale (AFS) and held-for-trading (HFT) segments. The securities in the HTM segment do not need to be marked-to-market except that the excess of book value (or holding rate) over par value will have to be written off on a straight-line basis over the balance life of the security, under the extant regulations. Since the amount is known, there is no uncertainty about the charge on the profit and loss account on this score. **The HTM portfolio therefore need not be identified as a risk, for the purposes of accounting**.

(ii) On the other hand, mark-to-market is merely an accounting recognition of the economic loss in the value of a security sustained through a rise in market rates. The economic loss is, in a way, an opportunity loss: having locked into an older, lower rate of return, the investor cannot now take advantage of the prevailing higher returns. Such **economic loss is sustained even on the HTM segment** of the debt securities portfolio.

(iii) The first issue to be considered for the purposes of risk identification is whether to identify merely the accounting risk on portfolios of debt securities (that is on the AFS and HFT segments alone), or the economic risks on the entire portfolio.

(b) *Spread Risks*

(i) Debt securities issued by non-sovereign issuers carry a premium over G-Sec yields representing the credit risk. The premium depends on the credit rating of the instrument, but the **spreads** between G-Sec yields and corporate bond yields in various rating categories, and for different maturities, **are not constant**. It is a function of the demand and supply for that type of instrument. Thus, there is a spread risk between G-Sec yield, AAA bonds, AA bonds, etc.

(ii) There is also a similar **spread risk in the prices of interest rate derivatives** like swaps and forward rate agreements, and the corresponding G-Secs. To that extent, there is a spread risk in the derivatives book as well. Since interest rate swaps should be priced to take account of credit risk on non-sovereign counterparties, on first principles, swap rates should be higher than G-Sec yields for corresponding maturities. This is the case in international markets but, in the Indian market, swap prices have often ruled below G-Sec yields. In any case, the spread between G-secs and swap rates keeps fluctuating.

(c) *Derivatives Contracts*

(i) Derivative contracts used to hedge the gaps in the asset: liabilities book are not subject to price risk so long as they continue to be effective hedges and are eligible for hedge accounting treatment, a topic discussed subsequently in Chapter 18.

(ii) Again, derivative contracts entered into on a fully back-to-back basis, to earn the pricing spread, strictly speaking do not face price risks. However, many banks include them in the trading book, and in the trading risk limit. The author believes that it will be useful to keep separate trading and hedging books, with the latter carrying no price risk except, in some cases, a basis risk. This point is discussed in more detail in paragraph 16.2.2.2. However, changes in the **market prices** of even fully back-to-back derivative transactions **have an implication for the credit risk**, a point discussed in paragraph 16.3 below.

(iii) The trading book in derivatives is of course subject to price risk: indeed, a trading book will not exist unless the investor is willing to deliberately take price risks in order to benefit from price movements.

16.2.2 Risk Measurement

There are essentially two recognized methods for measuring the price risk on a portfolio of fixed income securities—**price volatility** and **value at risk**.

The price volatility of a security depends on its modified duration and convexity as discussed in Chapter 13. From the price volatility of one security, the price volatility of a portfolio can also be readily calculated, and is a rough and ready measure of the price risk on the portfolio. The calculations are simple—multiplication of price volatility by a given change in yield and the full market value of the portfolio, provides a good estimate of the likely change in value. On the other hand, it suffers from several major weaknesses:

(a) Calculations of the change in value of a portfolio based on its price volatility number, would be reasonably accurate only if the assumed yield change is a **parallel shift of the yield curve**, i.e., yields increase by say 1% across all maturities. In practice, such parallel shifts of the yield curve are unlikely and, in general, yields move by different percentages for different maturities. In other words, one should expect that the shape of the yield curve will also alter. The effect of this on the market value of the portfolio cannot be readily estimated or measured using price volatility as a measure of the risk.

(b) The mathematics of calculating price volatility, implies that the percentage change is applied to the full market value (i.e. quoted price + accrued interest) of the portfolio. Current accounting practices do not require banks to maintain the book values of individual securities, even in segments subject to mark-to-market, at their market values. Again, the book value is at clean prices. Therefore, for risk measurement, management accounting and information purposes, it would be necessary for a separate computer file/spread sheet to be maintained to give the full market prices of the securities in the portfolio.

(c) One other limitation of using modified duration or volatility as a measure of the price risk is that it cannot make a distinction between liquid and illiquid securities.

(d) One also needs to make an assumption about the likely change in yield. This is a matter of judgment and, therefore, may not represent the actual changes.

Most banks active in trading of debt securities or derivatives **prefer to use VaR** to measure the risk. For one thing, it is not based on the (unrealistic) assumption of a parallel shift in the yield curve, as the duration measure presupposes. Nor does it require an assumption to be made about the change in yields. An equally important reason for preferring VaR is that it is a risk measure applicable across segments like currencies, commodities, equities, fixed interest and derivatives and, indeed, credit risks in the loan book. It therefore allows comparison of the risk adjusted return in different segments, helping more efficient allocation of capital across business lines.

16.2.2.1 Debt Securities

(a) If the objective is to measure economic, as distinct from accounting, risks, one needs to measure the risk on the HTM segment as well. Most banks would find it adequate to use modified duration for the purpose, rather than VaR. The targeted modified duration would need to take into account the totality of the asset liability book, and the desired duration gap.

(b) Again, inasmuch as the AFS portfolio is not very actively traded, the price risk on this segment could also be measured through **the modified duration of the portfolio**.

(c) On the other hand, as far as the trading portfolio (HFT) segment is concerned, it would be advisable to measure the risk through VaR or, its variant, the daily earnings at risk (DEAR) measure. Apart from a portfolio VaR for the HFT segment, it may be useful to impose stop loss limits on each individual security in the portfolio. The concept of stop loss is that if the price moves adversely to the extent of the stop loss limit, the investor must exit from that security.

(d) **Stop loss limits may not be useful as far as the AFS portfolio is concerned**. This is because merely selling one security and buying another may not really reduce the portfolio risk. Depending on what security has been purchased, the modified duration may even go up.

When the risk limit is hit, there are two alternative courses of action open. One is to alter the portfolio by selling some (riskier) securities and replacing them with others so as to bring the portfolio risk within the limit. Another is to hedge some of the exposures in the derivatives market, in order to reduce the portfolio risk.

16.2.2.2 Hedging the Price Risk

Active participants in the market often find it more efficient to use derivatives to reduce the risk rather than switching securities. This would work provided the derivative meets with hedge effectiveness criteria, a point discussed in Chapter 18. **The hedging instrument can be either exchange traded bond futures, or OTC interest rate swaps.** In India, a few interest futures contracts were introduced but there is no market as such. Therefore, the only way to hedge the price risk on a bond will be through an interest rate swap—

pay fix, receive floating. Inclusive of the hedge, the portfolio risk would come down and can be brought within the limit.

While the regulator has prescribed hedge effectiveness criteria for exchange traded derivatives, as of now, no such criteria have been laid down for OTC derivatives. For exchange traded derivatives, the criterion is that the ratio of price variation between the hedge and the hedged item should be between 80 to 125%. The same norm could be used for hedges in the OTC derivatives market as well.

In practice, it is difficult to find derivatives which exactly mirror the characteristics of the hedged item—maturity, coupon, etc. There is an added problem in the case of OTC swaps: while, in general, the prices of G-Secs and swaps will move in the same direction, the extent of change also depends on the changing spread between G-Sec yields and swap prices.

In the absence of a perfect hedge, the **notional principal of the derivative can be so fixed** that the absolute (as distinct from the percentage) change in its value is near to the change in the value of the hedged bond. For this purpose, hedgers calculate ratios of the PV01 (see paragraph 13.6.1) of the two, i.e., the derivative and the hedged item, and use it to determine the ratio of notional principal of the derivative to the face value of the hedged bond: the objective is that the price changes in the two should match closely.

16.2.2.3 Risk Measurement: Derivatives Book

For the purpose of measuring and managing the price risk, the author believes that it would be useful to maintain the derivatives portfolio in three parts:

- Balance sheet hedges;
- Customer contracts and their back-to-back hedges;
- The trading book.

We discuss some of the issues involved under each of the these categories.

(a) Balance sheet hedges: Derivative contracts in the form of balance sheet hedges would be undertaken in order to hedge the interest rate risk arising from the maturity mismatch in the asset: liability book, as part of asset: liability management. Such contracts may also be undertaken to hedge the fair value of an asset or liability. Such hedges could be either in the OTC market or on a futures exchange. There is no need to impose a price risk limit on the balance sheet hedges, or to mark them to market, so long as they continue to meet hedge effectiveness standards. This point is discussed in some detail in Chapter 18.

(b) Customer contracts:

(i) **It will be prudent if the customer book carries zero (or very limited) price risk**. This would be the case where every customer contract is hedged exactly back-to-back. In other words, the customer and hedge contracts will have exactly identical rights and obligations, except for the price. (The prices under the two contracts would obviously be different to provide for the bank's profit margin.) The hedges for customer contracts (or for asset: liability mismatches) could be with external counterparties. On the other hand, the bank may be running a book, or maintaining a position, in the particular derivative instrument and may prefer to hedge the customer deal in its own trading book, by treating such customer transactions as part of the trading book for the purpose of risk measurement and management.

(ii) The author, however, believes that it is more **prudent to segregate the customer contracts and their back-to-back hedges**, from the trading book. One reason for this is that the genesis of the two transactions is different—in the customer book, the objective is to earn a spread or margin as compared to the market price of the contract. On the other hand, the objective of a trading position is to profit from price movements. Again, separating the two segments (customer and trading books) facilitates separation of customer and trading profits and provides an audit trail between customer and hedge deals. It also helps monitor credit risks (see below).

(iii) Maintaining the hedging and trading book separately is simple if the hedge is with an external counterparty. If, however, the bank is running a trading book in that particular derivative, the **correct practice is to enter into an internal deal** between the customer transaction desk and the trading desk. This deal would be at the market price and ensure that the hedge book does not carry any market/price risk. The operational issues in respect of such internal deals are discussed in Chapter 17.

(iv) In (b)(i) above, a reference has been made to "zero (or very limited) price risk" in the customer book. The limited risk arises because **some derivatives cannot be perfectly hedged, and carry a basis risk,** for example, MIFOR swaps. In such cases, a limit should be placed on the basis risk, and a system put in place to monitor it. Such basis risk is an integral part of the customer book and should be tracked within it.

(c) The trading book: Risk measurement in the trading book should be done in the form of Value at Risk or its variant, the daily earnings at risk, as in the case of the held for trading segment of the debt securities portfolio.

(d) The RBI has imposed a limit of 0.25% of a bank's net worth, on the gross PV01 of all non-option derivatives.

16.2.3 Risk Control

16.2.3.1 Risk Limits

In general, under normal, that is positive, yield curve scenarios (longer the maturity higher the yield), an increase in yield comes only through holding of longer maturity/duration securities. But, longer duration securities, by definition, are exposed to higher price risks in the sense that a given change in yields affects the prices of longer duration securities more (in percentage terms), than the prices of shorter duration securities. If yields rise, the price fall would be higher in respect of longer duration securities: to be sure, they would also result into higher price gains if the yield falls. The question that needs to be analysed therefore is **what should be the optimum duration (or value at risk) of the portfolio** in order to balance, in a prudent fashion, the risk and rewards. While there are no "mathematical" answers to the question, some of the issues that need consideration are as follows:

- What is the bearable level of valuation loss on the portfolio?
- What is the time horizon?

The second question is somewhat easier to answer: the **time horizon could be the end of the accounting year, or the next 12 months on a rolling basis**. On the other hand, the first question does not permit an easy answer. However, there need be no two opinions about some of the considerations to be kept in view while trying to quantify an answer:

- The maximum loss should **not exceed a small percentage of normal operating profits**;
- This level would need to be such as does **not lead to either a rating downgrade** for the bank, or scare the depositors, or trigger a fall in the share price. This is a matter of judgment and also of the inherent, comparative financial strength of the bank.
- If the risk limit is through modified duration, not VaR, the change in yield that should be considered as a benchmark for this purpose should be decided at the beginning of a year at the highest levels of management/board: a specimen number would be say a 1% rise in

yields. This of course is an ad hoc number and would need to be fixed from expectations about interest rate changes over the next 12 months. **A careful evaluation of this number needs to be made, preferably at the board or investment committee level and a conscious decision arrived at**: if this means that one has to accept lower yields, so be it. Note that the benchmark for yield changes to be considered for deciding on the portfolio modified duration limit, need not be the same as used for the regulatory capital (see paragraph 16.4). It could even change from time to time depending on market conditions.

- One other point having a bearing on the subject is the **balance of the investment fluctuation reserve**, and the excess of book value over the current market value, of any of the securities in the portfolio. This is a cushion to be taken into account while fixing the risk limit, as these amounts limit the accounting loss.

16.2.3.2 Flexibility in Risk Limits

One issue in terms of fixing the market risk limit is how flexible it should be in relation to market conditions. In other words, should it be increased when there are expectations of a fall in yields? The answer depends on

- the Board/management attitude towards risk; and
- the confidence in forecasting interest rate scenarios.

As for building expectations about changes in yields, several important factors need to be kept in view. Some are discussed below:

(a) One important consideration would be the **shape of the yield curve —in other words, how much extra yield one is earning for how much extra price risk**. When the yield curve is relatively flat as it was in the Indian market in 2004 for example (yield difference of just ½% between 1- and 10-year yields), clearly the extra earnings by way of higher yields were a very meager compensation for the extra price risk. While it is difficult to specify a desirable ratio between the extra yield and the extra price risk, one would need to look at the issue from several perspectives:

   (i) The historical yield differences between say 1-, 5-, 10- and 15-year yields, and how these compare with current yield differences;

   (ii) For a given change in yields, say 1%, how long will it take for **the current extra yield** to compensate for the mark-to-market provision arising from that rise? As a rule of thumb, one should be cautious if the extra yield over the duration of a security does not compensate for the fall in value arising from a 1% change in yields;

(b) Careful weighing of the prospects for future interest rates in the light of

(i) **the existing "real" bond yields**, i.e. adjusted for current inflation, and how they compare with the historical numbers;

(ii) the **stance of monetary policy** and the future prospects for inflation;

(iii) The **current and expected liquidity situation** in the system having regard to demand for bank credit from the government and commercial sectors;

(iv) Conditions in the exchange market; etc.

Effective asset: Liability management requires a view to be taken on the future direction of interest rates in any case. It would be much better if this is done in a structured, conscious fashion taking into account the various factors likely to affect the level of interest rates as outlined above.

16.2.3.3 Derivatives Book

If, as argued in paragraph 16.2.2.2 above, the customer transactions are fully hedged on a back-to-back basis either through external or internal deals, the entire market risk in the derivatives book will be in the trading portfolio. Depending on the scale of activities, major players may like to have **record keeping done, and risk limits imposed, separately for each type of derivative being traded**. The advantage of doing so is that this will readily allow product-wise profitability to be estimated, and that too on a risk adjusted basis.

Each trading book in the derivatives segment should have a separate VaR or DEAR limit fixed. As we shall see later, since capital needs to be earmarked to back the trading book, it is obviously necessary to monitor that the returns provide an adequate return on the capital charge.

As an alternative to the Value at Risk, or, if so desired, in addition to it, the PV 01 of the derivatives portfolio can be used to monitor the risk. The trading book in each product segment could be subjected to a PV 01 limit, as also aggregate for the derivatives trading book as a whole. (It will be recalled that PV 01 is an estimate of the likely change in the value of the portfolio in the event of a 0.01% change in the yields or swap prices or spot rates.)

16.2.3.4 Internal Controls

Once price risk limits have been decided, there has to be in place a proper internal **control system to monitor that these limits are being adhered to**, and any infractions reported promptly for appropriate action. Actively trading banks find it useful to set up an **independent middle (or risk) office to track the magnitude of market risk** on a real time basis. It is the responsibility of the middle office to not only monitor but to report, through suitable management information systems, the extent of market risk faced by the bank. Just as any breaches of limits should be immediately reported and acted upon, it will also be useful if any **positive numbers exceeding the daily earnings at risk limits, are also enquired into**, particularly if such days of high profitability occur with a frequency much greater than the confidence level (95% or 99%) used for calculating the DEAR number: since the methodology underlying such calculations is based on the assumption of log-normality, in other words, symmetrical distribution around the mean, occurrences of large profits or losses should have similar frequencies. Therefore, even large profits accruing with greater frequency could well be a symptom/pointer to the possibility that, in point of fact, the **actual risk being run is more than the number that is being reported**: in principle, there can be no large profits without large risks!

The monitoring of market risk needs to be undertaken not only on the aggregate, or portfolio, level, but also in terms of the observance of stop loss on individual trading positions, if such a system is part of the price risk management.

The middle office should clearly be independent of the treasury, and report to the head, risk, or the CFO etc. as per the organization structure. In fact, active banks may expand the **role of the middle or risk function for developing or vetting the models used,** continuously refine the risk measurement models, subject them to back and stress testing periodically, and act as a resource for the entire trading activity but without any actual profit responsibility. The daily risk report emanating from the middle/risk office to the top management should not merely be a numerical statement but should contain qualitative comments on the change in valuation, the factors which have led to the positive or negative change, scenario analysis etc. Since the daily risk report would be circulated to non-specialist senior management, it is advisable that it is written and communicated in a simple, non-jargonised fashion.

16.3 Credit Risk Management

We proceed to look at some of the issues in the management of credit risk in debt securities and derivatives separately. As far as debt securities are concerned there are no credit risks on G-Secs. However, other debt securities, for example corporate bonds and debentures, state government guaranteed bonds, etc., do carry credit risks. Again, all derivatives transactions in the over-the-counter market are subject to counterparty credit risks. There are also settlement risks unless settlement of trades is being done through a clearing corporation or other similar entity.

16.3.1 Credit Risk on State Government Securities

While there have been no defaults on the so-called state development loans included in the SLR portfolio, state governments have defaulted on other obligations, for example, guaranteed bonds. In fact, in the author's view, since state development loans carry a premium over G-Sec yields, they also carry some credit risk. (Else, why the extra yield?) Some state governments and state-government backed bonds have credit ratings, and these are a pointer to the risks. But, overall, assessing state government credit risks is a difficult proposition, and it would be prudent to **limit the exposure to state government securities to a small proportion of the investment portfolio, and spread it over several issuers**. Investment policy should prescribe norms on the subject.

16.3.2 Credit Risk on Other Debt Securities

In general, most such securities would carry a credit rating from an independent rating company. The premium over G-sec yields which such bonds pay is crucially dependent on the credit rating. Generally, banks would do their own credit assessment rather than relying completely on external rating. While credit assessment is outside the scope of the book, one **difference between a loan risk and a bond risk** should be noted. If the issuer is the same, or has the same rating, in principle, the credit risk and, therefore, pricing, would be similar. However, under the capital adequacy norms, the capital charge for the two is not identical. For a loan, there is a capital charge for the credit risk, but for a bond there is not only a capital charge for the credit risk ("specific risk"), but, as we shall see in the subsequent paragraph, a capital charge for the market risk as well. In other words therefore, the **capital charge on a bond is higher than on an equivalent loan**. Therefore, the question of adequate return on equity is of even greater importance in respect of non-SLR investments in debt securities. The difference between the YTM and the transfer price on funds, should provide an adequate return on the capital. For properly monitoring this issue, the investor needs to have well formulated, rational and quantified methodologies for calculating the funds transfer price and the cost of equity. **Unless the return on capital is higher than the cost of equity,** there is no economic justification for such investments.

However, if the intermediary's capital is not under pressure, such investment decisions are often taken on the basis of marginal yields as distinct from providing an adequate return on capital.

16.3.3 Credit Risk on Derivative Contracts: Swaps/FRAs

In paragraph 12.7, we have discussed the counterparty credit exposures inherent in over the counter swap contracts. In principle, there are two ways of measuring such exposures: the **initial exposure method, and the current exposure method**. Under the first one, the credit exposure is calculated by multiplying the notional principal by a conversion factor (0.5% for instruments with a maturity of less than one year and an additional 1% p.a. for longer maturities). This remains unchanged through the life of the contract.

The second method, namely the current exposure method, starts with the mark-to-market value of the contract and adds to it a factor representing the potential future exposure (PFE) measured through either the conversion factor **for the balance maturity**, or based on the volatility of the price of that contract: the latter is the counterpart of VaR for measuring credit risks. The first part, namely the mark-to-market value, is considered only when the contract is in-the-money for the bank and would involve recovery of moneys from the counterparty if it is to be unwound. On the other hand, if the contract is in the money for the counterparty, the mark-to-market valuation is ignored. In that case, only the PFE is the credit exposure.

Depending on the credit rating and operational convenience, banks may impose an aggregate credit limit for derivatives on a counterparty, or look at each transaction individually. In either case, the **exposure becomes part of the total risk exposure** on the counterparty. A system needs to be in place for monitoring the credit risk on derivatives like any other credit risk on the customer. Some banks also impose credit covenants in the documentation with the corporate counterparty.

16.3.4 Complex Derivatives

Sometimes, banks offer to customers complex derivatives on fully back-to-back basis which they are unable to price themselves. In such cases, they have necessarily to depend on the counterparty bank for periodic valuations. While such transactions may have no price risk, they do carry a credit risk. Given the complexity, it is prudent to monitor credit risks in such transactions by the current exposure method and **make arrangements with the counterparty bank for advising mark-to-market valuations periodically and promptly.**

16.3.5 Settlement Risk

Settlement risk arises whenever there is a time gap between the delivery of the two assets involved in a trade. It came in sharp focus in the foreign exchange market in 1974 in the Herstatt case: the German authorities suspended the operations of the bank at the end of German trading hours, after the DEM leg of USD: DEM trades involving the bank were executed, but before the USD leg could be settled during New York trading hours. Counterparty banks due to receive dollars from Herstatt suffered heavy losses.

In principle, the same situation can arise in the purchase of a debt security in the secondary market, if rupees are paid out before the security is delivered, i.e., if the DvP, delivery vs payment, system is not being observed. In the case of OTC derivatives, interest rate swaps for example, the problem is not so serious as only the net amount is paid by one counterparty to the other. (OTC derivatives of course suffer from counterparty credit risk in general, as discussed in the previous paragraph.)

Settlement risk does not exist in the case of trades settled through a clearing house. This is because the clearing house, once it accepts a trade for settlement, steps in between the buyer and the seller, guaranteeing the performance of both. (Pre-settlement and settlement counterparty risks are also absent when trading on exchanges.) In the Indian market at present, while all interbank G-Sec trades are settled through the Clearing Corporation of India Ltd. (CCIL), trades in other debt securities are settled bilaterally.

In principle, exchanges and clearing houses the world over follow similar systems to manage the counterparty risks which they are exposed to. The **system of margins is at the heart of hedging the counterparty risk**. The system has worked so well that there have been hardly any cases of losses being suffered because of counterparty failures in exchange trading. The system was perhaps tested most severely at the time of the collapse of Barings, when it suffered huge losses on its positions on the Singapore Exchange (SIMEX), and went insolvent. No counterparty suffered, and all trades were honoured.

In general, the margin is operated through the clearing house, which settles the trades. **Clearing companies often have a 3-tier margin system:**

- Between a buyer/seller and his broker (for instance, purchase of equities on an exchange);
- Between the broker and a member of the clearing house (if the broker himself is not a member of the clearing house); and
- Between clearing house members and the clearing house.

As for the first tier, the margin requirements can be higher, but in any case not lower, than the margins imposed by the clearing house on its members. Margin moneys can earn interest and/or are provided in the form of government paper.

Again, margins are generally of three types:

- The initial margin is prescribed by the exchange/clearing house for each contract traded. It can be as low as 0.5% of the amount of the contract or as high as 20% or more. The initial margin depends on the volatility of the price of the contract in question; the higher the volatility, the higher will be the margin.
- The maintenance margin, typically, say, 75% of the initial margin, is the amount that must remain deposited, when the initial margin amount falls because of adverse movement in the price of the contract (see below). When the initial margin falls below the maintenance margin, additional margin moneys have to be deposited to restore the initial level.
- The outstanding contracts are "marked to market" at the settlement, or closing, price of the contract each day, and the difference debited/credited to the initial margin account. To give an example, if 'A' has a long position in a contract and the price falls, the difference will be recovered from the initial margin. 'A' will have to deposit additional margin if, after such a debit, the margin falls below the prescribed maintenance margin. If he fails to do so, the contract will be liquidated.

While this is the general way in which the margin system operates, there are variations in the rules and practices of different exchanges and clearing houses on issues such as:

- The way margins can be deposited, i.e., in cash or collateral;
- Whether margins are to be paid on gross positions (long plus short) or only on the net position in each contract;
- Margins on intra-day transactions;
- When actual margin held exceeds the initial margin through a favourable movement in the price of the contract, whether the excess can be refunded, or must be retained; etc.

Again, most exchanges have the right to call for "advance margins" intra-day in the event of unusual price volatility. Such advance margins are adjusted against the end-of-the-day variation margin. There are also limits on intra-day price movements of each contract traded. When the limit is reached, trading in the contract is suspended.

The objective of the elaborate margin system is to ensure that the clearing house vis-à-vis every member (and broker vis-à-vis his client) always has enough margin money to honour all outstanding contracts at the settlement, or end-of-the-day price.

16.4 Economic Capital and Connected Issues

Capital, or equity, in a business is what stands between the value of its assets, and the business' ability to meet its liabilities. For financial intermediaries like banks, the value of assets can be impaired because of the credit/market/operations risks faced in conducting the business. Economic capital is the level of capital needed to enable the enterprise to absorb the potential losses inherent in the business, without impairing its ability to honour its liabilities. As will be readily seen, at the heart of calculating economic capital is the ability to measure the risks. On the other hand, regulatory capital is the capital charge prescribed by regulators for different businesses: we look at the current regulatory prescription in the paragraph 16.5.

While earlier the distinction between economic and regulatory capital was material, in recent decades, in particular with the initiatives taken by the Basle Committee, there has been a **conscious effort to bring regulatory capital increasingly in alignment with economic capital**. The amendment to the Basle I capital accord to incorporate market risks is one example of this: the regulatory capital is based on the market risk faced by the portfolio, as measured by the value at risk. Similarly, Basle II aims at varying the capital charge relating to the credit risk, based upon the actual credit risk of a portfolio as calculated by the probability of default, loss given default, etc. of all the credit exposures in the portfolio.

While the two are coming nearer, management needs to take a **conscious decision whether it would use its own models for calculating economic capital for different business segments**, —or use regulatory norms. A quantification of capital in different business is essential to

- Measure returns;
- Prescribe hurdle rates for the return on equity; and
- Allocate capital to different business segments.

To quote from an article by Hans Blommstein in a Financial Times supplement, "Mastering Risk",

- *"An important recent development in risk management has been the adoption of economic capital models. Broadly speaking, these seek to assess the amount of capital needed to support business activities and absorb potential losses related to the different sources of risk that a company faces."*
- *"The central challenge for banks and other types of businesses is to determine whether they have the right balance between capital, returns and risk by measuring performance on a risk-adjusted basis. One of the key measures that enables them to do this is risk-adjusted return on capital (Raroc), which is calculated by relating risk-adjusted return to risk-adjusted, or economic, capital."*
- *"Over time, the competitive edge of economic capital models is eroded because they became more widely available. Today's competitive advantage lies in the successful integration of economic capital information into decision-making processes at all management levels. This sophisticated approach not only gives precise risk-adjusted information about pricing but also about the profitability of business lines and investment decisions."*

16.4.1 The Cost of or Return on Capital

Clearly, at least in principle, a **bank should not be engaging in any business unless the return on equity or economic capital is more than its cost** or the desired or targeted return on capital. Two approaches are possible:

- One based on the capital asset pricing model (CAPM); or
- An absolute number

The CAPM approach is based on the following concepts:

(a) the risk free rate (the on-going yield on say 10 year maturity government paper);

(b) Market risk premium, which is the difference between the long-term return on a portfolio of equities, as represented by a broad share market index, and the risk-free return. The market return takes into account both the dividend, assumed to be reinvested in the same stock at the price ruling, and the capital appreciation.

(c) The 'Beta' of the particular share. This is a measure of the risk in that particular share, relative to that of the market as a whole, as measured by the co-variance of the return on the specific share with the market return.

On the basis of the CAPM concepts and methodology, the desired return on equity should be

$$= R(f) + \{[R(m)] - R(f)\} \times \beta(i)$$

Where $R(f)$ is the risk free rate;

$R(m)$ is the return on the market portfolio;

$R(i)$ is the return on company/industry shares;

$\beta(i)$ is Cov $(R(i), R(m))/(\sigma^2(R(m))$;

and $\sigma^2(R(m))$ is the variance of market return.

(Those interested in getting a better understanding of the concepts and mathematics involved may like to refer to a standard work like William Sharpe's "Portfolio Theory and Capital Markets".)

While the CAPM-based model for the desired return on equity may be more "scientific", it is also complex and the number changes with market conditions. In practice, therefore, **most banks target a number, or a range, based on the CAPM principles, but not strictly determined by them**. Such targeted returns would also take into account the competitor/industry returns. The return on equity for a given business segment is calculated by dividing the net profit of that business segment by the economic capital allocated to it.

16.5 Capital Charge: Regulatory Prescription

It should be noted that the following discussion of the topic is based on the regulations in force in mid-2006 for scheduled banks; may not be complete in all details; and is subject to change from time to time. It should not therefore be considered definitive.

16.5.1 Market Risk in Debt Securities

The charge is in two parts:

- "Specific risk" on each security, which really is charge for the credit risk with the actual amount depending on the issuer. It is zero for G-Secs and currently 9% for corporate bonds.

- "General market risk" on debt securities held in the HFT and AFS categories. The amount is based on the modified duration of each security and stipulated changes in yield. The latter is 1% for shorter duration securities, going down to 0.6% for the longest duration: the assumption obviously is that yield variations are higher at the short end as compared to the longer dated securities.

16.5.2 Market Risk in Derivatives

Interest rate derivatives "in the trading book and derivatives entered into for hedging trading book exposures" are also subject to a capital charge for general market risk. Interest rate derivatives include interest futures, FRAs and swaps. The prescribed procedure is complex and involved, and provides for "horizontal" and "vertical" disallowances to take care of basis risks. Again, each interest rate derivative will be considered as a portfolio of two securities for the purposes of calculating the maturities in different time buckets. For example, an interest rate swap (say, pay floating, receive fixed) would be considered as issuance of a floating rate bond and investment in a fixed rate bond. The modified durations of the two legs can now be readily calculated.

A specific charge is currently applicable on interest rate futures or forward contracts on corporate securities.

16.5.3 Investment Fluctuation Reserve (IFR)

While it is beyond the scope of this book to go into details of calculation of tier 1 and tier 2 capital for the purposes of capital adequacy, the position regarding IFR is being touched upon since it is linked directly to the investment portfolio.

In 2002, the RBI advised scheduled banks to create an Investment Fluctuation Reserve (IFR) equal to 5% of the investments in the "Held for Trading (HFT)" and "Available for Sale (AFS)" categories, by March 2006.

IFR is treated as tier 2 capital but, where a bank has complied with capital adequacy norm for both the AFS and HFT, portfolios, the balance of IFR in excess of 5% can be transferred to strategic reserves, and becomes eligible for tier 1 status.

16.5.4 Capital Charge on Corporate Debt Securities

While loans to corporate clients are subject only to the capital charge on credit risk, a debt security is subject to both specific and general market risk capital charge: in other words, for the same borrower, the charge is higher on a bond as compared to a loan. An implication of this regulatory prescription is that, for identical maturities, **coupon on a bond should be higher than the interest rate on a loan (same borrower), if the desired return on equity target is to be met.**

Chapter 17

Operational Risk

17.1 Introduction

Operational risk has been defined by the Basel Committee on Banking Supervision as "the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This definition includes legal risk, but excludes strategic and reputational risk". The exclusion of reputational risk from the definition is somewhat odd as reputations get damaged from disputes with counterparties, leading to legal proceedings and, to that extent, it is an integral part of legal risk. The Basle Committee has prescribed capital charges for operational risk, and suggested methodology for measuring it.

In general, while the topic of price risk and its management receives more attention, it is as well to note that banks and other players have suffered far bigger losses through mismanagement of the operational risk, than in cases involving price risk. Some of the cases of large losses which could have been averted by proper management of the operational risk, are summarized later in this chapter. For us in India, the securities scam of 1992 is a classic example of what happens when internal controls on operations are lacking and mal-practices are allowed to creep in and continue. Since this was a seminal event in the history of India's bond market, it is summarized in Annexure 17.1.

17.1.1 Important Operational Risks

For the purposes of this book we identify the following as the important issues in management of operational risk:

(a) Internal fraud: intentional misreporting of positions;

(b) Clients, products and business practices: fiduciary breaches, sale of unauthorized products;
(c) Execution, delivery and process management: data entry errors, incomplete legal documentation, etc.

17.1.2 Scheme of the Chapter

In paragraph 17.2, we discuss the importance of documentation of procedures. Paragraph 17.3 discusses identification and assessment of operational risks, while paragraph 17.4 deals with issues in monitoring and control of risks. We then go on to discuss some other connected issues (paragraph 17.5) and summarize some actual cases leading to large losses, which would have been preventable with proper internal controls (paragraph 17.6).

17.2 Documentation of Policies and Procedures

The author's experience as a consultant evidences that, in many Indian banks, a proper treasury policy manual often does not exist. The importance of such a manual in order to manage risks prudently cannot be over-emphasized. The manual should inter alia cover the following points:

(a) Treasury policy, products to be dealt in, the basis on which each product will be used (back-to-back basis, running a book, trading, etc.), product papers on individual products, valuation methodologies, regulatory and appropriateness issues;
(b) Treasury functions organization—front office, mid/risk office and back office and settlements; the duties and responsibilities of each, segregation of functions and reporting channels;
(c) Procedures including for deal making, deal entry, access to IT systems, deal modifications and amendments, accounting entries, etc.;
(d) Procedure for making changes in the file/folder structure or other parameters of the IT system in use;
(e) Price and credit risk management—limits, monitoring responsibilities, MIS and regulatory reports, etc.;
(f) Procedures for measuring desk-wise profitability and use of funds;
(g) Procedure for amendment of the manual, the responsibility for maintaining and updating it, etc.

A detailed manual including coverage of the points mentioned above, is particularly useful given that there are frequent changes of personnel. It also leads to clarity of duties and responsibilities of each desk in the treasury and what is expected from it. The internal or concurrent audit function would do the auditing in relation to the manual, simultaneously reviewing the adequacy and efficacy of the control system.

17.3 Identification and Assessment

While many of the routines of the internal control system are mundane and procedural in nature, their importance cannot be over-emphasised. In many ways, if the front office has primary responsibility for revenue, and can be compared to the accelerator of a car, the internal control system acts more like a brake: to continue the analogy, no car can run safely without an accelerator and a brake, both equally strong and effective. A culture which over-emphasises revenue and does not take breaches of the internal control system with adequate seriousness, can lead to major losses as several cases evidence. The existence of a proper control culture and accountability for any shortfalls in observance of internal control procedures, are important, and senior managements/boards have a duty to inculcate these in the organisation.

Quite often, control systems that function well for a given set of products, sometimes fail to be effective when new products and activities are introduced, or when significant changes occur in business conditions and environment. There needs to be a procedure for introduction of new products, including the identification and assessment of various risks, the control systems needed, etc. Banks needs to ensure that before new products, activities, processes or systems are introduced the market, credit and operational risks are clearly identified and assessed, documented and suitable controls put in place.

Segregation of duties and reporting channels, independent verification of prices in real time, deal confirmations, reconciliations, etc. are important as their absence can be very costly. After studying a number of cases of banks suffering losses because of inadequate internal control of operational risks, the author finds a common theme running through many of them. Losses are incurred in the ordinary course of trading; the dealer tries to hide them in the hope of recovering the losses in subsequent trading; and the weakness in internal control systems allows the dealer to do so. In hardly any cases have dealers undertaken fraudulent actions to benefit personally; in most cases, such actions were aimed at hiding losses. Ultimately, the losses surface when they become too large to be hidden, or there is a change of personnel.

This sequence emphasizes the need for a corporate culture which accepts that trading losses will occur; that they are, indeed, an integral part of the risks inherent in trading. Dealers should not be working in an atmosphere where losses are frowned upon; enquiries/actions are called for only if control systems, stop loss levels for example, are deliberately breached, and not in respect of losses in the ordinary course of trading.

One area in which adequate procedures need to be in place, is product appropriateness norms for derivatives, in relation to client sophistication. Sale of inappropriate products, particularly to clients in whose case the bank may have a fiduciary responsibility, can be very risky: this is all the more so in the case of complex derivatives, and a bank needs to have a transaction appropriateness policy in place. Inappropriate transactions not only carry a reputation risk but also a risk of losses for compensating clients.

17.4 Monitoring and Control

The need for a treasury manual containing formal, written policies and procedures has already been referred to above. A system of effective internal controls alone can ensure that the bank is in compliance with not only external laws and regulations but also internal policies, rules and procedures. Such a system requires not only segregation of duties and personnel, but the availability of information/data to all the concerned personnel to enable them to fulfill their responsibilities properly. For instance, independent verification of dealt prices would require the personnel responsible for price verification to have independent, real time access to the information system.

Some of the features of the internal control system, some peculiar to conditions in India, include the following:

(a) Regulations for "ready forward contracts", i.e. repo transactions;

(b) Regulations for use of bank receipts;

(c) Separation of own account trades and transactions on behalf of customers;

(d) Internal controls like:

  (i) Functional separation of trading; settlement, monitoring and control; and accounting;

  (ii) Proper recording of SGL forms and bank receipts, reconciliation of holdings with SGL accounts at the RBI's public debt office;

  (iii) Proper distribution of business with different brokers, etc.

The Reserve Bank has issued detailed guidelines on internal controls on operational risk. Various papers from the Bank for International Settlements are also very useful. All these are available on the respective websites.

17.5 Some Other Issues

A few other points, often not adequately emphasized are as follows:

(a) Monitoring of cash used in trading activities. While deals, positions and reports can be manipulated to hide losses, there is no way to hide the need for cash to meet the losses. In the normal course, the need for cash would have some relation to the value-at-risk limits on trading portfolios. Therefore, accounting systems to monitor use of cash is a very useful part of the overall internal control system. As we will see latter, if Barings and the Allied Irish Bank had monitored the use of cash, they would have been saved of huge losses.

(b) Another equally important point is the training of staff in the mid/back office and internal audit. Very often, while front office dealers get adequate training opportunities, very little training is imparted to the other personnel. They too need to be properly trained so that they are in a position to perform their functions properly.

(c) An equally important point is the need to question unusually large profit, for instance well in excess of the value at risk. By definition, large profits cannot be earned without taking large risks and are a prima facie evidence of the possibility of larger risk exposures being actually and unauthorisedly taken, which are not reflected in the VAR number.

17.5.1 Internal Deals

Sometimes, the derivatives contract structuring desk in a bank treasury, responsible for structuring customer transactions, enters into internal deals with the appropriate trading desks within the treasury, for hedging customer contracts. This ensures that the customer book does not carry any price or market risk. While internal deals do not lead to any actual exchange of cash flows, from an accounting and control perspective, it is advisable to adopt the following procedure for booking and follow up of internal deals:

(a) the price should be agreed, and the deal accepted, by both the dealers. This may be done either by both the dealers signing the deal ticket, or, post facto, by the dealers scrutinising and signing a system generated desk-wise report of all internal deals;

(b) (i) There should be a one to one relationship in the internal deals between the sales book/folder and the trading book/folder(s). In other words, one internal deal should not cover more than one customer deal.

(ii) There can however be more than one internal deals with different trading desks, to cover one customer deal.

(c) (i) The actions taken on maturing/cancelled internal deals need to be rigorously verified as part of the internal controls. This should be done by actual scrutiny of maturing internal deals on an on-going, daily basis. For this purpose, internal deals should also be listed in the list of maturing transactions.

(ii) Notional cash flows from internal deals need to be attributed to the appropriate sales or trading desk as the case may be, so that desk-wise profitability can be properly calculated for MIS purposes (see next paragraph).

17.5.2 Maintenance of Mirror Accounts

All exchanges of cash flows arising from derivative contracts pass through either the customer's account with the bank and/or the bank's nostro account with another bank. Banks maintain a mirror account in their own books to record the entries in the nostro account, and periodically reconcile the two.

It may be useful to keep each mirror account in different segments corresponding to the profit centres within the treasury. This will facilitate the tracking of internal deals and calculation of desk-wise profitability after accounting for funds cost.

17.5.3 Separation of Trading and Customer Contract Books

This point is discussed in paragraph 18.5.

17.6 Cases

As stated earlier, banks and other participants in the securities and derivatives market have suffered large losses through weak internal controls. Perhaps the largest loss in the trading of debt securities was sustained by the New York branch of Japan's Daiwa Bank. When the loss was discovered, it had been continuing for 11 years and ultimately totalled \$ 1.1 bn, i.e., an average of \$ 400,000 per working day! And, it was not detected by any internal or statutory audits, or central bank inspections: it came to light only when the trader, who had fraudulently hidden the losses, confessed to them on his own.

To summarise the case, the trader started incurring losses in the ordinary course of trading. Instead of reporting them, he started meeting them initially by selling securities from the bank's own portfolio and later by selling securities from the constituents' holdings. He could keep the unauthorized and fraudulent sales hidden because he was himself in charge of functions like settlements, reconciliation of accounts—both nostro and securities custody accounts—etc. He was getting unsigned, computerized statements of holdings from the custodian; these were being replaced by fraudulent statements showing an altogether different picture, hiding the sales made to finance losses. The case clearly underscores the paramount importance of functional separation of trading and settlements/accounting/reconciliation.

Barings Bank's Singapore subsidiary lost huge sums of money in what was supposed to be arbitrage between the Osaka and Singapore exchanges on the price of the Nikkei Index Futures Contract. Once again, the losses could be hidden until they reached gigantic proportions, because the trader himself was in charge of back office functions. The Barings management in London came in for a lot of criticism, also because hundreds of millions of pounds were remitted to Singapore, as demanded, without any inquiries. The losses could have been stopped much earlier, and the bank avoided the ignominy of being sold for pound one, if there was some control over the cash used by the Singapore subsidiary.

The case of the US subsidiary of the Allied Irish Bank, also illustrates several weaknesses in internal control systems:

(a) Lack of control on confirmation of contracts with/from counterparties;
(b) Ignorance of back office personnel about the basics of options pricing, which allowed the trader to get away with fraudulent option deals he entered in the trading book; and
(c) Once again, lack of control on cash. The trading desk used hundreds of millions of dollars of funding, when its value at risk limit was barely $ 1.5 mn, without questions being raised.

17.7 Measuring Operational Risk

The capital adequacy norms under the Basle II guidelines have prescribed a capital ratio for operational risk. This is the first time that regulators are seeking to impose a specific capital charge for operational risk.

One major issue in relation to the capital charge is how to measure operational risk. While there is no consensus on the subject amongst academics and regulators, Basle II envisages three different approaches.

- The **Basic Indicator Approach** (BIA) is a relatively simple method. It uses 15% of the average gross revenue over the previous 3 years, for arriving at the capital charge. This approach is also expected to be used in India.
- The **Standardized Approach** (SA) is a amore sophisticated version of BIA. It recognizes that operational risks would vary not only with the gross revenue of the bank, but also within different business segments. The Basle Committee has identified 8 business segments for this purpose and prescribed the *beta,* or multiplicant, for each. The multiplicant is taken into account to calculate the capital charge for each business segment and then aggregated for the bank as a whole.
- The **Advanced Measurement Approach (AMA)** is the most complex and sophisticated methodology of the three, using the probability distribution of operational losses and calculating the expected loss at a given level of confidence: in other words, AMA applies to the measurement of operational risk a conceptual framework similar to that used for measuring market risk. Within AMA itself, different methodologies are used, in isolation or in different combinations. One problem common to all is the question of data availability for different business segments and combinations.

Annexure 17.1 The Securities SCAM–1992

17.1 Background

Many of the now customary, and indeed mandatory, internal controls on securities transactions have been the direct fallout of a scandal which hit the market back in 1992: the securities scam. As such, it will be useful to recount here, in brief, what the scam was, its background, and the system weaknesses it exposed.

17.2 Securities Market Before the Scam

17.2.1 Hardly any securities were issued by the central government prior to the second world war. The volume started growing, albeit gradually, in the 1950s and more issuers like the state governments also entered the market. Brokers were initially operating only in the primary market, i.e., for marketing the securities to purchasers at the time of their initial issue.

17.2.2 By the early 1980s, the principal securities in the market consisted of:

(a) Central government securities issued by the central government to finance its budget deficit.

(b) State government securities, similar to (a) but issued by state governments.

(c) Bonds of financial institutions engaged in giving long term loans to industry, and public sector undertakings, guaranteed by the central government. Public Sector Undertakings, or "PSUs" were limited companies registered under the Companies Act, or corporations with limited liability established by special statutes, the majority or all shares thereof being held by the central government.

(d) Bonds of state government undertakings (similar to PSUs, but with shareholdings with the state governments), guaranteed by state governments.

17.2.3 Interest rates on all these securities were fixed by the Reserve Bank of India (RBI). These were kept well below the rates at which investors would have voluntarily bought the securities (i.e. "market rates"), in order to keep the cost of borrowing for the government low. The result was that the only buyers of such securities were the captive market consisting of:

(a) Commercial banks for their reserve requirements.

(b) Life and general insurance companies which were required to hold the bulk of their investments in such securities.

(c) Provident funds, both company specific and central, which also were required to hold specified percentages of their assets in central and state government or government guaranteed securities. Public trusts were also investors in such securities.

17.2.4 Given regulated, below market coupons, and that the investment portfolios of these entities were valued at cost (and not market rates) there were not many transactions in the secondary market. What there were, consisted of deals to optimise the maturity patterns of the portfolios in accordance with individual bank's investment policies. Foreign banks, for example, preferred shorter maturities; Indian banks did not mind longer dated securities to benefit from higher coupons. Again, a few foreign banks were also keeping a small trading portfolio. However, the market lacked depth and there were no regular, transparent price quotations. Most investments were held by the investor to maturity. A few repo transactions or "ready forwards" also used to take place.

17.2.5 The holdings of government securities were not in the form of physical scrip but through entries in the Subsidiary General Ledgers (SGL) maintained by the Public Debt Offices of the Reserve Bank of India. For the admittedly few transactions in the secondary market, the seller would receive the price and hand over to the buyer an SGL transfer form to be lodged with RBI. The SGL accounts were maintained security-wise with the result that a bank's total holdings across all securities were not readily available at one place. Again, there was no system of sending debit/credit advices for transactions in SGL accounts, or balance confirmations or regular statements. These weaknesses did not matter very much when, as stated above, transactions were few.

17.3 Developments in the 1980s

There occurred several major changes in the traditional structure, instruments, and players in the market in the second half of the 1980s.

17.3.1 PSU Bonds

A. Some public sector undertakings started issuing large amounts of bonds in the capital market as the fiscal support to their resources needs started coming down. Some of these were not guaranteed by the central government, and were not SLR securities. If the bond issues were to succeed, some liquidity, at least short term, had to be created since there was no active secondary market for trading the bonds. In the second half of the decade, such bond issues aggregated around Rs 200 bn.

B. Commercial banks were permitted for the first time to form "merchant banking" subsidiaries. Their activities included managing equity and bond issues, floatation of mutual funds, dealing in the short term corporate funds market, etc. These merchant banking subsidiaries were far less regulated and supervised than the commercial banking system. For the first time, commercial banks had an opportunity to overcome the rigidity of the regulated interest rate structure on their deposits and advances through these entities. These subsidiaries managed PSU bond issues, and often subscribed to them themselves, or through their mutual funds or parent banks.

C. There were often long delays of a year or two between bond issues and the availability of the physical scrip. Such PSU bonds were not part of the RBI's SGL system. In the interim the issuer would send letters of allotment to the buyers of the bond issue. These were generally for the bulk amounts subscribed to by institutional investors. If, before receipt of the physical scrip, and for an amount lower than the letter of allotment, a repo or sale transaction had to be done, there was no satisfactory way of handling it. This was the genuine reason for the birth of an instrument called "bank receipts" or BRs. In substance a BR evidences that the seller was holding in trust for the buyer the required amount of bonds (or other securities) until completion of the second leg of the transaction, or physical delivery of the scrip, as the case may be.

D. The bonds were issued in two forms—taxable, and tax free—obviously at different coupons. The former broadly represented market interest rates and the latter had lower coupons to compensate for the tax benefit.

17.3.2 Portfolio Management Schemes

A. The PSUs issuing bonds had surplus funds until they could be used. Some other public organisations—the Oil Industry Development Board, for example—were also flush with temporarily surplus rupee resources. Again, the late 1980s and early 1990s witnessed some PSUs raising foreign currency loans and selling the proceeds to the central bank for rupees. In some cases, such borrowing programmes by PSUs did not represent their corporate needs but were undertaken to finance mounting external deficits in the country's balance of payments. In effect sovereign loans were disguised as corporate borrowings in the external commercial market. The FX resources were surrendered to the central bank for rupees, adding to the country's reserves.

B. Such PSUs, having sold the foreign exchange for rupees, were facing a serious exchange risk at a time when the rupee was being depreciated. Traditional deployment of such surplus rupees in say bank deposits was not yielding enough returns to pay the interest on the foreign currency loans and to take care of the exchange risk. This was because the regulated bank interest rates were low. PSUs otherwise possessing surplus rupees also found bank interest rates unattractive. All these entities therefore were keenly interested in increasing the yields on their surplus rupee resources. Several banks and some merchant banking subsidiaries floated different types of portfolio management schemes under which the surplus rupees could earn higher returns through investment of surplus rupees in the securities and capital markets. Such schemes were termed as "portfolio management schemes" in which the portfolio manager, i.e., the bank, would advise about what investments to make, arrange to make the investments on the client's behalf, and charge a fee for the service. Such portfolios were not therefore part of the managing bank's balance sheet, but they did earn income in terms of the fees received.

17.3.3 US 64

Yet another instrument which was traded the market during the period was the units of the Unit Scheme 1964 (US 64) managed by the Unit Trust of India. US 64 was initially meant for the small individual investor who also got certain tax concessions on the dividend income from his holdings in US 64. US 64 was an open ended scheme with UTI announcing periodically its sale and repurchase prices. US 64's book-closure was 31st May. The pattern of UTI's sale/purchase prices therefore was that they would keep increasing from say June to May and drop after dividend declaration.

While initially meant for the individual investor, US 64 received a big boost in the 1980s when a tax law change allowed the dividend to be tax-free in the hands of corporates or banks investing in the units. Since the dividend yield was around the same level as market interest rates, this was a bonanza for the corporate world. While the interest cost of funds used to buy units in US 64 was tax deductible (so long as no direct nexus could be established), the dividend income was tax-free. The corporates and banks were therefore very enthusiastic subscribers to US 64 given the tax benefit and liquidity of the scheme, and the corpus of the scheme jumped manyfold. A very active secondary market developed in US 64 units as part of the securities market. The market prices naturally ruled between UTI's sale and repurchase prices. Again, since there was a stamp duty on transfers, the general practice was that the units traded in the secondary market would be sent for transfer only just before book-closure although, before that, through the year, they may have changed hands several times. BRs also came to be used in the secondary market transactions in units to avoid physical handling of huge amounts of paper certificates.

17.3.4 Repo Transactions

Repos in government securities also became established as banks used these to finance shortfalls in cash reserves through repos of SLR securities held in excess of statutory reserve requirements. The counterparty was a bank with surplus cash reserves, on which it otherwise earned no return. By being counterparty to repos it earned income on the surplus. Such transactions were particularly large on reporting Fridays. Repos were also being done with nonbank clients in order to give them returns higher than the regulated bank deposit interest rates.

As the repo transactions increased in volume, and given the operational weaknesses of the RBI's SGL system, bank receipts (BRs) came to be used in support of repos, in preference to actual sale/purchase entries in the RBI's subsidiary general ledgers. The BRs were extinguished on completion of the repo's second leg.

17.3.5 In short, towards the end of the 1980s, all the securities (SLR securities, PSU bonds, US 64—and a few other—units etc.) and instruments (repos, BRs etc.) which were to figure so prominently in the scam, were in place—for bona fide business reasons. Also, the participation in the securities market had widened through the merchant banking subsidiaries of some of the Indian public sector banks, and a couple of private sector non-banking finance companies, active particularly in the new instruments introduced in the market and the various portfolio management schemes.

17.4 Brokers

Brokers had always been an integral part of the secondary market in securities. While in theory all members of the stock exchange could have brokered securities transactions, all along only a few were active in the securities segment. In fact at no time did the number of active brokers exceed about a dozen. There were a number of perhaps unusual practices that characterised the role of brokers in securities transactions during this period, as described below:

- Securities transactions took place on an over-the-counter (OTC) basis, i.e. not on the floor of the exchange but over telephones or in personal meetings with the broker, and with each deal having a single buyer and a single seller. The basic precaution would be for the principals to exchange contracts once a deal had been struck through a broker. But this was not followed by some players in the securities market who treated the broker's note as adequate documentary evidence of the deal as though it had taken place on the floor of the Stock Exchange.
- The broker's commission was often not separately disclosed in the deal but was included in the price or had to be otherwise settled. Where the brokerage was included in the price this meant that the prices quoted to the counterparties to a transaction were often different. In this case the buyer bank would issue a cheque in favour of the seller bank which included the broker's commission. Some banks adopted a practice of crediting cheques in their favour to the broker's account. In many cases such credits were given to broker accounts on the basis of instructions of the issuer of the cheque to that effect. But not always, as some brokers had the facility to credit to their own account cheques in the name of their bank.

- Finally, settlement of securities transactions and physical delivery of cheques, securities SGL forms/BRs etc. between counterparties was often allowed to be effected by the brokers.
- In short, practices varied from bank to bank, and brokers aware of the laxity in systems/procedures were in a position to take advantage by abusing them.

17.5 Regulatory Environment

17.5.1 Statutory Liquidity Ratio

The SLR prescribed by RBI during the relevant period was significantly higher than the minimum 25%. It was around 38.5%.

17.5.2 Interest Rate Regime

The deposit taking and lending activities of banks were extensively regulated by the RBI. Thus, the type of deposit facility which a bank could offer, period of deposits and interest payable on different types of deposits were governed by the RBI directives. Similarly rates of interest to be levied on loans and advances were also subject to RBI directives.

17.5.3 Other RBI Regulations

The important provisions of the regulatory environment included

(a) Prohibition of repos in respect of holdings of public sector bonds, or corporate shares and securities, or with non-bank clients.

(b) In inter-bank repos in government (and other approved) securities, the net differential in *full* (i.e. quoted price plus accrued interest) sale and repurchase prices not to exceed the prevailing ceiling on call money rate in the inter-bank market.

(c) There should be no short sales, i.e., sale without the seller having the security sold.

(d) Inter-bank transactions should not be put through brokers accounts.

(e) Banks should not issue BRs on behalf of customers including brokers.

(f) Returns of SGL transfer forms (for inadequate balances or otherwise) should be immediately reported to RBI with details of the transactions.

(g) Banks should adopt the format prescribed by IBA for issue of BRs and to strictly follow the guidelines prescribed by IBA on the subject of BRs.
(h) PMS should be in the nature of investment consultancy without guaranteeing either directly or indirectly a pre-determined return. Banks should charge a definite fee for the services independent of the return to the customers.
(i) Funds should not be accepted for management for a period of less than one year.
(j) Funds should not be deployed for lending in call money/bills market and lending to/placement with corporate bodies.
(k) Maintenance of client-wise account/records of funds and investments.
(l) Strict segregation of banks' own investments and those on behalf of clients.

17.6 Proximate Background to the Scam

17.6.1 Booms in Stock Markets

At the relevant time there was a boom in the stock market with the BSE index going up from 956 in Jan 1991 to a peak of 4467 in April 1992. In terms of their stock market operations the brokers were not merely intermediaries between counterparties but were very much in the market for proprietary trading activities.

17.6.2 Broker's Financing Needs

The continuous increase in stock prices required ever larger financing to be available to the brokers. Under the prevailing bank credit regulations, however, the brokers could not get bank finance on anywhere near the scale needed for financing their proprietary trading activities. To be sure, informal sources of finance, particularly for postponing deliveries from one settlement to the next (the so-called "badla" financing) were available. The cost however was high and the amount of such financing far below the needs—at one stage badla finance rates had gone as high as 60% p.a., a prohibitively high rate compared to the then prevailing bank interest rates. There was therefore a very strong temptation for the brokers to somehow arrange finance at a cheaper rate of interest. One of the obvious avenues was to manipulate the transactions in the securities market to raise such finance.

The brokers were active on their own account not only in the equity markets. With low rates on government securities gradually going up and likely to do so further, the brokers became active "own account" traders in the securities market as well. They also started operating in the call money market, on their own account. All these activities required unorthodox sources of finance.

17.6.3 Banks, Merchant Banking Subsidiaries and Non-bank Finance Companies

As far as the commercial banks were concerned, perhaps for the first time in Indian banking history, they were under pressure to improve treasury earnings (i.e. earnings from investments, as distinct from lending). Such pressures came firstly because with coupons inching up (but still below market rates), the value of existing portfolios was falling. These portfolios represented almost 40% of a bank's assets. Secondly, with very high cash and statutory liquidity reserves (25% of incremental deposits and 38.5% respectively), only 36.5% of increased deposits were available for lending. Of this too, 40% had to be to "priority" sector, at below market rates of interest. This left barely 22% of increased resources (60% of 36.5%) available for commercial lending. This led to pressure on profit margins which also contributed to the focus on treasury operations.

The newly established merchant banking subsidiaries, manned for the most part by personnel deputed from the parent bank, were anxious to prove their ability to generate profits. Again, these organisations and the personnel manning them were for the first time operating in an environment which was far less regulated and supervised than the parent banks. They were taking high cost deposits, and had therefore to deploy them in high cost, and therefore by definition high risk, assets. Broadly speaking only one private sector non-bank finance company (Fairgrowth Financial Services Ltd.) was active in the securities market or in portfolio management. For the most part, this company too was manned by personnel whose previous experience was in commercial banks. The exhilaration of operating in a far less regulated environment and the thrill of "deal-making" were tempting; the risks not as well appreciated.

For these players, the attraction of floating portfolio management schemes was to earn fee income on off balance sheet transactions. The returns they had "indicated" to their clients were much higher than the riskless rate of return then prevailing (to be sure, these "indicative" rates were lower than the rates at which brokers would need to raise finance in the badla market). If the "indicated" returns were to be achieved, they were forced to use the funds in riskier assets.

Having grown up and operated under a highly regulated system, the personnel manning the treasury desks of Indian banks, or in the merchant banking or finance companies, had little exposure to the principles of risk management, like:

(a) separation of front office function (i.e. dealing or making trades) from the back office (exchange of contracts, settlements, etc.)

(b) information systems to monitor on an ongoing basis the counterparty exposures, and to ensure that these were within the limits approved by management. For example, non-receipt of securities purchased after payment has been made, or acceptance of BRs from a bank, is like giving an unsecured loan to it, and therefore should be within limits approved for such loans.

(c) Proper documentation of trades

17.6.4 The Ceiling on Interbank Interest Rates

Perhaps the temptation and practices to structure transactions in the securities market to get around regulatory prescriptions had their initiation even before the scam. These arose from the ceiling of 10% on interbank call money interest rates—there was then no term interbank money market in India—and the very high reserve requirements on interbank borrowings.

The way out was to structure interbank loans as repo transactions in securities. Consider that a bank needed Rs 36.5 crore on a particular day. It would need to borrow Rs 100 crore in the interbank market to get usable funds of Rs 36.5 crore because of the additional cash and statutory liquidity reserves it would have to provide on the borrowings! Instead, if the transaction was structured as a repo in securities (sale and purchase) the borrower would be able to use the entire sale proceeds to fund his requirements. For the lender also, this was more remunerative as he could charge, through the difference between the buy and resale prices, an interest rate higher than the regulatory ceiling of 10% p.a. Often BRs were the documents issued by the seller in support of repos, even when BRs were not supposed to be used for transactions which could be routed through the RBI's subsidiary general ledger.

When the RBI stipulated that the interest rate implicit in the repo transactions should not exceed the interbank ceiling rate, there was a temptation, and sometimes the practice, to show repos as independent sale and purchase transactions in the records, by not disclosing the second leg.

17.7 Scam Transactions

While all kinds of transactions have come to be grouped under the "securities scam", they broadly fall under two major categories, which could have existed, and perhaps did, independently of each other.

(a) Transactions arising from traditional market practices and securities.

(b) Transactions arising from the newer instruments like BRs and portfolio management schemes.

17.7.1 The Perspectives of the Participants

The market practices that were in existence before the scam and as they developed during the scam period need to be looked at in the background of the objectives, compulsions, perspectives and weaknesses of the participants. These may be summarised as follows:

(a) The brokers in the market, who were fully aware of the weaknesses of the system, were anxious to get access to bank finance for their "own account" trading in the stocks and securities markets.

(b) The depositors in the portfolio management schemes needed returns higher than those available in bank deposits.

(c) The banks were striving for increased earnings. further, these banks and other entities offering portfolio management services were keen to develop off balance sheet, fee earning business. In the process, they had "indicated" returns much higher than available in riskless securities. The only way they could deliver was through repo transactions in the securities market undertaken through the brokers. While higher than the riskless rate of return, these yields were much lower than the cost to brokers of traditional finance. The brokers could use the money for their own purposes by diverting ostensibly interbank transactions to their own accounts through exploitation of the system weaknesses and flagrant misuse particularly of bank receipts.

(d) A general atmosphere in the finance community which considered regulatory prescriptions to be merely technical and therefore to be transgressed at will.

(e) Several banks also displayed an amazing lack of internal controls, and some were victims of irregular, and sometimes fraudulent, transactions.

17.7.2 The Weaknesses of the System

The weaknesses which allowed perpetrations of the scam can be categorised under six broad heads:

(a) The absence of direct exchange of contracts or contract confirmations between counterparties as disclosed in the brokers' notes evidencing the transactions between some banks; or otherwise less than rigorous documentation of the trades. The documentation on record often did not disclose the true nature and indeed price of the transaction. For example, the Janakiraman Committee, while reconciling the transactions between different financial intermediaries, found that "over 20% in number and 30% in value of the transactions cannot be matched, the transactions not appearing in the books of the counterparty bank named by the reporting bank". Again, call money transactions in the records of one counterparty were shown as securities transactions in that of the other. In umpteen cases, prices differed, sometimes widely, in the records of the counterparties. In many instances, the counterparty paid only a part of the price, the balance being recovered from the broker.

(b) The practice of some banks of crediting cheques in the name of banks to the brokers' accounts.

(c) The use of brokers for settlements.

(d) The indiscriminate use of BRs, often contrary to provisions of the IBA circular and with little regard to the counterparty exposure risks the BRs were creating.

(e) Violation of provisions of RBI circulars on portfolio management schemes, and other issues like repos with non-banks, interbank repos other than in government securities, etc.

(f) In consideration of guaranteeing returns, some brokers exercised undue control over transactions of some banks, leading to transactions being undertaken without adequate independent scrutiny.

Individual transactions in the scam evidenced a combination of various categories of practices. The end result was diversion of huge amounts of banks funds to the accounts of some brokers, through manipulation of securities transactions. The banks whose moneys were so diverted were left with no securities or BRs, or with BRs of little value, the issuers having no assets to back them.

17.8 Discovery and Aftermath

Matters came to a head with the publication of a news item in the Times of India on 23rd April 1992 reporting a huge unauthorised overdraft in the account of one of the most active brokers in the securities market, in the books of State Bank of India (SBI). The news item also reported that SBI was experiencing some difficulties in reconciling its investment account with the SGL records. This led to a great deal of publicity and comment in the media as well at the political level. The RBI's response was to appoint on 30th April 1992 a "Committee to Inquire into Securities Transactions of the Banks and Financial Institutions", popularly referred to as the Janakiraman Committee.

Meanwhile, the securities scam had also become a matter of hot political debate in Parliament and outside. There were vociferous demands for investigations by the Central Bureau of Investigations (CBI). The government was forced to concede these demands.

The two houses of Parliament also became involved in the investigations more directly by adopting motions on the 6th and 7th August 1992 to appoint a Joint Committee "to enquire into irregularities in securities and banking transactions".

17.8.1 The Janakiraman Committee Report

The report consists of 6 volumes and was a huge investigative effort undertaken by the Committee with the assistance of RBI officials. Some of the major conclusions in the report are as follows:

(a) The aggregate value of securities transactions put through in the market from 1st April 1991 to 23rd May 1992 was almost Rs 13 trillion (Janakiraman Committee Report 6.V.2). While similar data for earlier years was not available, the figure was many times bigger than the volume of transactions in earlier years.

(b) Of this, only 5.4% of the transactions represented outright sales/purchases. 44.1% were repos and 50.5% have been classified as "others". "In several cases, where commitments to repurchase or resell the securities have not been documented, but are matters of 'understanding' between the parties, the transactions have been reported by the banks as 'others' and not as ready forward". (Janakiraman Committee Report 6.V.2)

(c) 47% of the transactions related to government securities, 38% to PSU bonds and 12% to units. The balance were unclassified items (Janikaraman Committee Report 6.V.3).

(d) Almost half the total transactions were put through by 4 foreign banks—Citibank, Standard Chartered, Bank of America and ANZ Grindlays Bank (Jankiraman Committee Report 6.V.5).

(e) Of the 180 financial intermediaries whose transactions were scrutinised by the Committee, those of 32 have been specifically commented upon in the report. The presumption is that the other players in the market did not indulge in transactions considered irregular by the Committee, or that these were not significant enough to invite detailed comments.

(f) There was a consistent pattern of irregular practices aimed at circumventing the provisions of various RBI circulars.

(g) The principal source of funds for the irregular transactions was the moneys placed by the corporate sector in portfolio management and allied schemes, a total of about Rs 57 bn as on 30th June 1992.

(h) The banks deliberately encouraged the façade of PMS funds being placed as agent of the client, even while "indicating" certain returns to clients who thought PMS to be a deposit substitute. No details of investments made were furnished to clients and where actual returns were higher than the indicated returns, the excesses were not passed on to clients.

(i) Several banks purchased and sold securities in their own name without disclosing that they were acting on behalf of brokers, and even issued their own BRs in support of such transactions. The cost of purchases or sale proceeds, as the case may be, were respectively debited and credited to the broker's account.

(j) Brokers arranged contracts where the name of the selling bank was given without its knowledge, and the buyer's cheque credited to the broker's own account with the ostensible seller bank.

(k) Some banks entered into informal arrangements under which sale/purchase contracts were made at the broker's instance and risk, at an assured rate of return.

(l) Transactions in the same security and on the same date have been made at prices which varied significantly.

(m) A number of artificial transactions have been recorded without the actual transfer of securities.

(n) Contrary to provisions of RBI circulars, banks undertook repos in securities other than government (SLR) securities, and with nonbank entities camouflaging the latter violation in different ways.

(o) In most banks, provisions of the IBA circular regarding BRs were observed only in their breach.

(p) Contrary to the provisions of RBI circulars, some banks had large oversold positions in certain securities.

(q) There was a close nexus between certain brokers and certain banks, enabling the former to have unauthorised access to funds.

(r) There was a complete breakdown of internal control in several banks.

(s) As a result, "holes" developed in the investment portfolios, i.e., investments not backed by any securities/SGL transfer forms/BRs, or backed by worthless BRs.

Chapter 18

Issues in Accounting

18.1 Introduction

There are various important issues in accounting of debt securities in the investment portfolio and the income therefrom, as also in derivatives: the following comments are based on the current valuation/accounting regulations for banks as outlined in Chapter 15. We also discuss, on the basis of RBI's discussion papers, some of the major changes that are likely to be introduced.

18.1.1 Scheme of the Chapter

In paragraph 18.2, some issues relating to accounting of the investment portfolio are discussed. Paragraph 18.3 deals with issues in derivatives accounting, while paragraph 18.4 offers some suggestions for accounting of derivative contracts with customers and their hedges. Paragraph 18.5 looks at the accounting treatment of internal deals and maintenance of mirror accounts in such a way as to facilitate monitoring and calculation of segmental profitability.

18.2 Valuation/Accounting of the Investment Portfolio

18.2.1 Present Regulations

The present regulations, outlined in Chapter 15, suffer from several weaknesses.

The more important issues are as follows.

(a) Held-to-Maturity (HTM) Segment: One major issue is the difference in accounting between the treatment of premium and discount over face value, as reflected in the book value. As we have seen, if the difference between the book value and the face value is a premium, i.e. the book value is higher than the face value, the premium needs to be written off on a straight line basis over the balance life of the security. If, on the other hand, the difference happens to be a discount, the gain is accounted only at the time of maturity of the security. The result is that **even if two securities in the HTM book have the same yield to maturity, their contribution to the reported profit is different**, if one happens to be at a premium and the other at a discount.

(b) Available for sale (AFS) Segment: While the value of the **segment is marked-to-market periodically, any surplus** of book value over market value, **on the segment as a whole, is ignored.** Again, individual securities continue to be carried at historical book values. These practices lead to several anomalies:
   (i) Even on a segment basis, net appreciation is recognized only to the extent there is depreciation in some securities.
   (ii) Value of the individual securities, as also of the segment, does not reflect current market prices. Therefore, performance evaluation (by comparing coupon income +/– appreciation/depreciation with the book value) becomes less than meaningful.
   (iii) The contribution of individual securities, as also the segment, to the profit and loss account, changes from year to year, even in a stable interest rate scenario, and bears little relationship to the YTM.
   (iv) If the book value of a security happens to be above the market value, there is a reluctance to explicitly book a loss through sale, even if the security is overvalued on current yields in the market.

(c) Held for Trading (HFT) Segment: Since the valuation is maintained on the basis of published, i.e. clean, prices, this can lead to erroneous trading decisions. The reason is that, if the coupon is lower than the market yield, the clean price will go up with passage of time, even in the absence of any change in yields, or, in extreme cases, even when yield has gone up. Thus, sale would show a profit where none exists in actuality (contrarily, if coupon is more than the market yield, clean prices would disclose losses even in the absence of a change in yield).

(d) Accounting date: There is no clarity about whether, for accounting and subsequent mark-to-market purposes, the relevant date should be the trade date or the settlement date.

(e) Another distortion is the artificial 30/360 day count convention in the Indian securities market. The basis on which coupon is actually earned is on an actual-by-actual day count—in other words, the coupon is earned over the actual number of days in the half-year. Therefore, the per-day actual interest earned is different, for the same coupon, depending on the number of days in the half-year, something ignored by the market practice.

In short, using the conventional book values for management accounting purposes suffers from a number of weaknesses. A bank aiming at a rigorous evaluation may like to consider keeping management accounts separately from the published accounts. An additional problem is that the profit for tax purposes is not identical with either the book profit or the profit according to management accounting principles.

18.2.2 Likely Changes

The revised regulations for valuation/accounting of debt securities in the investment portfolio, which are likely to be introduced by RBI, would eliminate most of the anomalies and weaknesses discussed in the previous paragraph. These are based on international accounting standards.

Some of the major changes are discussed below:

(a) Held to Maturity (HTM)

Individual securities in the HTM portfolio will be valued on the principle of "amortised cost using the effective interest method". Unfortunately, the term "effective interest" has not been defined, but should be the original YTM (i.e. at the time of acquisition). The new rules will require the difference between the effective interest and the coupon earned during an accounting period, to be adjusted in the book value of the investment. This would mean that both the premium and discount in the book value as compared to the face value, would get amortised over the balance life of each security in the HTM portfolio.

Unfortunately, the RBI's discussion paper and the material on IAS 39 the author has perused, give illustrative calculations based only on full interest periods. In the author's opinion, where broken interest periods are involved, the following procedure could be used:

(i) Calculate the income that would accrue in each accounting period (say, quarterly for HTM securities, monthly or oftener for AFS securities and daily for HFT securities) **at the YTM ruling when the acquisition was made**.

(ii) Also calculate the amount going into interest accrued account, at the coupon rate.

(iii) (a) gives the amount that should go into income account and (b) the amount that has gone in the income account through the coupon rate.

(iv) The **difference between (a) and (b) should be added to** (subtracted from) **the book value of the security and credited** (debited) **to interest account—in effect, this means that the change in the clean price, at each accounting date, at the original or acquisition time YTM, also goes in the income account.**

(v) The adjustment for market value in the case of AFS and HFT securities should be done with reference to the new book value, in accordance with paragraph (b) below.

(It is advisable to consult the statutory auditors before adopting the suggested procedure.)

An example (Table 18.1) on the above assumptions, follows.

To elucidate, effective income in the first period, i.e. from 30th October to 31st December, should be 1.2180, i.e. the difference in the full price between the two dates. Of this, 1.9167 will come through the change in accrued interest (2.7153 – 0.7986). The difference of –0.6987 (1.2180 – 1.9167) will have to come through change in the book value of the security. As will be seen from the table, this is the exact difference between the clean prices on the two dates. In effect, 0.6987 will be debited to interest account and credited to investment account—note that the investment account has a debit balance and therefore the credit will reduce the value of the investment.

(b) AFS and HFT Securities

The same methodology should be used for debt securities in the AFS/HFT portfolio for calculating the interest income: in other words, the interest income is the amount arrived at **as per the original YTM** (i.e. YTM at the time of acquisition of the security). The new book value should be changed to the ruling market value by debiting/crediting the difference to

(i) P&L account in the case of HFT securities; and

(ii) A separate "Other Comprehensive Income"(OCI) account in the case of AFS securities. The balance of the OCI account should be included under "other liabilities" if in credit. It should be included under

Table 18.1 Calculation of Effective Interest

				11.5% Security 2007					
				Maturity		**5-Oct-07**			
				Settlement date		**30-Oct-06**			
				Full price		**104.7188**			
				Accrued interest		**0.7986**			
				Clean price		**103.9202**			
				YTM		**7.0600**			
	Date	**Days**	**cash flow**	**PV of cash flow**	**Full price**	**Accr-intt-coupon flow**	**Clean price**	**Effective income: change in full + Cash flow**	**Change in accr intt + cl price change + cash flow**
1	30-Oct-06		−104.7188	−104.7188	104.7188	0.7986	103.9202		
2	31-Dec-06	60			05.9368	2.7153	103.2215	1.2180	1.2180
3	31-Mar-07	90			107.7904	5.5903	102.2001	1.8536	1.8536
4	5-Apr-07	5	5.7500	5.5808	102.1443	0.0000	102.1443	0.1039	0.1039
5	30-Jun-07	85			103.8314	2.7153	101.1161	1.6871	1.6871
6	30-Sep-07	90			105.6481	5.5903	100.0579	1.6871	1.6871
7	5-Oct-07	5	105.7500	99.1381	0.0000	0.0000	0.0000	0.1019	0.1019

"other assets" if in debit, and deducted from tier I capital for capital adequacy purposes. The balance in OCI, for a given security, should be transferred to the profit and loss account on its sale or redemption as the case may be.

The securities in HFT category would need to be marked to market daily, and those in AFS category, monthly or more frequently.

(c) Held for Trading

For management accounting purposes, it would be better to maintain the trading portfolio on a full value basis so that the profit or losses are correctly available in the valuation of the portfolio, for evaluating trading performance.

(d) Discount Securities

In the case of discount securities like treasury bills, commercial paper, zero coupon bonds, etc. the principle is the same as in the case of HFT and AFS securities, namely, they should be valued at the amortised cost, in other words, acquisition cost plus discount accrued **at the rate prevailing at the time of acquisition**. Mark-to-market valuation should be done thereafter, if necessary.

18.3 Accounting for Derivatives

At present, there is no accounting standard for derivatives in India. Internationally, the two accepted standards are FAS 133 in the United States, and IAS 39 which is part of the International Financial Reporting Standards (IFRS). Both are complex and currently negotiations are going on, aimed at a convergence of the two. The general principle underlying both the standards is that **derivative contracts should be accounted on fair value basis,** the only exception being where a derivative contract can qualify as a hedge and therefore be eligible for hedge accounting rules. In that case, such derivative contracts can be **valued on accrual basis** (i.e. need not be marked-to-market) provided the underlying, i.e. **the hedged item, is also carried at historical values** and subjected to accrual accounting: in other words, the hedge and the hedged item should be subject to the same accounting treatment.

The hedge effectiveness criteria under either standard are extremely stringent, particularly in the case of portfolio hedges, for example, an interest rate swap undertaken to hedge the gaps in the asset: liability book.

In India, the Reserve Bank has prescribed hedge effectiveness rules for exchange traded derivatives, as follows:

Hedge Effectiveness: The hedge will be deemed to be "highly effective" if at inception and throughout the life of the hedge, changes in the marked to market value of the hedged items with reference to the marked to market value at the time of the hedging are "almost fully offset" by the changes in the marked to market value of the hedging instrument and the actual results are within a range of 80% to 125%. If changes in the marked to market values are outside the 80%–125% range, then the hedge would not be deemed to be highly effective.

(Reference: Reserve Bank of India's "Guidelines on Exchange Traded Interest Rate Derivatives" dated June 3, 2003)

Currently, no standards have been prescribed for over-the-counter (OTC) derivatives used as hedges.

The RBI is likely to prescribe accounting standards for derivatives shortly, on the basis of a discussion paper based on international accounting standards and practices.

18.3.1 International Standards: An Overview

The two recognized accounting standards on the subject of accounting for derivatives are

- The Financial Accounting Standard 133 in the US; and
- The International Accounting Standard 39, which has been adopted in Europe.

(The RBI's discussion paper on the subject, discussed in paragraph 18.4, is based on IAS 39.)

While both standards are complex, as far as accounting for derivatives is concerned, the basic rule, under both FAS 133 and IAS 39 is that derivatives should be marked-to-market and the changes in values reflected in published accounts. (Where market values are not available, valuation per mathematical models is also allowed.) The only exception is where a derivative contract is eligible to be treated as a hedge under the applicable accounting standard, in which case it need not be marked-to-market if the underlying, i.e. the hedged item, is carried in the books of account at historical values.

In principle, hedging is aimed at mitigating, if not eliminating, the impact of price risks on the entity's performance. A hedged item can be an asset, liability, firm commitment, or forecasted future transaction that is exposed to a risk of change in value or changes in future cash flows. The hedge could be in the form of a derivative, for example a forward contract on an exchange rate to which one is exposed, or a borrowing in a foreign currency where the enterprise has a regular revenue stream in the borrowed foreign currency.

However, not all derivatives or other transactions which may achieve the economic objective of hedging, qualify as hedges for accounting purposes under FAS 133 or IAS 39. For example, fixed interest securities in the HTM segment are exposed to risk of a **change in their economic value,** arising from changes in ruling interest rates. However, since such securities are not marked-to-market, there is no price risk in the accounting sense. It has, therefore, been argued that derivatives to hedge the economic exposure on HTM securities will not qualify for hedge accounting treatment.

18.3.2 Types of Hedges

IAS 39 recognises three types of hedges: fair value hedges, cash flow hedges and hedges of the net investment in a foreign entity.

(a) Fair value hedges: Fair value hedges are applicable to cases where the risk being hedged is **a change in the value of an asset or liability**. For example, changes in foreign exchange rates or interest rates would affect the value in the balance sheet, respectively of a foreign currency borrowing, or a fixed interest security in the AFS or HFT segments. Derivatives contracts entered into to hedge such price risks, provided they are effective hedges, will be considered fair value hedges.

(b) Cash flow hedges: In cash flow hedges the risk being hedged is **the potential changes in future cash flows**, affecting the profit and loss account. An example would be floating rate loans, where the applicable interest rate is re-fixed periodically with reference to LIBOR or some such benchmark. Hedges of such items are considered cash flow hedges.

(c) Net investment in a foreign entity: The hedge for the net investment could be either a derivative or a foreign currency borrowing in the same currency as the investment.

18.3.3 Hedge Effectiveness

Under IAS 39, hedge accounting principles can be applied only to hedged items, and derivatives used as hedges, which meet specified criteria. These may be summarized as follows:

(a) Hedged item: This should be such as creates an exposure to price risk that could affect the profit and loss account either immediately or later.

(b) Criteria for eligibility
 (i) The hedged item and the hedging instrument are specifically identified;
 (ii) The hedging relationship is formally documented;
 (iii) The documentation of the hedged relationship identifies the hedged risk and how the effectiveness of the hedge will be assessed;
 (iv) At the inception of the hedge, it must be expected to be highly effective, that is, the gains and losses on the hedged item and the hedging instrument should almost fully offset over the life of the hedge;
 (v) Effectiveness of the hedge must be tested regularly throughout its life.
 (vi) One to one designation is normally required between a single asset, liability or forecast transaction and a single **external derivative instrument**; and
 (vii) Hedges of forecast transactions are allowed if the forecast transaction is 'highly probable'.

(c) Hedging instruments: Only an external derivative contract can be used as hedging instrument if the transaction is to qualify for hedge accounting. Thus, IAS 39 does not recognize internal deals as hedging instruments.

(d) Hedge effectiveness: As a general rule, a hedge is effective when the changes in the fair value or cash flows of the hedged item and the hedging instrument almost fully compensate for each other. Quantitatively, the changes should be within 80–125% of each other for the hedge to be considered effective.

18.4 RBI's Discussion Paper

The RBI's discussion paper broadly follows the definitions and rules of IAS 39. Some of the more important points are discussed below:

(a) Fair value: Since, as a rule, derivative contracts are to be marked to market, the definition of how to arrive at market, or fair, values is important. "Fair Value" itself is defined as, *"the amount for which an asset could be exchanged, or a liability settled, between knowledgeable, willing parties in an arm's length transaction….. Fair value may be obtained from various sources, such as:*

- *A published price quotation in an active market (current bid price for an asset and current asking price for a liability);*
- *In the absence of a current bid or asking price, by reference to prices available from most recent transactions as long as there has not been a significant change in economic circumstances since the time of the transaction; and*
- *In the absence of an active market, fair value is estimated on the basis of the results of a valuation technique that makes maximum use of market inputs, and relies as little as possible on entity-specific inputs."*

"Valuation techniques" would obviously include mathematical models.

(b) Hedging instrument is defined as

"(a) *a designated derivative; or*

(b) *in the case of hedging of the risk of changes in foreign currency exchange rates, a designated non-derivative financial asset or non-derivative financial liability; whose fair value or cash flows are expected to offset changes in the fair value or cash flows of a designated hedged item."*

(c) Hedged item: "*A hedged item is an asset, liability, firm commitment, highly probable forecast transaction or net investment in a foreign operation that (a) exposes the entity to risk of changes in fair value or future cash flows and (b) is designated as being hedged.*"

Note that, by this definition, a fixed interest bond not subject to mark-to-market or fair value accounting—such those held in HTM category, or tier 2 bonds issued—cannot be a hedged item.

(d) Classification of derivatives: *"Upon initial recognition all derivatives for 90 days or lesser will be designated by a bank in a new category called 'Derivative through Profit and Loss' (DPL)* ***unless they meet the hedge accounting criteria (c.f. paragraph no.7 & 8).*** *A derivative for a period longer than 90 days shall be included in a new category called 'Derivative through evaluation Account' (DRA)."*

The difference is, firstly, between short term and long term; secondly, in accounting for valuation changes through profit and loss account or in the balance sheet. The latter variation is parallel to the accounting for valuation changes in HFT and AFS securities as discussed in paragraph 18.2.2 above. A third difference is in accounting for "fee income": "*Fee received paid in respect of derivatives included under DPL and which have a fair value may be* ***taken to profit*** *and loss account upfront. In the case of derivatives included under DRA or DAC, fee received paid may be amortised over the life of the derivative instrument.*"

The discussion paper also provides that *"In respect of derivatives that are designated as hedging instruments and meet the hedge accounting criteria, banks should follow the applicable accounting guidelines",* and introduces a third classification, namely 'Derivatives at Cost'*: "If the fair value of a derivative, including a hedging instrument, cannot be reliably measured, it should be included in a new category 'Derivatives at Cost' (DAC)."*

(e) Gains and losses*: "The gains and losses on subsequent measurement of derivatives shall be recognised as follows:*

  (a) A gain or loss on subsequent measurement of a derivative included under DPL shall be recognised in the **Profit and loss account**.

  (b) A gain or loss on subsequent measurement of a derivative included under D A shall be recognised in a new account titled '**Unrealised Gain Loss on Derivatives' (UGD).**

  (c) *A derivative which is included under DAC should be held in the books* ***at cost until a fair value is reliably established or the derivative is closed out or the derivative matures****. A gain or loss is recognized in profit or loss when the derivative is closed out or at maturity"*.

(f) Hedge accounting: *"Hedging refers to assumption of a position in a hedging instrument such that change in its value or cash flows significantly offsets any change in the value or cash flows of another designated asset or liability (hedged item).*

(g) Fair value hedge*: "A hedge of the exposure to changes in fair value of a recognised asset or liability…that is attributable to a particular risk and could affect profit or loss."*

(h) Cash flow hedge: "*A hedge of the exposure to variability in cash flows that is attributable to a particular risk associated with a recognised asset or liability (such as all or some future interest payments on variable rate debt)."*

(i) Hedge effectiveness: "*A hedge is regarded as highly effective, only if (a) and (b) are met:*

  (a) At the inception of the hedge and in subsequent periods, the hedge is expected to be highly effective in achieving offsetting changes in fair value or cash flows of the hedged item attributable to the hedged risk during the period for which the hedge is designated. Such an expectation can be demonstrated

    (i) by comparison of past changes in, or

    (ii) by demonstrating a high correlation between the fair values or cash flows of the hedged item and the hedging instrument,

(b) The actual results of the hedge are within a range of 80 and 125 percent.

For example, if actual results are such that the loss on the hedging instrument is Rs 120 and the gain on the cash instrument is Rs 100, offset can be measured by 120/100, which is 120 percent, or by 100/120, which is 83 percent. In this example, assuming the hedge meets the condition in (a), the bank would conclude that the hedge has been highly effective."

The paper also prescribes the periodicity of assessing hedge effectiveness (quarterly) and requires the formal adoption of methodology for such assessment.

(j) Portfolio hedges: "*In the case of interest rate risk, hedge effectiveness may be assessed by preparing a maturity schedule for financial assets and financial liabilities that shows the net interest rate exposure for each time period, provided that the net exposure is associated with a specific asset or liability (or a specific group of assets or liabilities or a specific portion of them) giving rise to the net exposure, and hedge effectiveness is assessed against that asset or liability*".

The prescription to associate the net exposure to "*a specific group of assets or liabilities*" may need detailed documentation. To add to the complexity, the paper prescribes that *"A hedge of an overall net position (for example: the net of all fixed rate assets and fixed rate liabilities with similar maturities), rather than a specified hedged item, does not qualify for hedge accounting.*

(k) Hedge effectiveness (contd.): *"The fixed interest rate on a hedged item need not exactly match the fixed interest rate on a swap designated as a fair value hedge. Nor does the variable interest rate on an interest-bearing asset or liability need to be the same as the variable interest rate on a swap designated as a cash flow hedge."*

The paper is silent about notional principals of the hedge and the hedged item: in general, hedge ratios would differ from unity as we have seen earlier.

(l) Qualifying hedging instrument: *"Only instruments that involve* ***a party external to the reporting*** *entity (i.e., external to the group, segment or individual entity that is being reported on) can be designated as hedging instruments."*

(m) The paper also prescribes the details of various accounting heads and the contents of balance sheet disclosures.

18.5 Contracts with Customers

(a) Under IAS 39, derivative contracts themselves do not qualify for being considered as the hedged item. Prima facie, this is a somewhat odd reservation as, in many cases, the hedge for a derivative contract with a customer is often another derivative contract in the market. However, IAS 39 requires that even derivative contracts entered into on a completely back to back basis, and therefore not carrying any price risk, need to be treated as part of the trading book and therefore marked-to-market. The genesis of this accounting rule could be in the fact that, internationally, major banks run trading books in derivatives, and rarely hedge derivative contracts with customers on a one-to-one basis. This is not the position in India, at least at present but the RBI's discussion paper seems to follow IAS 39.

(b) Whatever the accounting rule, in the author's view, there are major differences between derivative contracts with customers on a fully hedged basis, and those entered into for trading purposes, and these need to be reflected in the accounting system. The important differences are as follows:

   (i) Positions taken for trading purposes are generally held for the short term, with the intent of profiting from price movements. They are therefore subject to reversal in the market **at the discretion of the trader**.

   (ii) On the other hand, derivative contracts with customers are entered into for the purpose of earning the price difference, i.e. the difference in the customer price and hedge cost or market price, as the case may be. Again, **they cannot be unwound at will**, and often need to be held in the books till maturity, which may sometimes extend to several years.

   (iii) Fully hedged customer transactions do not carry any market or price risk, unlike transactions undertaken for trading purposes: indeed, in the case of the latter, price risk is deliberately assumed to profit from price movements.

   (iv) The margin between the customer price and the hedge cost represents partly compensation for providing a service, and partly the credit spread which the bank is earning by taking a credit risk on the customer. Therefore, in the case of fully hedged customer transactions, mark-to-market valuations are useful only for the purpose of monitoring the credit risk.

   (v) Banking regulators require that **customer contracts should be so valued as to ensure that unearned credit spreads are not accounted** for in the profit and loss account. This point is important for, if customer contracts are revalued at the same price as other trading contracts, even the unearned credit spread would get reflected in the trading profit and be accounted for upfront.

To elaborate the last point, consider a 5-year interest rate swap entered into with a customer, and hedged in the market with an exactly back-to-back transaction. If both the contracts are valued at the ruling market price for 5-year swaps, the entire margin or credit spread will get accounted as part of the trading profit. On the other hand, the credit risk on the customer will be outstanding for five years. Therefore, even if fully hedged customer contracts are to be valued on mark-to-market basis, as required by IAS 39, care must be taken to ensure that unearned credit spreads are excluded from the valuations.

Overall, in the author's view, it would be prudent to keep the trading book and the fully hedged customer contract book separate from each other, with the latter carrying no market risk—except perhaps some unavoidable basis risk.

Index