MOORAD CHOUDHRY

AN INTRODUCTION TO BANKING

Liquidity Risk and Asset-Liability Management

Foreword by Oldrich Masek

Managing Director, JPMorgan

CISI

CHARTERED INSTITUTE FOR SECURITIES & INVESTMENT

This page intentionally left blank

AN INTRODUCTION TO BANKING

LIQUIDITY RISK AND ASSET–LIABILITY MANAGEMENT

The Chartered Institute for Securities & Investment

Mission Statement:

> *To set standards of professional excellence and integrity for the investment and securities industry, providing qualifications and promoting the highest level of competence to our members, other individuals and firms.*

Formerly the Securities & Investment Institute (SII), and originally founded by members of the London Stock Exchange in 1992, the Institute is the leading examining, membership and awarding body for the securities and investment industry. We were awarded a royal charter in October 2009, becoming the Chartered Institute for Securities & Investment. We currently have around 40,000 members who benefit from a programme of professional and social events, with continuing professional development (CPD) and the promotion of integrity, very much at the heart of everything we do. Additionally, more than 40,000 examinations are taken annually in more than 50 countries throughout the world.

The CISI also currently works with a number of academic institutions offering qualifications, membership and exemptions as well as information on careers in financial services. We have over 40 schools and colleges offering our introductory qualifications and have 7 University Centres of Excellence recognised by the CISI as offering leadership in academic education on financial markets.

You can contact us through our website *www.cisi.org*

Our membership believes that keeping up to date is central to professional development. We are delighted to endorse the Wiley/CISI publishing partnership and recommend this series of books to our members and all those who work in the industry.

As part of the CISI CPD Scheme, reading relevant financial publications earns members of the Chartered Institute for Securities & Investment the appropriate number of CPD hours under the Self-Directed learning category. For further information, please visit *www.cisi.org/cpdscheme*

Ruth Martin
Managing Director

AN INTRODUCTION TO BANKING

LIQUIDITY RISK AND ASSET–LIABILITY MANAGEMENT

Moorad Choudhry

WILEY
A John Wiley and Sons, Ltd, Publication

This edition first published 2011

Registered office
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com.

A catalogue record for this book is available from the British Library.

ISBN 978-0-470-68725-3

Set in 10/12pt Trump Medieval by OPS Ltd, Great Yarmouth, Norfolk, UK
Printed in Great Britain by TJ International Ltd, Padstow, Cornwall, UK

For Mrs. Lindsay Choudhry

Ultimate yummy mummy

CONTENTS

This page intentionally left blank

FOREWORD

In many ways, a handbook that helps to contextualize the banking business as a portfolio of risk management activities could not be more welcome or timely. It should be no surprise that the globalization of the financial system has dramatically expanded the scope of risks a bank naturally accumulates in its day-to-day operations. Accordingly, the difficulty of valuing and administering these aggregate risks continues to broaden. Whilst computer technology has at least provided the processing faculty against this increasing challenge, the banking industry is continually pressed to develop the analytical theory and hedging tools necessary to cope with risk management's increasing complexity. The advent and rapid growth of markets such as asset securitization and credit derivatives, for instance, evidence such progress. Hence, any practical study of banking without a proper perspective on the fundamental liquidity, capital, interest rate, . . . , and credit risk management techniques in practice today would be incomplete.

With that said, the recent financial crisis has raised many questions around the merits of the so-called 'advances' made in valuation and risk theory over the past several decades. I would argue that 'financial engineering', as it has so dubiously been labelled, has taken a disproportionate share of the blame as the catalyst for the crisis. As above, the genesis of these new tools and approaches has been born out of necessity and are a natural consequence of the increasingly complex risk landscape for the financial system. So, although convenient, it would be an oversimplification to suggest that the tools of finance by their own construction had caused the problems outright. More appropriately, one should reflect on how these financial tools were employed and why their natural limitations were insufficiently appreciated. In retrospect, the latter is perhaps the main reason management at the most affected financial institutions did not see the level of risk they were exposed to until it was too late. Put differently, as measures of risk exposure filtered up through these organizations, the degree of sensitivity embedded in those risk measures was lost in translation. In effect, the worst hit financial institutions experienced a failure in risk management. Risk management, in this sense, refers not only to understanding the value of a financial asset at any given point in time but, more importantly, the sensitivity of its value to rapidly changing market conditions.

Stepping back, at the core of any true science is a set of basic fundamental principles and relationships that is accepted by all researchers as a foundation to expand upon. As a general matter, the science of finance is really no different. For most financial assets (bonds, equities, . . . , real estate), the analytical theory used to assess their value at any given moment is fairly developed and is supported by broad consensus. In fact, many of those basic theories are captured in this book. If these theories are so generally accepted, one might ask oneself: Why do any two parties ever differ in terms of the values they would assign to any similar asset? More concretely, in light of the near death experience of the financial system, why had the values assigned to financial assets by buyers and sellers (i.e., the 'bid and offer') become virtually irreconcilable. In short, valuation disparities tend to be driven more by divergent views on model inputs rather than opposing analytical approaches in themselves. This should not be too surprising; the financial industry purposefully looks to establish tools that are standardized and widely shared. Pragmatically, standardization with open architecture enhances transparency in an asset class promoting greater liquidity and increased business volumes.

Irrespective of one's trust or distrust in current financial theory, it is hard to dispute that the use of poorly founded input assumptions will render even the best model ineffective. As is the case with all scientific models used to predict and quantify an outcome, the quality of the output depends on the reliability of the input. In this regard, extracting dependable inference from historical source data is not a unique challenge to the science of finance. Interpreting historical source data to validate forward assumptions is challenged by sampling inaccuracy, insufficient time series, and reliance on 'constant conditions'. 'Constant conditions', in this sense, refer to the belief that every factor that has influenced historical source data will remain the same in the future as will its impact. Unlike theoretical science, though, financial markets do not exist in a controlled environment or vacuum. On the contrary, financial markets are highly dynamic and interconnected. Thus, historical data are not necessarily predictive of future actual outcomes neither in terms of average expectation nor the variance around that expectation. This brings one back again to the concept of financial risk management, whereby financial risk management looks to metric the impact that changing conditions have on the base assumptions behind valuation tools (i.e., the 2nd, 3rd, ..., *n*th order effects that changing market environments have on valuation outcomes). Not surprisingly, framing asset valuation sensitivity to capture the impact of changing conditions has only gotten more challenging in a globalizing financial world. Globalization by its very nature is a 'non-constant condition' that creates greater volatility in the reliability of forward assumptions relative to historical experience.

With that background, the structural limitations inherent in making forward predictions based on models were exemplified early in the crisis most notably with mortgage-backed securities. For many years, the cumulative borrower default rates assumed to value those securities relied heavily, among other things, on backward-looking observation. With the benefit of hindsight, these assumptions considerably underestimated the actual default rates currently being realized today. In other words, the true value of the cash flows from these securities was overestimated and the price paid for those securities at inception was too high. As the likelihood for worsening default rates transpired, investors reran their models using the more likely expectation only to learn that their investments were worth considerably less in many cases. The realization that so many could be so wrong created a crisis of confidence that ultimately put the entire financial system in disarray. It triggered questions by originators, investors, rating agencies and regulators as to the accuracy of all assumptions and models being used to deterministically set prices. This one event placed the entire financial industry into the limelight and onto its back foot.

So, why were the actual default rates being observed today not in the realm of imaginable possibility when compared with those actually used to populate the valuation models? Was it really the science of finance (i.e., 'financial engineering') in itself that caused the oversight? Well, as above, the overreliance on historical data to predict future outcomes had the most obvious role. In our mortgage-backed securities example, what many failed to appreciate was that lender underwriting standards had changed significantly. As a consequence, the historical source data used to support model inputs were no longer relevant. Said differently, the 'constant condition' between past and future was erroneously unquestioned. Interestingly, though, for those that invested in those mortgage-backed securities the consensus view on value between seller and buyer was very similar pre crisis. This was evidenced empirically by the very tight 'bid–offer' prices on those securities before the market melt-down. The 'bid–offer' can be viewed as a proxy measure of how in agreement buyers and sellers are on the inputs being used in their valuation models. But we know from hindsight, certain market participants avoided taking exposure to this asset class. Others went as far as to take deliberate views that the consensus values were so sufficiently overstated that they exercised their views by selling those securities short. These contrarians, despite being limited to the same tools and same historical data as anyone else, were ultimately correct in their divergent views. Were they simply smarter?

More realistically, they were not smarter. I would argue that they were just better at understanding the limitations and risks in relying on models and historical source data. Perhaps importantly, they looked to factors outside the usual numeric sources of information and applied judgment to stress their model assumptions beyond the historical experience. These 'risk managers' were more enlightened only to the extent that they recognized that the 'constant condition' was no longer valid. Basic questions around exponential origination growth, deteriorating demographics, increased use of teaser rates, high loan to values and documentation (i.e., all widely discussed in the public domain), should have given rise to reflection for all involved to question further whether the model inputs and hence model outputs made sense? In the end, no model can replace basic judgment, intuition or common sense. Perhaps this is the common sense lesson?

Although it is rare for finance books to be philosophical, hopefully, some of the viewpoints above will help to put perspective around the powers and pitfalls of financial science. As with all sciences, the theoretical frameworks, the analytical models, and the instruments themselves (i.e., 'collective financial technology') are only tools – their predictions and promises are not absolutes. While 'collective financial technology' allows for better understanding of valuation basics, more practically, their utility is best when considered as part of the broad suite of tools available to support decisions around 'financial risk management' . Upon reflection, perhaps the better nomenclature is 'financial risk judgment'. At least under this description, it marries both science and human intuition. Human intuition in this respect refers to our unique ability to question what we observe or what we are told; for example, are our data sources and assumptions reasonable? Furthermore, it refers to our unique ability to individually assess and weigh an expected financial result versus the consequences of an unexpected bad result: Can we live with the downside scenario if our assumptions are invalid? The long-run bull market leading up to the financial crisis clouded human judgment around downside risk awareness for many. The senior management at many financial institutions became obsessed with absolute revenues rather than risk-adjusted revenues. Consequently, many of the newer financial tools and innovations were used for speculation rather than for the purposes they were developed – such as risk immunization. Unfortunately, this behavioural trait is endemic of the human condition and recurring throughout history. Technology doesn't make decisions, humans do.

Like all technology, the tools of finance have the faculty to be used appropriately and inappropriately. Albeit, this is not to be confused with the notion that they are either 'good' or 'bad' as some would like to argue. Wrongly, such oversimplifications are often used to justify or discredit the utility of other science fields (i.e., nuclear energy, genetics and social planning). Thankfully, the world we live in is not that simple or binary. With that said, there is perhaps one absolute that most would agree upon. There is an unwritten duty that transcends all science practitioners: use the tools and knowledge conscientiously. As new and old students of finance study this text, it is incumbent upon you to appreciate the strengths and weaknesses of the discipline and transact responsibly within its boundaries.

Oldrich Masek
Managing Director, JPMorgan

This page intentionally left blank

PREFACE

Banking is a long-established and honourable profession. The provision of efficient loan and deposit facilities is an essential ingredient in human development and prosperity. For this reason, it is important that all banks are managed prudently. The art of banking remains unchanged from when banks were first established. At its core are the two principles of asset–liability mismatch and liquidity risk management. The act of undertaking loans and deposits creates the mismatch, because while investors like to lend for as short a term as possible, borrowers prefer to borrow for as long a term as possible. In other words, the act of banking is the process of *maturity transformation*, whereby banks 'lend long' and 'fund short'. Banks do not 'match-fund', because there would never be enough funds available to match a 25-year maturity mortgage with a 25-year fixed deposit. Thus, banking gives rise to liquidity risk, and bankers are therefore required to take steps to ensure that liquidity, the ability to roll over funding of long-dated loans, is continuously available.

We define banking as the provision of loans and deposits; the former produce interest income for the bank, while the latter create interest expense for the bank. On the bank's balance sheet the loan is the asset and the deposit is the liability, and the bank acts as the intermediary between borrowers and lenders. The fact that all banks irrespective of their size, approach or strategy must manage the two basic principles of asset–liability management (ALM) and liquidity management means that they are ultimately identical institutions. They deal within the same markets and with each other. That means that the bankruptcy of any one bank, while serious for its customers and creditors, can have a bigger impact still on the wider economy because of the risk this poses to other banks. It is this systemic risk which posed the danger for the world's economies in 2008, after Lehman Brothers collapsed, and which remains a challenge for financial regulators.

This book introduces the fundamental art of banking, which is ALM and liquidity risk management. It does not describe the different types of banks and their organizational structures that exist around the world. Neither does it describe the wide range of bank products that are available or the great variation in financial markets and instruments that can be observed. These topics are covered abundantly in existing textbooks. The object of this book is to present bank ALM and liquidity management at an introductory level, something that is not so common in textbooks on finance. These topics deserve to be understood and appreciated by everyone involved in banking, because it was unsound practices in these fields that helped to create the banking crisis in 2008, and made its impact so much worse than it need have been. A proper respect for the art of ALM will mitigate the impact on banks of the next financial crash.

Layout of the book

This book comprises 10 chapters. The first four provide a necessary background on bank capital, the money markets, the yield curve and market risk hedging. This is essential reading for all newcomers to the financial markets. Chapters 5–7 discuss the asset–liability management (ALM) process for a bank – the essential art of banking – and the role of the ALM committee or ALCO, which is the most important executive management committee in a bank.

Chapter 8 takes a detailed look at liquidity risk management, while Chapter 9 focuses on bank strategy and return. The final chapter looks at regulatory capital, the availability and treatment of which drives bank strategy.

For newcomers to the market there is a primer on financial market arithmetic in Appendix B (p. 317).

Highlights of the book include

- an accessible look at the ALM function undertaken at banks and securities houses, including risk management and management reporting;
- the role of the bank ALM committee (ALCO);
- a review of liquidity risk management and the main liquidity metrics used in banks;

- a discussion of bank strategy and why this should focus on sustainable returns over the business cycle;
- an introduction to the Basel II and Basel III regulatory capital rules and their implications.

As always, the intention is to remain accessible and practical throughout, and we hope this aim has been achieved. Comments on the text are most welcome and should be sent to the author, care of John Wiley & Sons (UK) Ltd.

Acknowledgements

Thanks to Adrian Buckley, Khurram Butt, George Evans, Sean Jayasekara, Grant Jenkinson, Gino Landuyt, Sharon Mandeville, Neil McDougall, Ekaterina Mihova, Lamiaa Mohammed, Frank Stoltz, Stuart Turner, Dianne Weston, the chaps in the Post Room, and Graeme Wolvaardt for their help during the time I was at Europe Arab Bank; and to Roger Drayton, Tope Fasua, Martyn Hoccom, Adam Lawson, Stuart Medlen, Abhijit Patharkar, Bill Rickard and Frank Spiteri for their help after I left there.

Thanks to *The Raynes Park Footy Boys*. A Solid Bond in Your Heart.

Moorad Choudhry
Surrey, England
2 October 2010

This page intentionally left blank

ABOUT THE AUTHOR

Moorad Choudhry is Managing Director, Head of Business Treasury, Global Banking and Markets at The Royal Bank of Scotland. He was previously Head of Treasury at Europe Arab Bank, Head of Treasury at KBC Financial Products and Vice President in Structured Finance Services at JPMorgan Chase Bank.

Dr. Choudhry is Visiting Professor at the Department of Economics, London Metropolitan University; Visiting Research Fellow at the ICMA Centre, University of Reading; Associate Research Fellow at the School of Information Systems, Computing and Mathematics, Brunel University; Visiting Teaching Fellow at the Department of Management, Birkbeck, University of London; a Fellow of the Chartered Institute for Securities & Investment; a Fellow of the *ifs-School of Finance*; a Fellow of the Global Association of Risk Professionals; a Fellow of the Institute of Sales and Marketing Management; and a Fellow of the Institute of Directors. He is on the editorial boards of *Qualitative Research in Financial Markets*, *Securities & Investment Review* and the *Journal of Structured Finance* and on the advisory board of the *American Securitization Forum*.

He critically failed to delegate or appoint talented people lest they might undermine his overall authority. Instead he promoted those whose weaknesses he understood and could exploit. Competence was not an issue.

– James Wyllie, *Goering and Goering: Hitler's Henchman and His Anti-Nazi Brother*, The History Press, 2006

Chapter 1

BANK BUSINESS AND CAPITAL

Banking has a long and honourable history. Today it encompasses a wide range of activities of varying degrees of complexity. Whatever the precise business, the common denominators of all banking activities are those of risk, return and the bringing together of the providers of capital. Return on capital is the focus of all banking activity. The co-ordination of all banking activity could be said to be the focus of asset–liability management (ALM), although some practitioners will give ALM a narrower focus. Either way, we need to be familiar with the wide-ranging nature of banking business and the importance of bank capital. This then acts as a guide for what follows.

In this introductory chapter we place ALM in context by describing the financial markets and the concept of bank capital. We begin with a look at the business of banking. We then consider the different types of revenue generated by a bank, the concept of the banking book and the trading book, financial statements and the concept of provisions.

BANKING BUSINESS

Banking operations encompass a wide range of activities, all of which contribute to the asset and liability profile of a bank. Table 1.1 shows selected banking activities and the type of risk exposure they represent. The terms used in the table, such as 'market risk', are explained elsewhere in this book. In another chapter we discuss the elementary aspects of financial analysis – using key financial ratios – that are used to examine the profitability and asset quality of a bank. We also discuss bank regulation and the concept of bank capital.

Before considering the concept of ALM, all readers should be familiar with the way a bank's earnings and performance are reported in its financial statements. A bank's income statement will break down earnings by type, as we have defined in Table 1.1. So we need to be familiar with interest income, trading income and so on. The other side of an income statement is costs, such as operating expenses and bad loan provisions.

That the universe of banks encompasses many different varieties of beasts is evident from the way they earn their money. Traditional banking institutions, perhaps typified by a regional bank in the United States (US) or a building society in the United Kingdom (UK), will generate a much greater share of their revenues through

Table 1.1 Selected banking activities and services

Service or function	Revenue generated	Risk
Lending		
– Retail	Interest income, fees	Credit, market
– Commercial	Interest income, fees	Credit, market
– Mortgage	Interest income, fees	Credit, market
– Syndicated	Trading, interest income, fees	Credit, market
Credit cards	Interest income, fees	Credit, operational
Project finance	Interest income, fees	Credit
Trade finance	Interest income, fees	Credit, operational
Cash management		
– Processing	Fees	Operational
– Payments	Fees	Credit, operational
Custodian	Fees	Credit, operational
Private banking	Commission income, interest income, fees	Operational
Asset management	Fees, performance payments	Credit, market, operational
Capital markets		
– Investment banking	Fees	Credit, market
– Corporate finance	Fees	Credit, market
– Equities	Trading income, fees	Credit, market
– Bonds	Trading income, interest income, fees	Credit, market
– Foreign exchange	Trading income, fees	Credit, market
– Derivatives	Trading income, interest income, fees	Credit, market

net interest income than trading income, and vice versa for a firm with an investment bank heritage such as Morgan Stanley. Such firms will earn a greater share of their revenues through fees and trading income. The breakdown varies widely across regions and banks.

Let us now consider the different types of income streams and costs.

Interest income

Interest income, or net interest income (NII), is the main source of revenue for the majority of banks worldwide. It can form upwards of 60% of operating income, and for smaller banks and building societies it reaches 80% or more.

NII is generated from lending activity and interest-bearing assets, 'net' return is this interest income minus the cost of funding loans. Funding, which is a cost to the bank, is obtained from a wide variety of sources. For many banks, deposits are a key source of funding, as well as one of the cheapest. They are generally short term, though, or available on demand, so must be supplemented by longer term funding. Other sources of funds include senior debt, in the form of bonds, securitized bonds and money market paper.

NII is sensitive to both credit risk and market risk. Market risk, which we look at later, is essentially interest rate risk for loans and deposits. Interest rate risk will be driven by the maturity structure of the loan book, as well as the match (or mismatch) between the maturity of loans against the maturity of funding. This is known as the interest rate gap.

Fees and commissions

Banks generate fee income as a result of providing services to customers. Fee income is very popular with bank senior management because it is less volatile and not susceptible to market risk like trading income or even NII. There is also no credit risk because fees are often paid upfront. There are other benefits as well, such as the opportunity to build up a diversified customer base for this additional range of services, but these are of less concern to a bank's ALM desk.

Fee income uses less capital and also carries no market risk, but does carry other risks, such as operational risk.

Trading income

Banks generate trading income through trading activity in financial products such as equities (shares), bonds and derivative instruments. This includes acting as a dealer or market-maker in these products as well as taking proprietary positions for speculative purposes.

Running positions in securities (as opposed to derivatives) in some cases generates interest income; some banks strip this out of the capital gain made when the security is traded to profit, while others include it as part of overall trading income.

Trading income is the most volatile income source for a bank. It also generates relatively high market risk, as well as not inconsiderable credit risk. Many banks, although by no means all, use the Value-at-Risk (VaR) methodology to measure the risk arising from trading activity, which gives a statistical measure of expected losses to the trading portfolio under certain market scenarios.

Costs

Bank operating costs comprise staff costs and operating costs, such as provision of premises, information technology and office equipment. Other significant elements of cost are provisions for loan losses, which are charges against the loan revenues of the bank. Provision is based on subjective measurement by management of how much of the loan portfolio can be expected to be repaid by the borrower.

CAPITAL MARKETS

A 'capital market' is the term used to describe the market for raising and investing finance. The economies of developed countries and a large number of developing countries are based on financial systems that encompass investors and borrowers, *markets* and trading arrangements. A market can be one in the traditional sense such as an exchange where *financial instruments* are bought and sold on a trading floor, or it may refer to one where participants deal with each other over the telephone or via electronic screens. The basic principles are the same in any type of market. There are two primary users of capital markets: lenders and borrowers. The source of lenders' funds is, to a large extent, the personal sector made up of household savings and those acting as their investment managers such as life assurance companies and pension funds. The borrowers are made up of the government, local government and companies (called corporates). There is a basic conflict between the financial objectives of borrowers and lenders, in that those who are investing funds wish to remain *liquid*, which means having easy access to their investments. They also wish to maximize the return on their investment. A corporate, on the other hand, will wish to generate maximum net profit on its activities, which will require continuous investment in plant, equipment, human resources and so on. Such investment will therefore need to be as long term as possible. Government borrowing as well is often related to long-term projects such as the construction of schools, hospitals and roads. So while investors wish to have ready access to their cash and invest short, borrowers desire funding to be as long term as possible. One economist referred to this conflict as the 'constitutional weakness' of financial markets (Hicks, 1939), especially as there is no conduit through which to reconcile the needs of lenders and borrowers. To facilitate the efficient operation of financial markets and the price mechanism, intermediaries exist to bring together the needs of lenders and borrowers. A bank is the best example of this. Banks accept deposits from investors, which makes up the *liability* side of their balance sheet, and lend funds to borrowers, which forms the *assets* on their balance sheet. If a bank builds up a sufficiently large asset and liability base, it will be able to meet the needs of both investors and borrowers, as it can maintain liquidity to meet investors requirements as well as create long-term assets to meet the needs of borrowers. A bank is exposed to two primary risks in carrying out its operations: that a large number of investors decide to withdraw their funds at the same time (a 'run' on the bank) or that a large number of borrowers go bankrupt and default on their loans. The bank in acting as a financial intermediary reduces the *risk* it is exposed to by spreading and pooling risk across a wide asset and liability base.

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

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

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

The bond and money markets play a vital and essential role in raising finance for both governments and corporations. In 2009 the market in dollar-denominated bonds alone was worth over $13 trillion, which gives some idea of its importance. The basic bond instrument, which is a loan of funds by the buyer to the issuer of the bond, in return for regular interest payments up to the termination date of the loan, is still the most commonly issued instrument in debt markets. Nowadays there are a large variety of bond instruments, issued by a variety of institutions. An almost exclusively corporate instrument, the international bond or Eurobond, is a large and diverse market. In 2009 the size of the Eurobond market was over $2 trillion.

In every capital market the first financing instrument ever developed was the bill and then the bond; today, in certain developing economies the government short-dated bond market is often the only liquid market in existence. Over time – as financial systems develop and corporate debt and equity markets take shape – the money and bond markets retain their importance due to their flexibility and the ease with which transactions can be undertaken. In advanced financial markets – such as those in place in developed countries today – the introduction of *financial engineering* techniques has greatly expanded the range of instruments that can be traded. These instruments include instruments used for *hedging* positions held in bonds and other *cash* products, as well as meeting the investment and *risk management* needs of a whole host of market participants. Debt capital markets have been and continue to be tremendously important to the economic development of all countries, as they represent the means of *intermediation* for governments and corporates to finance their activities. In fact, it is difficult to imagine long-term capital-intensive projects – such as those undertaken by, say, petroleum, construction or aerospace companies – taking place without the existence of a debt capital market to allow the raising of vital finance.

SCOPE OF BANKING ACTIVITIES

We have introduced the different aspects of banking business. For the largest banks these aspects vary widely in nature. For our purposes we may group them together as shown at Figure 1.1. Put very simply, 'retail' or 'commercial' banking covers the more traditional lending and trust activities while 'investment' banking covers trading activity and fee-based income such as stock exchange listing and mergers and acquisitions. The one common objective of all banking activity is return on capital. Depending on the degree of risk it represents, a particular activity will be required to achieve a specified return on the capital it uses. The issue of banking capital is vital to an apprecia-

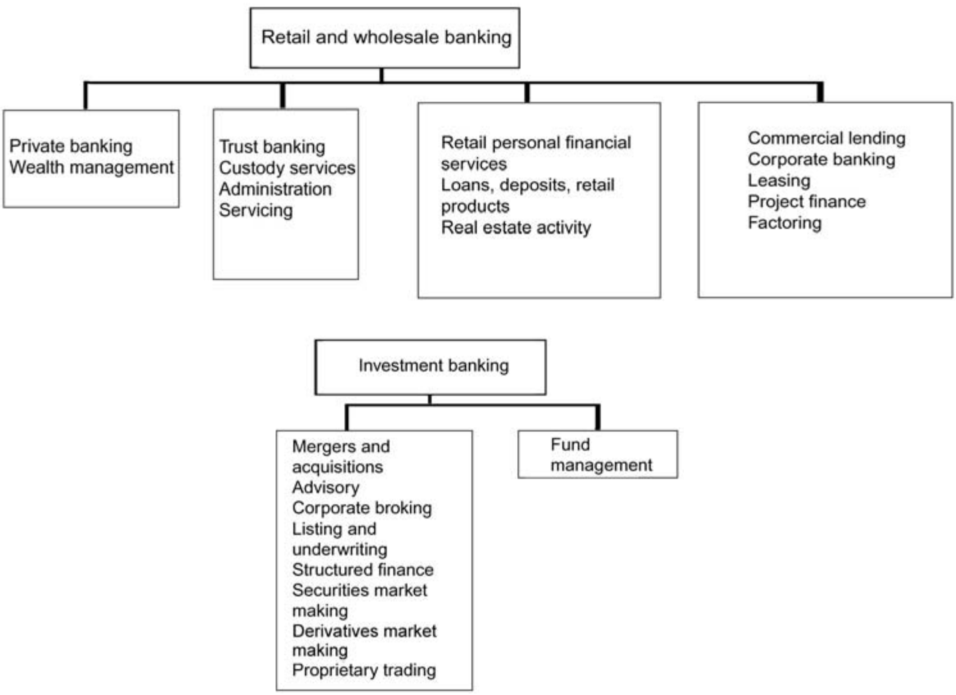


Figure 1.1 Scope of banking activities.

tion of the banking business; entire new business lines (such as securitization) have been devised in response to the need to make the use of capital more efficient.

As we can see from Figure 1.1, the scope of banking business is wide. Activities range from essentially plain vanilla activity, such as corporate lending, to complex transactions such as securitization and hybrid product trading. There is a vast literature on all these activities, so we do not need to cover them here. However, it is important to have a grounding in the basic products; subsequent chapters will introduce these.

ALM is concerned with the efficient management of banking capital among other things. It therefore concerns itself with all banking operations, even if day-to-day contact between the ALM desk (or Treasury desk) and other parts of the bank is remote. The ALM desk will be responsible for the Treasury and money market activities of the entire bank. So, if we wish, we could draw a box with ALM in it around the whole of Figure 1.1. This is not to say that the ALM function does all these activities; rather, it is just to make clear that all the various activities represent assets and liabilities for the bank, and one central function is responsible for this side of these activities.

For capital management purposes a bank's business is organized into a 'banking book' and a 'trading book'. We consider them next; first though, a word on bank capital.

Capital

Bank capital is the equity of the bank. It is important as it is the cushion that absorbs any unreserved losses that the bank incurs. By acting as this cushion, it enables the bank to continue operating and thus avoid insolvency or bankruptcy during periods of market correction or economic downturn. When the bank suffers a loss or writes off a loss-making or otherwise economically untenable activity, the capital is used to absorb the loss. This can be done by eating into reserves, freezing dividend payments or (in more extreme scenarios) a writedown of equity capital. In the capital structure, the rights of capital creditors including equity holders are subordinated to senior creditors and deposit holders.

Banks occupy a vital and pivotal position in any economy, as the suppliers of credit and financial liquidity, so bank capital is important. As such, banks are heavily regulated by central monetary authorities, and their capital is subject to regulatory rules compiled by the Bank for International Settlements (BIS), based in Basel, Switzerland. For this reason its regulatory capital rules are often called the 'Basel rules'. Under the original Basel rules (Basel I) a banking institution was required to hold a minimum capital level of 8% against the assets on its book.[1] Total capital is comprised of

- equity capital;
- reserves;
- retained earnings;
- preference share issue proceeds;
- hybrid capital instruments;
- subordinated debt.

Capital is split into Tier 1 capital and Tier 2 capital. The first three items in the bullet list comprise Tier 1 capital while the remaining items are Tier 2 capital.

The quality of the capital in a bank reflects its mix of Tier 1 and Tier 2 capital. Tier 1 or 'core capital' is the highest quality capital, as it is not obliged to be repaid; moreover, there is no impact on the bank's reputation if it is not repaid. Tier 2 is considered lower quality as it is not 'loss absorbing'; it is repayable and also of shorter term than equity capital. Assessing the financial strength and quality of a particular banking institution often requires calculating key capital ratios for the bank and comparing them with market averages and other benchmarks.

Analysts use a number of ratios to assess bank capital strength. Some of the more common ones are shown in Table 1.2.

Banking and trading books

Banks and financial institutions make a distinction between their activities for capital management purposes, including regulatory capital. Activities are split between the 'banking book' and the 'trading book'. Put simply, the banking book holds the more traditional banking activities such as commercial banking, loans and deposits. This would cover lending to individuals as well as

[1] There is more to this than just this simple statement, and we consider this in Chapter 10.

Table 1.2 Bank analysis ratios for capital strength

Ratio	Calculation	Notes
Core capital ratio	Tier 1 capital/ Risk-weighted assets	A key ratio monitored, in particular, by rating agencies as a measure of high-quality non-repayable capital, available to absorb losses incurred by the bank
Tier 1 capital ratio	Eligible Tier 1 capital/ Risk-weighted assets	Another important ratio monitored by investors and rating agencies. Represents the amount of high-quality, non-repayable capital available to the bank
Total capital ratio	Total capital/ Risk-weighted assets	Represents total capital available to the bank
Off-balance-sheet risk to total capital	Off-balance-sheet and continent risk/ Total capital	Measure of adequacy of capital against off-balance-sheet risk including derivatives exposure and committed, undrawn credit lines

Source: Higson (1995).

corporates and other banks, and so will interact with investment banking business.[2] The trading book records wholesale market transactions, such as market-making and proprietary trading in bonds and derivatives. Again, speaking simply, the primary difference between the two books is that the overriding principle of the banking book is one of 'buy and hold'—that is, a long-term acquisition. Assets may be held on the book for up to 30 years or longer. The trading book is just that, it employs a trading philosophy so that assets may be held for very short terms, less than one day in some cases. The regulatory capital and accounting treatment of each book differs. The primary difference here is that the trading book employs

[2] For a start, there will be a commonality of clients. A corporate client will borrow from a bank and may also retain the bank's underwriting or structured finance departments to arrange a share issue or securitization on its behalf.

the 'mark-to-market' approach to record profit and loss (P&L), which is the daily 'marking' of an asset to its market value. An increase or decrease in the mark on the previous day's mark is recorded as an unrealized profit or loss on the book: on disposal of the asset, the realized profit or loss is the change in the mark at disposal compared with its mark at purchase.

The banking book

Traditional banking activity – such as deposits and loans – is recorded in the banking book. The accounting treatment for the banking book follows the accrual concept, which accrues interest cashflows as they occur. There is no mark to market. The banking book holds assets for which both corporate and retail counterparties as well as banking counterparties are represented. So it is the type of business activity that dictates whether it is placed in the banking book, not the type of counterparty or which department of the bank is conducting it. Assets and liabilities on the banking book generate interest rate and credit risk exposure for the bank. They also create liquidity and term mismatch ('gap') risks. Liquidity refers to the ease with which an asset can be transformed into cash and to the ease with which funds can be raised in the market. So we see that 'liquidity risk' actually refers to two related but separate issues.

All these risks form part of ALM. Interest rate risk management is a critical part of Treasury policy and ALM, while credit risk policy will be set and dictated by the credit policy of the bank. Gap risk creates an excess or shortgage of cash, which must be managed. This is the cash management part of ALM. There is also a mismatch risk associated with fixed rate and floating rate interest liabilities. The central role of financial markets is to enable cash management and interest rate management to be undertaken efficiently. ALM of the banking book will centre on interest rate risk management and hedging as well as liquidity management. Note how there is no 'market risk' for the banking book in principle, because there is no marking to market. However, the interest rate exposure of the book creates an exposure that is subject to market movements in interest rates, so in reality the banking book is exposed to market risk.

Trading book

Wholesale market activity including market-making and proprietary trading is recorded in the trading book. Assets on the trading book can be expected to have a high turnover, although not necessarily so, and are marked to market daily. Counterparties to this trading activity can include other banks and financial institutions such as hedge funds, corporates and central banks. Trading book activity generates the same risk exposure as that on the banking book, including market risk, credit risk and liquidity risk. It also creates a need for cash management. Much trading book activity involves derivative instruments, as opposed to 'cash' products. Derivatives include futures, swaps and options. These can be equity, interest rate, credit, commodity, foreign exchange (FX), weather and other derivatives. Derivatives are known as 'off-balance-sheet' instruments because they are recorded 'off' the (cash) balance sheet. Their widespread use and acceptance has greatly improved the efficiency of the process behind risk exposure hedging for banks and other institutions alike.

Off-balance-sheet transactions refer to 'contingent liabilities', which are so called because they refer to future exposure contracted now. These are not only derivatives contracts such as interest rate swaps or writing an option, but also include guarantees such as a credit line to a third-party customer or a group subsidiary company. These represent a liability for the bank that may be required to be honoured at some future date. In most cases they do not generate cash inflow or outflow at inception – unlike a cash transaction – but represent future exposure. If a credit line is drawn on, it represents a cash outflow and that transaction is then recorded on the balance sheet.

FINANCIAL STATEMENTS AND RATIOS

A key information tool for bank analysis is the financial statement, which comprises the balance sheet and the P&L account. Assets on the balance sheet should equal the assets on a bank's ALM report, while receipt of revenue (such as interest and fees income) and payout of costs during a specified period is recorded in the P&L report or income statement.

The balance sheet

The balance sheet is a statement of a company's assets and liabilities as determined by accounting rules. It is a snapshot of a particular point in time, and so by the time it is produced it is already out of date. However, it is an important information statement. A number of management information ratios are used when analysing the balance sheet; they are considered in the next chapter.

In Chapter 2 we use a hypothetical example to illustrate balance sheets. For a bank, there are usually five parts to a balance sheet, split up in such a way to show separately

- lending and deposits, or traditional bank business;
- trading assets;
- Treasury and interbank assets;
- off-balance-sheet assets;
- long-term assets, including fixed assets, shares in subsidiary companies, together with equity and Tier 2 capital.

This is illustrated in Table 1.3. The actual balance sheet of a retail or commercial bank will differ significantly from that of an investment bank, due to the relative importance of their various business lines, but the basic layout will be similar.

Profit and loss report

The income statement for a bank is the P&L report, which records all income and losses during a specified period of time. A bank income statement will show revenues that can be accounted for as net interest income, fees and commissions, and trading income. The precise mix of these sources will reflect the type of banking institution and the business lines it operates in. Revenue is offset by operating (non-interest) expenses, loan loss provisions, trading losses and tax expense.

A more 'traditional' commercial bank will have a much higher dependence on interest revenues than an investment bank that

Table 1.3 Components of a bank balance sheet

Assets	Liabilities
Cash	Short-term liabilities
Loans	Deposits
Financial instruments (long)	Financial instruments (short)
Fixed assets	Long-dated debt
Off balance sheet (receivables)	Equity
	Off balance sheet (liabilities)

Table 1.4 Components of bank income statement, typical structure for retail bank

	%	**Expressed as percentage of**
Core operating income	100	
Net interest income	64	Core operating income
Commissions and fee income	31	Core operating income
Trading income	8	Core operating income
+ Net other operating income	8	Core operating income
– Operating expenses	61	Revenues
Personnel	38	Revenues
Other, depreciation		
– Loan loss provisions	23	Pre-provision net income
= Net operating income		
+ Other non-operating income		
= Profit before tax		
– Tax		
= Net income		
– Minority interest		
= Attributable income		

Source: Bank financial statements.

engages in large-scale wholesale capital market business. Investment banks have a higher share of revenue comprising trading and fee income. Table 1.4 shows the components of a UK retail bank's income statement.

The composition of earnings varies widely among different institutions. Figure 1.2 shows the breakdown for a UK building society and the UK branch of a US investment bank in 2005, as reported in their financial accounts for that year.

Net interest income

The traditional source of revenue for retail banks – net interest income (NII) – remains as such today (see Figure 1.2). NII is driven by lending, interest-earning asset volumes and the net yield available on these assets after taking into account the cost of funding. While the main focus is on the loan book, the ALM desk will also concentrate on the bank's investment portfolio. The latter will include coupon receipts from money market and bond market assets, as well as dividends received from any equity holdings.

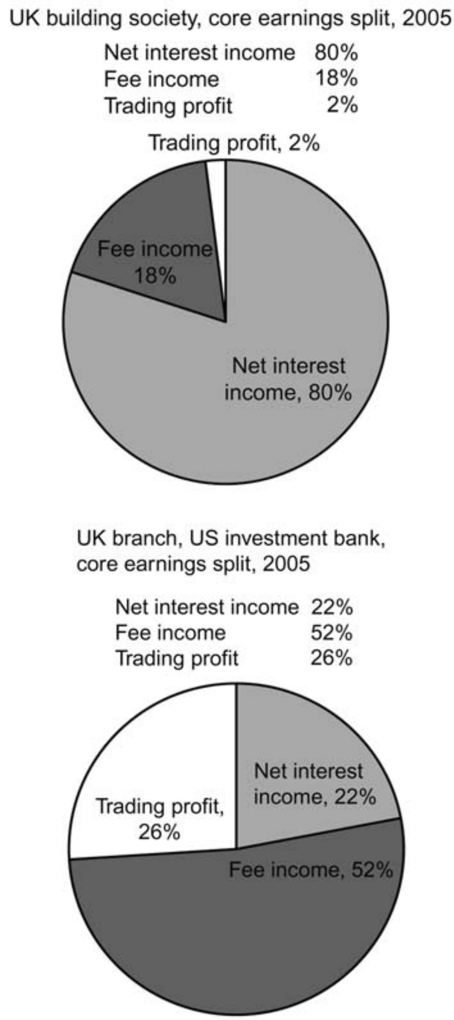


Figure 1.2 Composition of earnings.
Source: Bank financial statements.

The cost of funding is a key variable in generating overall NII. For a retail bank the cheapest source of funds is deposits, especially non-interest-bearing deposits such as cheque accounts.[3] Even in an era of high-street competition, the interest payable on short-term

[3] These are referred to as NIBLs (non-interest-bearing liabilities).

liabilities such as instant access deposits is far below the wholesale market interest rate. This is a funding advantage for retail banks when compared with investment banks, which generally do not have a retail deposit base. Other funding sources include capital markets (senior debt), wholesale markets (the interbank money market), securitized markets and covered bonds. The overall composition of funding significantly affects net interest margin and, if constrained, can reduce the activities of the bank.

The risk profile of asset classes that generate yields for the bank should lead to a range of net interest margins being reported across the sector, such that a bank with a strong unsecured lending franchise should seek significantly higher yields than one investing in secured mortgage loans; this reflects the different risk profiles of assets. The proportion of non-interest-bearing liabilities will also have a significant impact on the net interest margin of the institution. While a high net interest margin is desirable, it should also be adequate return for the risk incurred in holding the assets.

Bank NII is sensitive to both credit risk and market risk. Interest income is sensitive to changes in interest rates and the maturity profile of the balance sheet. Banks that have assets that mature earlier than their funding liabilities will gain from an environment of rising interest rates. The opposite applies where the asset book has a maturity profile that is longer dated than the liability book. Note that in a declining or low-interest-rate environment, banks may suffer from negative net interest income irrespective of their asset–liability maturity profile, as it becomes more and more difficult to pass on interest rate cuts to depositors.

While investment banks are less sensitive to changes in overall NII expectations due to their lower reliance on NII itself, their trading book will also be sensitive to changes in interest rates.

Fee and commission income

Fee revenue is generated from the sale and provision of financial services to customers. The level of fees and commission are communicated in advance to customers. Fee income known as non-interest income is separate from trading income and is desirable for banks because it represents a stable source of revenue that is not exposed to market risk. It is also attractive because it provides an opportunity for the bank to cross-sell new products and services to existing customers, and provision of these services does not expose the bank to additional credit or market risk. Fee income represents diversification in a bank's revenue base.

Note, though, that although fee-based business may not expose the bank to market risk directly, it does bring with it other risks, and these can include indirect exposure to market risk.[4] In addition, an ability to provide fee-based financial services may require significant investment in infrastructure and human resources.

Trading income

Trading income arises from the capital gain earned from buying and selling financial instruments. These instruments include both cash and derivative (off-balance-sheet) instruments and can arise from undertaking market-making, which in theory is undertaken to meet client demands and the proprietary business needs of the bank's own trading book. Note that interest income earned while holding assets on the trading book should really be considered NII and not trading income, but sometimes it is not stripped out from overall trading book P&L. There is no uniformity of approach among banks in this regard.

Trading income is the most volatile form of bank revenue. Even a record of consistent profit in trading over a long period is no guarantee against future losses arising out of market corrections or simply making the wrong bet on financial markets. Trading activity was the first type of banking activity whose risk exposure was measured using the Value-at-Risk methodology, which replaced duration-based risk measures in the 1990s.

Operating expenses

Banking operating costs typically contain human resources costs (remuneration and other personnel-related expenses) together with other operating costs such as premises and infrastructure costs, depreciation charges and goodwill.[5] Cost is generally measured as

---

[4] For example, a strategy pursued by banks in the 1990s was to merge with or acquire insurance companies, creating so-called *bancassurance* groups. Although much insurance business is fee-based, the acquisition of insurance portfolios brought with it added market risk for banks.

[5] These are accounting terms common to all corporate entities and are not used just to describe bank operating costs.

a proportion of revenue. A number of cost/income ratios are used by analysts, some of which are given in Table 1.5.

The return on equity (ROE) measure is probably the most commonly encountered and is usually part of bank strategy, with a target ROE level stated explicitly in management objectives. Note that there is a difference between accounting ROE and market ROE; the latter is calculated as a price return, rather like a standard P&L calculation, taken as the difference between market prices between two dates. During the 1990s, and certainly into 2005, average required ROE was in the order of 15% or higher – with investment banks usually set a higher target of 20%, 22% or even higher for certain higher risk business. The ROE target needs to reflect the relative risks of different business activities.

Return on assets (ROA) is another common measure of performance. It is calculated as follows:

$$\text{Current income (Interest income} + \text{Fees)} \times \text{Asset value}$$

Both financial statement P&L reports and measures such as ROE and ROA are bland calculations of absolute values; that is, they do not make any adjustment for relative risk exposure so cannot stand too much comparison with equivalent figures from another institution. This is because risk exposure – not to mention the specific type of business activity – will differ from one bank to another. However, there are general approximate values that serve as benchmarks for certain sectors, such as the 15% ROE level we state above. Banks also calculate risk-adjusted ratios.

Provisions

Banks expect a percentage of loan assets, and other assets, to suffer loss or become unrecoverable completely. Provisions are set aside out of reserves to cover for these losses each year; they are a charge against the loan revenues of the bank. The size of the provision taken is a function of what writeoffs may be required against the loan portfolio in the current period and in the future, and the size and adequacy of loan loss reserves currently available. In some jurisdictions there are regulatory requirements that dictate the minimum size of loss provision.

Provisions fund the bank's loan loss reserve, and the reserve will grow in size when the bank provides more for expected credit losses than the actual amount that is written off. If the bank believes

Table 1.5 Bank cost/income ratios

Ratio	Calculation	Notes
Pre-tax ROE	Pre-tax income/ Average shareholders equity	Measures the pre-tax return on equity. A measure above 20% is viewed as above average and strong
ROE	Attributable net income/ Average shareholders' equity	Measures return on equity. A measure above 10% is considered strong
ROA	Net income/ Average assets	Measures return on assets. A measure above 1% is considered strong
Cost–income ratio	Non-interest costs/ Total net revenues	Non-interest costs minus non-cash items such as goodwill or depreciation of intangible assets. The cost to produce one unit of net interest and non-interest income. The lower the ratio, the more efficient the bank
Net interest margin	Net interest income/ Average earnings assets	Difference between tax-equivalent yield on earning assets and the rate paid on funds to support those assets, divided by average earning assets
Loan loss provision	Loan loss provision/Pre-provision, pre-tax income	The proportion of pre-tax income that is being absorbed by loan losses. This is the credit cost of conducting the business
Non-interest income	Non-interest income/ Net revenues	Non-interest income includes service charges on deposits, trust fees, advisory fees, servicing fees, net trading profits from trading books, and commissions and fees from off-balance-sheet items. Generally, the higher the ratio, the greater the bank's sensitivity to changes in interest rates

subsequently that the size of the reserve built up is in excess of what is currently required, it may write back a percentage of it.

The amount of provisioning will vary with the business cycle. During a boom period in the cycle, corporate and retail default rates are at historically lower levels, and so a bank can afford to lower the level of its provisioning. However, prudent management dictates that senior managers are familiar with their markets and are able to judge when provision levels should increase. In other words, banks should 'know their market'.

REFERENCES

Hicks, J.R. (1939) *Value and Capital*, Oxford: Clarendon Press.
Higson, C. (1995) *Business Finance*, Oxford: Blackwell.

This page intentionally left blank

Chapter 2

THE MONEY MARKETS

Part of the global debt capital markets, the money markets are a separate market in their own right. Money market securities are defined as debt instruments with an original maturity of less than 1 year, although it is common to find that the maturity profile of banks' money market desks runs out to 2 years.

Money markets exist in every market economy, which is practically every country in the world. They are often the first element of a developing capital market. In every case they are comprised of securities with maturities of up to 12 months. Money market debt is an important part of global capital markets, and facilitates the smooth running of the banking industry as well as providing working capital for industrial and commercial corporate institutions. The market provides users with a wide range of opportunities and funding possibilities, and the market is characterized by the diverse range of products that can be traded within it. Money market instruments allow issuers, including financial organizations and corporates, to raise funds for short-term periods at relatively low interest rates. These issuers include sovereign governments, who issue Treasury bills, corporates issuing commercial paper and banks issuing bills and certificates of deposit. At the same time, investors are attracted to the market because the instruments are highly liquid and carry relatively low credit risk. The Treasury bill market in any country is that country's lowest risk instrument, and consequently carries the lowest yield of any debt instrument. Indeed, the first market that develops in any country is usually the Treasury bill market. Investors in the money market include banks, local authorities, corporations, money market investment funds and mutual funds, and individuals.

In addition to cash instruments, the money markets also consist of a wide range of exchange-traded and over-the-counter off-balance-sheet derivative instruments. These instruments are used mainly to establish future borrowing and lending rates, and to hedge or change existing interest rate exposure. This activity is carried out by both banks, central banks and corporates. The main derivatives are short-term interest rate futures, forward rate agreements and short-dated interest rate swaps, such as overnight index swaps.

In this chapter we review the cash instruments traded in the money market. In further chapters we review banking asset and liability management, and the market in repurchase agreements. Finally, we consider the market in money market derivative instruments including interest rate futures and forward rate agreements.

INTRODUCTION

The cash instruments traded in money markets include the following:

- time deposits;
- Treasury bills;
- certificates of deposit;
- commercial paper;
- banker's acceptances;
- bills of exchange;
- repo and stock lending.

Treasury bills are used by sovereign governments to raise short-term funds, while certificates of deposit (CDs) are used by banks to raise finance. The other instruments are used by corporates and occasionally banks. Each instrument represents an obligation on the borrower to repay the amount borrowed on the maturity date together with interest if this applies. The instruments above fall into one of two main classes of money market securities: those quoted on a *yield* basis and those quoted on a *discount* basis. These two terms are discussed below. A *repurchase agreement* or 'repo' is also a money market instrument.

The calculation of interest in the money markets often differs from the calculation of accrued interest in the corresponding bond market. Generally, the day-count convention in the money market is the exact number of days that the instrument is held over the number of days in the year. In the UK sterling market the year base is 365 days, so the interest calculation for sterling money market instruments is given by (2.1):

$$i = \frac{n}{365} \tag{2.1}$$

However, the majority of currencies, including the US dollar and the euro, calculate interest on a 360-day base. The process by which an interest rate quoted on one basis is converted to one quoted on the other basis is shown on p. 68. Those markets that calculate interest based on a 365-day year are also listed on p. 68.

Dealers will want to know the interest day base for a currency before dealing in it as foreign exchange (FX) or money markets. Bloomberg

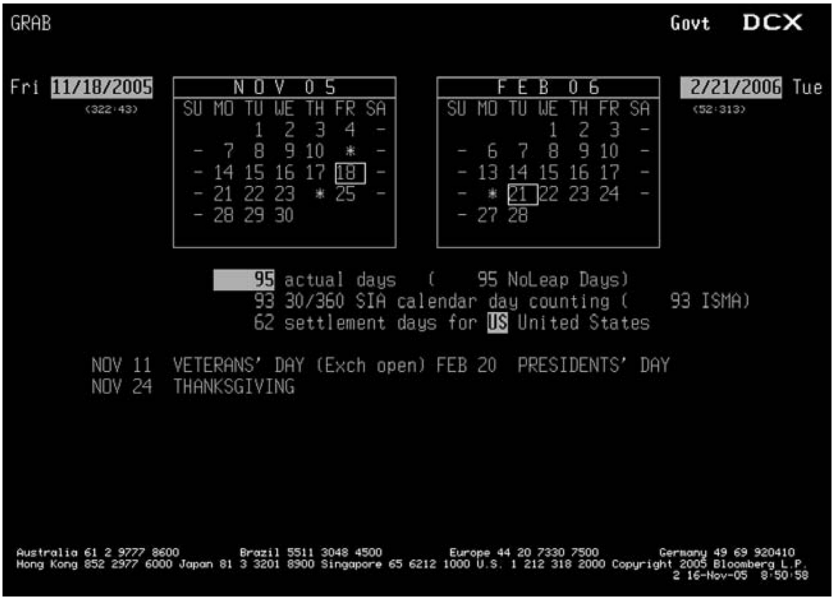


Figure 2.1 Bloomberg screen DCX used for US dollar market, 3-month loan taken out for value 18 November 2005.

users can use screen DCX to look up the number of days of an interest period. For instance, Figure 2.1 shows screen DCX for the US dollar market, for a loan taken out on 16 November 2005 for spot value on 18 November 2005 for a straight 3-month period. This matures on 21 February 2006; we see from Figure 2.1 that this is a good day. We see also that 20 February 2006 is a USD holiday. The loan period is actually 95 days, and 93 days under the 30/360-day convention (a bond market accrued interest convention). The number of business days is 62.

For the same loan taken out in Singapore dollars, look at Figure 2.2. This shows that 20 February 2006 is not a public holiday for SGD and so the loan runs for the period 18 December 2005 to 20 February 2006.

Settlement of money market instruments can be for value today (generally only when traded before mid-day), tomorrow or 2 days forward, which is known as *spot*. The latter is most common.

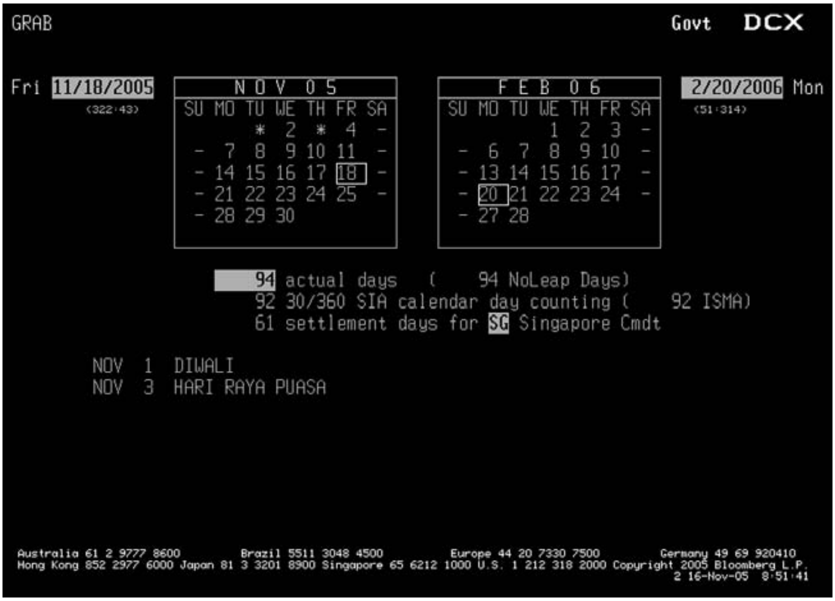


Figure 2.2 Bloomberg screen DCX for Singapore dollar market, 3-month loan taken out for value 18 November 2005.

SECURITIES QUOTED ON A YIELD BASIS

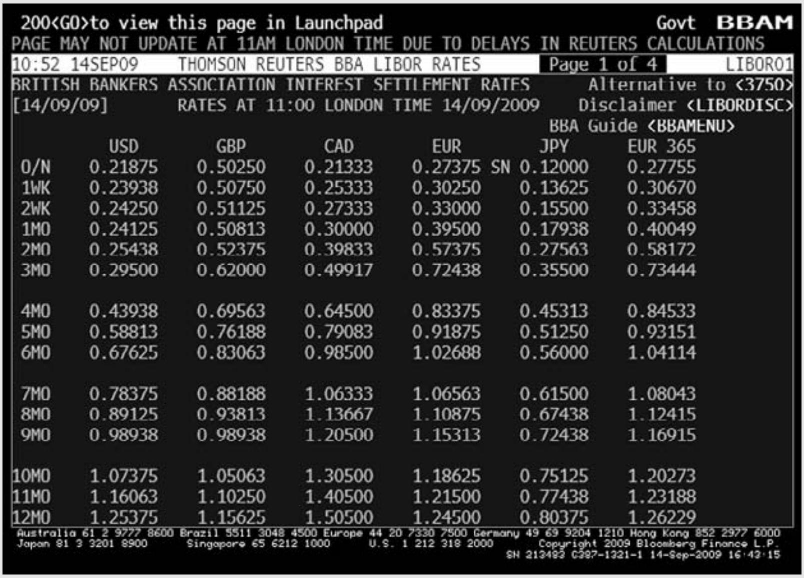
Two of the instruments in the list at the top of p. 25 are yield-based instruments.

Money market deposits

These are fixed interest term deposits of up to 1 year with banks and securities houses. They are also known as *time deposits* or *clean deposits*. They are not negotiable so cannot be liquidated before maturity. The interest rate on the deposit is fixed for the term and related to the London Interbank Offered Rate (LIBOR) of the same term. Interest and capital are paid on maturity.

LIBOR

The term LIBOR or 'Libor' comes from London Interbank Offered Rate and is the interest rate at which one London bank offers funds to another London bank of acceptable credit quality in the form of a cash deposit. The rate is 'fixed' by the British Bankers Association at 11 a.m. every business day morning (in practice, the fix is usually about 20 minutes later) by taking the average of the rates supplied by member banks. The term LIBID is the bank's 'bid' rate – that is, the rate at which it pays for funds in the London market. The quote spread for a selected maturity is therefore the difference between LIBOR and LIBID. The convention in London is to quote the two rates as LIBOR–LIBID, thus matching the yield convention for other instruments. In some other markets the quote convention is reversed. EURIBOR is the interbank rate offered for euros as reported by the European Central Bank, fixed in Brussels. Figure 2.3 shows the Bloomberg screen BBAM, which is the daily listing of the BBA Libor fix, as at 14 September 2009.


200<GO>to view this page in Launchpad Govt BBAM
PAGE MAY NOT UPDATE AT 11AM LONDON TIME DUE TO DELAYS IN REUTERS CALCULATIONS
10:52 14SEP09 THOMSON REUTERS BBA LIBOR RATES Page 1 of 4 LIBOR01
BRITISH BANKERS ASSOCIATION INTEREST SETTLEMENT RATES Alternative to <3750>
[14/09/09] RATES AT 11:00 LONDON TIME 14/09/2009 Disclaimer <LIBORDISC>
BBA Guide <BBAMENU>

	USD	GBP	CAD	EUR	JPY	EUR 365
O/N	0.21875	0.50250	0.21333	0.27375 SN	0.12000	0.27755
1WK	0.23938	0.50750	0.25333	0.30250	0.13625	0.30670
2WK	0.24250	0.51125	0.27333	0.33000	0.15500	0.33458
1MO	0.24125	0.50813	0.30000	0.39500	0.17938	0.40049
2MO	0.25438	0.52375	0.39833	0.57375	0.27563	0.58172
3MO	0.29500	0.62000	0.49917	0.72438	0.35500	0.73444
4MO	0.43938	0.69563	0.64500	0.83375	0.45313	0.84533
5MO	0.58813	0.76188	0.79083	0.91875	0.51250	0.93151
6MO	0.67625	0.83063	0.98500	1.02688	0.56000	1.04114
7MO	0.78375	0.88188	1.06333	1.06563	0.61500	1.08043
8MO	0.89125	0.93813	1.13667	1.10875	0.67438	1.12415
9MO	0.98938	0.98938	1.20500	1.15313	0.72438	1.16915
10MO	1.07375	1.05063	1.30500	1.18625	0.75125	1.20273
11MO	1.16063	1.10250	1.40500	1.21500	0.77438	1.23188
12MO	1.25375	1.15625	1.50500	1.24500	0.80375	1.26229

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2009 Bloomberg Finance L.P.
SN 213493 C387-1321-1 14-Sep-2009 16:43:15

Figure 2.3 British Bankers' Association Libor fixing, Bloomberg page BBAM, as at 14 September 2009.

The effective rate on a money market deposit is the annual equivalent interest rate for an instrument with a maturity of less than 1 year.

Example 2.1

A sum of £250,000 is deposited for 270 days, at the end of which the total proceeds are £261,000. What are the simple and effective rates of return on a 365-day basis?

$$\text{Simple rate of return} = \left(\frac{\text{Total proceeds}}{\text{Initial investment}} - 1\right) \times \frac{M}{n}$$

$$= \left(\frac{261{,}000}{250{,}000} - 1\right) \times \frac{365}{270} = 5.9481\%$$

$$\text{Effective rate of return} = \left(\frac{\text{Total proceeds}}{\text{Initial investment}}\right)^{M/n} - 1$$

$$= \left(\frac{261{,}000}{250{,}000}\right)^{365/270} - 1 = 5.9938\%$$

Certificates of deposit

Certificates of deposit (CDs) are receipts from banks for deposits that have been placed with them. They were first introduced in the sterling market in 1958. The deposits themselves carry a fixed rate of interest related to LIBOR and have a fixed term to maturity, so cannot be withdrawn before maturity. However, the certificates themselves can be traded in a secondary market – that is, they are negotiable.[1] CDs are therefore very similar to negotiable money market deposits, although the yields are about 0.15% below the equivalent deposit rates because of the added benefit of liquidity. Most CDs issued are of between 1 and 3 months' maturity, although they do trade in maturities of 1 to 5 years. Interest is paid on maturity except for CDs lasting longer than 1 year, where interest is paid annually or, occasionally, semiannually.

Banks, merchant banks and building societies issue CDs to raise funds to finance their business activities. A CD will have a stated interest rate and fixed maturity date, and can be issued in any denomination. On issue a CD is sold for face value, so the settlement proceeds of a CD on issue are always equal to its nominal value. The interest is paid, together with the face amount, on maturity. The interest rate is sometimes called the *coupon*, but unless the CD

[1] A small number of CDs are non-negotiable.

is held to maturity this will not equal the yield, which is of course the current rate available in the market and varies over time. The largest group of CD investors are banks, money market funds, corporates and local authority treasurers.

Unlike coupons on bonds, which are paid in rounded amounts, CD coupon is calculated to the exact day.

CD yields

The coupon quoted on a CD is a function of the credit quality of the issuing bank, its expected liquidity level in the market and, of course, the maturity of the CD, as this will be considered relative to the money market yield curve. As CDs are issued by banks as part of their short-term funding and liquidity requirement, issue volumes are driven by the demand for bank loans and the availability of alternative sources of funds for bank customers. The credit quality of the issuing bank is the primary consideration, however; in the sterling market the lowest yield is paid by 'clearer' CDs, which are CDs issued by the clearing banks – such as RBS NatWest plc, HSBC and Barclays plc. In the US market 'prime' CDs, issued by highly rated domestic banks, trade at a lower yield than non-prime CDs. In both markets CDs issued by foreign banks – such as French or Japanese banks – will trade at higher yields.

Euro-CDs, which are CDs issued in a different currency from that of the home currency, also trade at higher yields in the US because of reserve and deposit insurance restrictions.

If the current market price of the CD including accrued interest is P and the current quoted yield is r, the yield can be calculated given the price, using (2.2):

$$r = \left(\frac{M}{P} \times \left(1 + C\left(\frac{N_{im}}{B}\right)\right) - 1\right) \times \left(\frac{B}{N_{sm}}\right) \tag{2.2}$$

The price can be calculated given the yield using (2.3):

$$\begin{aligned} P &= M \times \left(1 + C\left(\frac{N_{im}}{B}\right)\right) \Big/ 1 + r\left(\frac{N_{sm}}{B}\right) \\ &= F \Big/ \left(1 + r\left(\frac{N_{sm}}{B}\right)\right) \end{aligned} \tag{2.3}$$

where $C =$ Quoted coupon on the CD;
$M =$ Face value of the CD;
$B =$ Year day basis (365 or 360);
$F =$ Maturity value of the CD;
$N_{im} =$ Number of days between issue and maturity;
$N_{sm} =$ Number of days between settlement and maturity;
$N_{is} =$ Number of days between issue and settlement.

After issue a CD can be traded in the secondary market. The secondary market in CDs in the UK is very liquid, and CDs will trade at the rate prevalent at the time, which will invariably be different from the coupon rate on the CD at issue. When a CD is traded in the secondary market, the settlement proceeds will need to take into account interest that has accrued on the paper and the different rate at which the CD has now been dealt. The formula for calculating the settlement figure is given at (2.4) which applies to the sterling market and its 365 day-count basis:

$$\text{Proceeds} = \frac{M \times \text{Tenor} \times C \times 100 + 36{,}500}{\text{Days remaining} \times r \times 100 + 36{,}500} \tag{2.4}$$

The settlement figure for a new issue CD is, of course, its face value . . .![2]

The *tenor* of a CD is the life of the CD in days, while *days remaining* is the number of days left to maturity from the time of trade.

The return on holding a CD is given by (2.5):

$$R = \left(\frac{1 + \text{Purchase yield} \times \dfrac{\text{Days from purchase to maturity}}{B}}{1 + \text{Sale yield} \times \dfrac{\text{Days from sale to maturity}}{B}} - 1 \right) \times \frac{B}{\text{Days held}} \tag{2.5}$$

[2] With thanks to Del Boy during the time he was at Tradition for pointing this out after I'd just bought a sizeable chunk of Japanese bank CDs . . . circa 1993.

Example 2.2

A 3-month CD is issued on 6 September 1999 and matures on 6 December 1999 (maturity of 91 days). It has a face value of £20,000,000 and a coupon of 5.45%. What are the total maturity proceeds?

$$\begin{aligned}\text{Proceeds} &= 20 \text{ millions} \times \left(1 + 0.0545 \times \frac{91}{365}\right)\\ &= £20{,}271{,}753.42.\end{aligned}$$

What are the secondary market proceeds on 11 October if the yield for short 60-day paper is 5.60%?

$$P = \frac{20{,}271{,}753.42}{\left(1 + 0.056 \times \frac{56}{365}\right)} = £20{,}099{,}066.64.$$

On 18 November the yield on short 3-week paper is 5.215%. What rate of return is earned from holding the CD for the 38 days from 11 October to 18 November?

$$R = \left(\frac{1 + 0.0560 \times \frac{56}{365}}{1 + 0.052\,15 \times \frac{38}{365}} - 1\right) \times \frac{365}{38} = 9.6355\%.$$

An example of the way CDs and time deposits are quoted on screen is shown at Figure 2.4, which shows one of the rates screens displayed by Tullett & Tokyo, money brokers in London, on a Bloomberg screen. Essentially the same screen is displayed on Reuters. The screen has been reproduced with permission from Tullett's and Bloomberg. The screen displays sterling interbank and CD bid and offer rates for maturities up to 1 year as at 18 November 2005. The maturity marked 'O/N' is the overnight rate, which at that time was 4.35–4.40. The maturity marked 'T/N' is 'tom-next', or 'tomorrow-to-the-next', which is the overnight rate for deposits commencing tomorrow. Note that the liquidity of CDs means that they trade at a lower yield to deposits. The bid–offer convention in sterling is that the rate at which the market-maker will pay for funds – its borrowing rate – is placed on the left. A 6-month time deposit is lent at 4.62%.

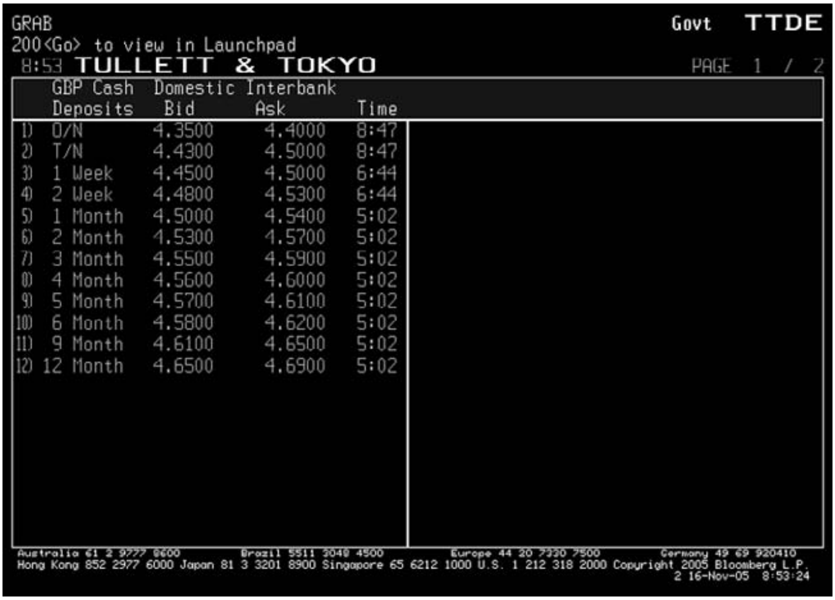


Figure 2.4 Tullett & Tokyo brokers' sterling money markets screen, 18 November 2005.

This is a reversal of the sterling market convention of placing the offered rate on the left-hand side, which existed until the end of the 1990s.

US dollar market rates

Treasury bills

The Treasury bill (*T-bill*) market in the US is the most liquid and transparent debt market in the world. Consequently, the bid–offer spread on them is very narrow. The Treasury issues bills at a weekly auction each Monday, made up of 91-day and 182-day bills. Every fourth week the Treasury also issues 52-week bills as well. As a result there are large numbers of T-bills outstanding at any one time. The interest earned on T-bills is not liable to state and local income taxes. T-bill rates are the lowest in the dollar market (as indeed any bill market is in respective domestic environments) and as such represent the corporate financier's *risk-free* interest rate.

Federal funds

Commercial banks in the US are required to keep reserves on deposit at the Federal Reserve. Banks with reserves in excess of required reserves can lend these funds to other banks, and these interbank loans are called *federal funds* or *fed funds* and are usually overnight loans. Through the fed funds market, commercial banks with excess funds are able to lend to banks that are short of reserves, thus facilitating liquidity. The transactions are very large denominations, and are lent at the *fed funds rate*, which can be a relatively volatile interest rate because it fluctuates with market shortages. On average, it trades about 15 basis points or so below the overnight Libor fix. The difference can be gauged by looking at Figures 2.5 and 2.6, which are the graphs for historical USD fed funds and overnight Libor rates, respectively.

Prime rate

The *prime interest rate* in the US is often said to represent the rate at which commercial banks lend to their most creditworthy customers. In practice, many loans are made at rates below the prime rate, so the prime rate is not the best rate at which highly rated firms may borrow. Nevertheless, the prime rate is a benchmark indicator of the level of US money market rates, and is often used as a reference rate for floating-rate instruments. As the market for bank loans is highly competitive, all commercial banks quote a single prime rate, and the rate for all banks changes simultaneously.

SECURITIES QUOTED ON A DISCOUNT BASIS

The remaining money market instruments are all quoted on a *discount* basis, and so are known as 'discount' instruments. This means that they are issued on a discount to face value, and are redeemed on maturity at face value. Hence T-bills, bills of exchange, banker's acceptances and commercial paper are examples of money market securities that are quoted on a discount basis – that is, they are sold on the basis of a discount to par. The difference between the price paid at the time of purchase and the redemption value (par) is the interest earned by the holder of the paper. Explicit interest is not paid on discount instruments, rather interest is reflected implicitly in the difference between the discounted issue price and the par value received at maturity.

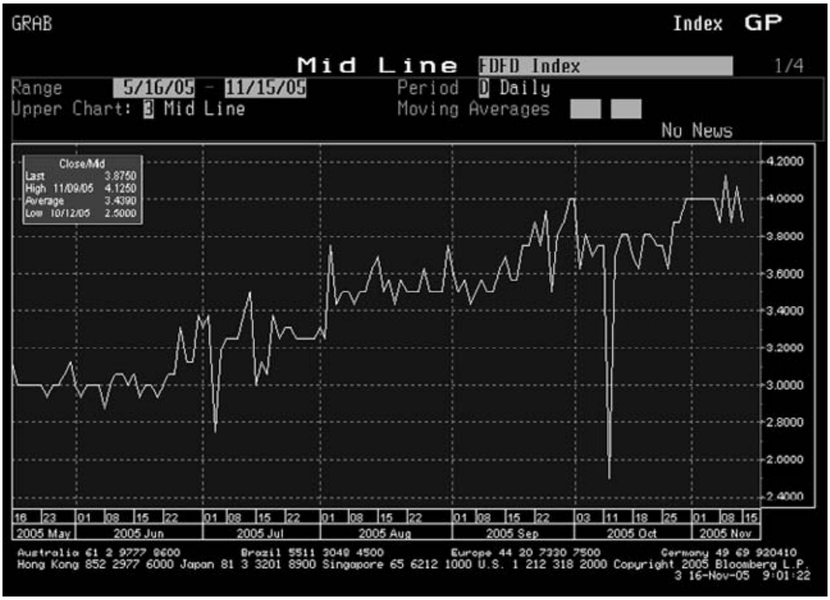


Figure 2.5 Bloomberg screen GP showing fed funds rate for period May–November 2005.

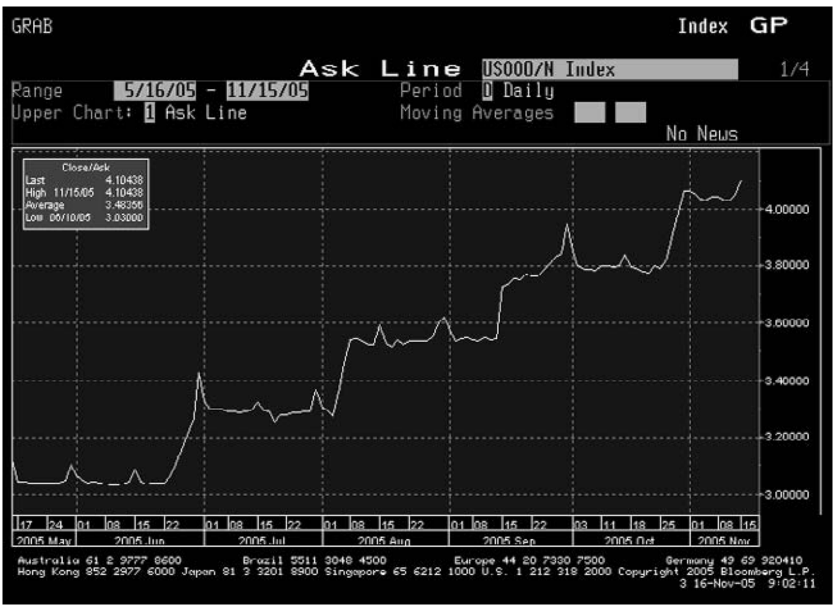


Figure 2.6 Bloomberg screen GP showing USD overnight Libor for period May–November 2005.

Treasury bills

Treasury bills (*T-bills*) are short-term government 'IOUs' of short duration, often 3-month maturity. For example, if a bill is issued on 10 January it will mature on 10 April. Bills of 1-month and 6-month maturity are issued in certain markets, but only rarely by the UK Treasury. On maturity the holder of a T-bill receives the par value of the bill by presenting it to the central bank. In the UK most such bills are denominated in sterling but issues are also made in euros. In a capital market, T-bill yields are regarded as the *risk-free* yield, as they represent the yield from short-term government debt. In emerging markets they are often the most liquid instruments available for investors.

A sterling T-bill with £10 million face value issued for 91 days will be redeemed on maturity at £10 million. If the 3-month yield at the time of issue is 5.25%, the price of the bill at issue is:

$$P = \frac{10{,}000{,}000}{\left(1 + 0.0525 \times \frac{91}{365}\right)}$$

$$= £9{,}870{,}800.69$$

In the UK market the interest rate on discount instruments is quoted as a *discount rate* rather than a yield. This is the amount of discount expressed as an annualized percentage of the face value, and not as a percentage of the original amount paid. By definition, the discount rate is always lower than the corresponding yield. If the discount rate on a bill is d, then the amount of discount is given by (2.6):

$$d_{value} = M \times d \times \frac{n}{B} \qquad (2.6)$$

The price P paid for the bill is the face value minus the discount amount, given by (2.7):

$$P = 100 \times \left(\frac{1 - d \times (N_{sm}/365)}{100}\right) \qquad (2.7)$$

If we know the yield on the bill then we can calculate its price at issue by using the simple present value formula, as shown at (2.8):

$$P = \frac{M}{1 + r\dfrac{N_{sm}}{365}} \qquad (2.8)$$

The discount rate d for T-bills is calculated using (2.9):

$$d = (1 - P) \times \frac{B}{n} \tag{2.9}$$

The relationship between discount rate and true yield is given by (2.10):

$$\left.\begin{aligned} d &= \frac{r}{\left(1 + r \times \frac{n}{B}\right)} \\ r &= \frac{d}{1 - d \times \frac{n}{B}} \end{aligned}\right\} \tag{2.10}$$

Example 2.3

A 91-day £100 T-bill is issued with a yield of 4.75%. What is its issue price?

$$\begin{aligned} P &= £100 \Big/ \left(1 + 0.0475\left(\frac{91}{365}\right)\right) \\ &= £98.80 \end{aligned}$$

A UK T-bill with a remaining maturity of 39 days is quoted at a discount of 4.95% What is the equivalent yield?

$$\begin{aligned} r &= \frac{0.0495}{1 - 0.0495 \times \frac{39}{365}} \\ &= 4.976\% \end{aligned}$$

If a T-Bill is traded in the secondary market, the settlement proceeds from the trade are calculated using (2.11):

$$\text{Proceeds} = M - \left(\frac{M \times \text{Days remaining} \times d}{B \times 100}\right) \tag{2.11}$$

Banker's acceptances

A banker's acceptance is a written promise issued by a borrower to a bank to repay borrowed funds. The lending bank lends funds and in return accepts the banker's acceptance. The acceptance is negotiable and can be sold in the secondary market. The investor who buys the acceptance can collect the loan on the day that repayment is due. If the borrower defaults, the investor has legal recourse to the bank that made the first acceptance. Banker's acceptances are also known as *bills of exchange*, *bank bills*, *trade bills* or *commercial bills*.

Essentially, banker's acceptances are instruments created to facilitate commercial trade transactions. The instrument is called a *banker's acceptance* because a bank accepts the ultimate responsibility to repay the loan to its holder. The use of banker's acceptances to finance commercial transactions is known as *acceptance financing*. The transactions for which acceptances are created include import and export of goods, the storage and shipping of goods between two overseas countries, where neither the importer nor the exporter is based in the home country,[3] and the storage and shipping of goods between two entities based at home. Acceptances are discount instruments and are purchased by banks, local authorities and money market investment funds.

The rate that a bank charges a customer for issuing a banker's acceptance is a function of the rate at which the bank thinks it will be able to sell it in the secondary market. A commission is added to this rate. For ineligible banker's acceptances (see below) the issuing bank will add an amount to offset the cost of additional reserve requirements.

Eligible banker's acceptance

An accepting bank that chooses to retain a banker's acceptance in its portfolio may be able to use it as collateral for a loan obtained from the central bank during open market operations – for example, the Bank of England in the UK and the Federal Reserve in the US. Not all acceptances are eligible to be used as collateral in this way, as they must meet certain criteria set by the central bank. The main requirement for eligibility is that the acceptance must be within a certain maturity band (a maximum of 6 months in the US and 3 months in the UK), and that it must have been created to finance a self-liquidating commercial transaction. In the US eligibility is also important because the Federal Reserve imposes a reserve requirement on funds raised via banker's acceptances that are ineligible.

---

[3] A banker's acceptance created to finance such a transaction is known as a *third-party acceptance*.

Banker's acceptances sold by an accepting bank are potential liabilities for the bank, but the reserve imposes a limit on the amount of eligible banker's acceptances that a bank may issue. Bills eligible for deposit at a central bank enjoy a finer rate than ineligible bills, and also act as a benchmark for prices in the secondary market.

COMMERCIAL PAPER

Commercial paper (CP) is a short-term money market funding instrument issued by corporates. In the UK and US it is a discount instrument. A company's short-term capital and *working* capital requirement is usually sourced directly from banks, in the form of bank loans. An alternative short-term funding instrument is CP, which is available to corporates that have a sufficiently strong credit rating. CP is a short-term unsecured promissory note. The issuer of the note promises to pay its holder a specified amount on a specified maturity date. CP normally has a zero coupon and trades at a *discount* to its face value. The discount represents interest to the investor in the period to maturity. CP is typically issued in bearer form, although some issues are in registered form.

Originally, the CP market was restricted to borrowers with high credit ratings, and although lower rated borrowers do now issue CP, sometimes by obtaining credit enhancements or setting up collateral arrangements, issuance in the market is still dominated by highly rated companies. The majority of issues are very short term, from 30 to 90 days in maturity; it is extremely rare to observe paper with a maturity of more than 270 days or 9 months. This is because of regulatory requirements in the US,[4] which state that debt instruments with a maturity of less than 270 days need not be registered. Companies therefore issue CP with a maturity lower than 9 months and so avoid the administration costs associated with registering issues with the SEC.

There are two major markets, the US dollar market with an outstanding amount in 2005 just under $1 trillion, and the Eurocommercial paper market with an outstanding value of $490 billion at the end of 2005.[5] Commercial paper markets are wholesale

---

[4] This is the Securities Act of 1933. Registration is with the Securities and Exchange Commission.

[5] *Source*: BIS.

Table 2.1 Comparison of US CP and Eurocommercial CP.

	US CP	**Eurocommercial CP**
Currency	US dollar	Any euro currency
Maturity	1–270 days	2–365 days
Common maturity	30–180 days	30–90 days
Interest	Zero coupon, issued at discount	Fixed coupon
Quotation	On a discount rate basis	On a yield basis
Settlement	$T + 0, T + 1$	$T + 2$
Registration	Bearer form	Bearer form
Negotiable	Yes	Yes

markets, and transactions are typically very large. In the US over a third of all CP is purchased by money market unit trusts, known as mutual funds; other investors include pension fund managers, retail or commercial banks, local authorities and corporate treasurers. A comparison between USCP and ECP is given in Table 2.1.

Although there is a secondary market in CP, very little trading activity takes place since investors generally hold CP until maturity. This is to be expected because investors purchase CP that matches their specific maturity requirement. When an investor does wish to sell paper, it can be sold back to the dealer or, where the issuer has placed the paper directly in the market (and not via an investment bank), it can be sold back to the issuer.

Commercial paper programmes

The issuers of CP are often divided into two categories of company: banking and financial institutions and non-financial companies. The majority of CP issues are by financial companies. Financial companies include not only banks but also the financing arms of corporates – such as British Airways, BP and Ford Motor Credit. Most of the issuers have strong credit ratings, but lower rated borrowers have tapped the market, often after arranging credit support from a higher rated company, such as a *letter of credit* from a bank, or by arranging collateral for the issue in the form of high-quality assets such as Treasury bonds. CP issued with credit support is known as *credit-supported commercial paper*, while paper backed with assets is known naturally enough as *asset-backed commercial paper*. Paper that is backed by a bank letter of credit is termed *LOC paper*.

Although banks charge a fee for issuing letters of credit, borrowers are often happy to arrange for this, since by so doing they are able to tap the CP market. The yield paid on an issue of CP will be lower than that on a commercial bank loan.

Although CP is a short-dated security, typically of 3-to-6-month maturity, it is issued within a longer term programme, usually for 3 to 5 years for euro paper; US CP programmes are often open-ended. For example, a company might arrange a 5-year CP programme with a limit of $100 million. Once the programme is established the company can issue CP up to this amount – say, for maturities of 30 or 60 days. The programme is continuous and new CP can be issued at any time, daily if required. The total amount in issue cannot exceed the limit set for the programme. A CP programme can be used by a company to manage its short-term liquidity – that is, its working capital requirements. New paper can be issued whenever a need for cash arises, and for an appropriate maturity.

Issuers often roll over their funding and use funds from a new issue of CP to redeem a maturing issue. There is a risk that an issuer might be unable to roll over the paper where there is a lack of investor interest in the new issue. To provide protection against this risk issuers often arrange a standby line of credit from a bank, normally for all of the CP programme, to draw against in the event that it cannot place a new issue.

There are two methods by which CP is issued, known as *direct-issued* or *direct paper* and *dealer-issued* or *dealer paper*. Direct paper is sold by the issuing firm directly to investors, and no agent bank or securities house is involved. It is common for financial companies to issue CP directly to their customers, often because they have continuous programmes and constantly roll over their paper. It is therefore cost-effective for them to have their own sales arm and sell their CP direct. The treasury arms of certain non-financial companies also issue direct paper; this includes, for example, British Airways plc corporate treasury, which runs a continuous direct CP programme, used to provide short-term working capital for the company. Dealer paper is paper that is sold using a banking or securities house intermediary. In the US, dealer CP is effectively dominated by investment banks, as retail (commercial) banks were until recently forbidden from underwriting commercial paper. This restriction has since been removed and now both investment banks and commercial paper underwrite dealer paper.

Commercial paper yields

CP is sold at a discount to its maturity value, and the difference between this maturity value and the purchase price is the interest earned by the investor. The CP day-count base is 360 days in the US and euro markets, and 365 days in the UK. The paper is quoted on a discount yield basis, in the same manner as T-bills. The yield on CP follows that of other money market instruments and is a function of the short-dated yield curve. The yield on CP is higher than the T-bill rate; this is due to the credit risk that the investor is exposed to when holding CP, for tax reasons (in certain jurisdictions interest earned on T-bills is exempt from income tax) and because of the lower level of liquidity available in the CP market. CP also pays a higher yield than CDs, due to the lower liquidity of the CP market.

Although CP is a discount instrument and trades as such in the US and UK, euro currency eurocommercial paper trades on a yield basis, similar to a CD. The expressions below illustrate the relationship between true yield and discount rate:

$$P = \frac{M}{1 + r \times \dfrac{\text{Days}}{\text{Year}}} \tag{2.12}$$

$$rd = \frac{r}{1 + r \times \dfrac{\text{Days}}{\text{Year}}} \tag{2.13}$$

$$r = \frac{rd}{1 - rd \times \dfrac{\text{Days}}{\text{Year}}} \tag{2.14}$$

where M is the face value of the instrument, rd is the discount rate and r the true yield.

Example 2.4

1. A 60-day CP note has a nominal value of £100,000. It is issued at a discount of $7\frac{1}{2}$% per annum. The discount is calculated as:

$$Dis = \frac{£100{,}000(0.075 \times 60)}{365}$$
$$= £1{,}232.88$$

The issue price for the CP is therefore £100,000 – £1,232, or

£98,768. The money market yield on this note at the time of issue is:

$$\left(\frac{365 \times 0.075}{365 - (0.075 \times 60)}\right) \times 100\% = 7.594\%$$

Another way to calculate this yield is to measure the capital gain (the discount) as a percentage of the CP's cost, and convert this from a 60-day yield to a 1-year (365-day) yield, as shown below:

$$r = \frac{1{,}232}{98{,}768} \times \frac{365}{60} \times 100\%$$
$$= 7.588\%$$

2. ABC plc wishes to issue CP with 90 days to maturity. The investment bank managing the issue advises that the discount rate should be 9.5%. What should the issue price be, and what is the money market yield for investors?

$$Dis = \frac{100(0.095 \times 90)}{365}$$
$$= 2.342$$

The issue price will be 97.658.

The yield to investors will be:

$$\frac{2.342}{97.658} \times \frac{365}{90} \times 100\% = 9.725\%$$

Asset-backed commercial paper

The rise in securitization has led to the growth of short-term instruments backed by cashflows from other assets, known as *asset-backed commercial paper* (ABCP). Securitization is the practice of using cash flows from a specified asset, such as residential mortgages, car loans or commercial bank loans, as backing for an issue of bonds. The assets themselves are transferred from the original owner (the *originator*) to a specially created legal entity known as a *special purpose vehicle* (SPV), so as to make them separate and bankruptcy-remote from the originator. In the meantime, the originator is able to benefit from capital market financing, often charged at a lower rate of interest than that earned by the originator on its assets. Securitized products are not money market instruments, and although ABCP is, most textbooks treat ABCP as part of the structured products market rather than as a money market product.

Generally, securitization is used as a funding instrument by companies for three main reasons: it offers lower cost funding compared with a traditional bank loan or bond financing; it is a mechanism by which assets such as corporate loans or mortgages can be removed from the balance sheet, thus improving the lender's return on assets or return on equity ratios; and it increases a borrower's funding options. When entering into securitization, an entity may issue term securities against assets into the public or private market, or it may issue commercial paper via a special vehicle known as a *conduit*. These conduits are usually sponsored by commercial banks.

Entities usually access the commercial paper market in order to secure permanent financing, rolling over individual issues as part of a longer term *programme* and using interest rate swaps to arrange a fixed rate if required. Conventional CP issues are typically supported by a line of credit from a commercial bank, and so this form of financing is in effect a form of bank funding. Issuing ABCP enables an originator to benefit from money market financing that it might otherwise not have access to because its credit rating is not sufficiently strong. A bank may also issue ABCP for balance sheet or funding reasons. ABCP trades, however, exactly as conventional CP. The administration and legal treatment is more onerous, however, because of the need to establish the CP trust structure and issuing SPV. The servicing of an ABCP programme follows that of conventional CP and is carried out by the same entities, such as the 'Trust' arms of banks such as Deutsche Bank and Bank of New York Mellon.

Example 2.5 (see p. 46) details a hypothetical ABCP issue and typical structure.

Basic characteristics

Asset-backed CP programmes are invariably issued out of specially incorporated legal entities (the SPV, sometimes called the SPC for special purpose corporation), which in the money markets are known as conduits. They are typically established by commerical banks and finance companies to enable them to access Libor-based funding, at close to Libor, and to obtain regulatory capital relief. This can be done for the bank or a customer.

An ABCP conduit has the following features:

- it is a bankruptcy-remote legal entity that issues commercial paper to finance a purchase of assets from a seller of assets;
- the interest on the CP issued by the conduit, and its principal on maturity, will be paid out of the receipts on the assets purchased by the conduit;
- conduits have also been set up to exploit credit arbitrage opportunities, such as raising finance at Libor to invest in high-quality assets such as investment-grade-rated structured finance securities that pay above Libor.

The assets that can be funded via a conduit programme are many and varied; to date they have included:

- trade receivables and equipment lease receivables;
- credit card receivables;
- auto loans and leases;
- corporate loans; franchise loans, mortgage loans;
- real estate leases;
- future (expected) cashflows.

Conduits are classified into a 'programme type', which refers to the makeup of the underlying asset portfolio. This can be single-seller or multi-seller, which indicates how many institutions or entities are selling assets to the conduit. They are also designated as funding or securities credit arbitrage vehicles.

A special class of conduit known as a structured investment vehicle (SIV, sometimes called a special investment vehicle) was introduced that issued both CP and medium-term notes (MTNs), used to fund the purchase of longer dated assets such as ABS and CDO securities. These were described as 'credit arbitrage vehicles' but were as much funding arbitrage vehicles. They were the first casualties of the 2007–2008 financial crisis and were either wound up or consolidated by their parent banks. The vehicles are now extinct and as a concept the SIV has been debunked.

Figure 2.7 illustrates a typical ABCP structure issuing to the USCP and ECP markets.

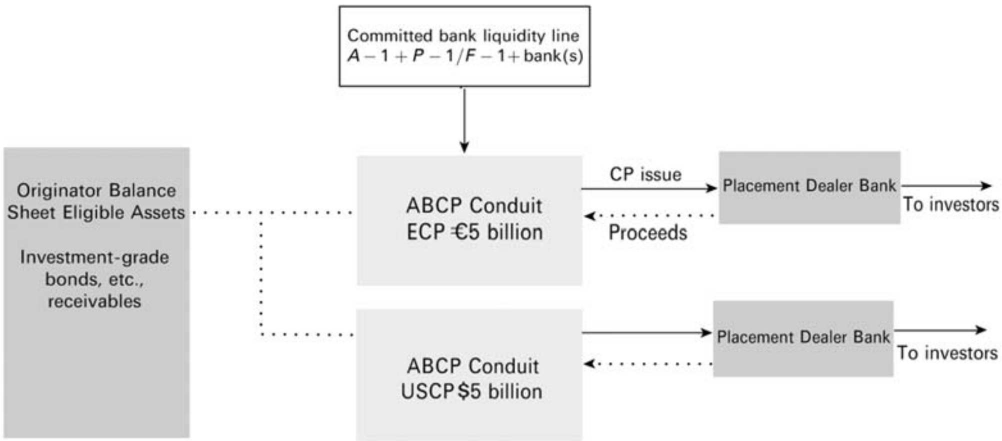


Figure 2.7 Single-seller conduit.

Example 2.5 Illustration of ABCP structure

In Figure 2.8 we illustrate a hypothetical example of securitization of bank loans in an ABCP structure. The loans have been made by ABC Bank plc and are secured on borrowers' specified assets. They are denominated in sterling. These might be a lien on property, cashflows of the borrowers' business or other assets. The bank makes a 'true sale' of the loans to a special purpose vehicle, named Claremont Finance. This has the effect of removing the loans from its balance sheet and also protecting them in the event of bankruptcy or liquidation of ABC Bank. The SPV raises finance by issuing commercial paper, via its appointed CP dealer(s), which is the Treasury desk of MC Investment Bank. The paper is rated A-1/P-1 by the rating agencies and is issued in US dollars. The

liability of the CP is met by the cashflow from the original ABC Bank loans.

ABC Manager is the SPV manager for Claremont Finance, a subsidiary of ABC Bank. Liquidity for Claremont Finance is provided by ABC Bank, who also act as the hedge provider. The hedge is effected by means of a swap agreement between Claremont and ABC Bank; in fact, ABC will fix a currency swap with a swap bank counterparty, who is most likely to be the swap desk of MC Investment Bank. The trustee for the transaction is Trust Bank Limited, who act as security trustee and represent the investors in the event of default.

The other terms of the structure are as follows:

Programme facility limit	US$500 million
Facility term	The facility is available on an uncommitted basis renewable annually by the agreement of the SPV manager and the security trustee. It has a final termination date five years from first issue.
Tenor of paper	Seven days to 270 days.
Pre-payment guarantee	In the event of pre-payment of a loan, the seller will provide Claremont Finance with a guaranteed rate of interest for the relevant interest period.
Hedge agreement	Claremont Finance will enter into currency and interest rate swaps with the hedge provider to hedge any interest rate or currency risk that arises.
Events of default	In the event of default the issuance programme will cease and in certain events will lead Claremont Finance to pay loan collections into a segregated specific collection account. Events of default can include non-payment by Claremont Finance under the transaction documentation, insolvency or ranking of charge (where the charge ceases to be a first-ranking charge over the assets of Claremont Finance).
Loans guarantee:	Loans purchased by Claremont Finance will meet a range of eligibility criteria, specified in the transaction-offering circular. These criteria will include requirements on currency of the loans, their term to maturity, confirmation that they can be assigned, that they are not in arrears, and so on.

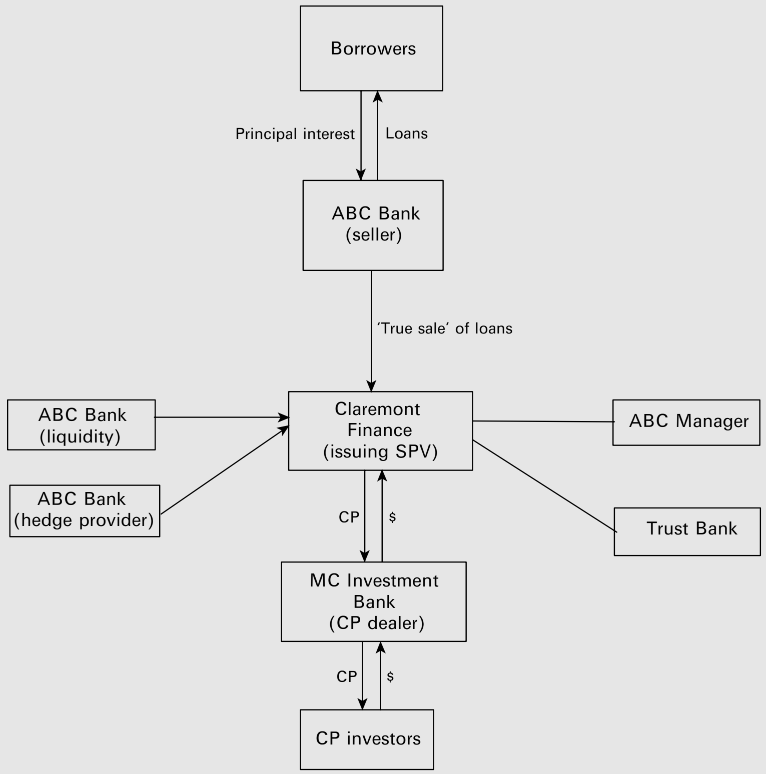


Figure 2.8 'Claremont Finance' ABCP structure.

REPO

The term *repo* is used to cover one of two different transactions, the *classic repo* and the *sell/buyback*, and sometimes is spoken of in the same context as a similar instrument, the *stock loan*. A fourth instrument is also economically similar in some respects to a repo, known as the *total return swap*, which is now commonly encountered as part of the market in credit derivatives. However, although these transactions differ in terms of their mechanics, legal documentation and accounting treatment, the economic effect of each of them is very similar. The structure of any particular market and the motivations of particular counterparties will determine which transaction is entered into; there is also some crossover between markets and participants.

Market participants enter into classic repo because they wish to invest cash, for which the transaction is deemed to be *cash-driven*, or because they wish to borrow a certain stock, for which purpose the trade is *stock-driven*. A sell/buyback, which is sometimes referred to as a *buy–sell*, is entered into for similar reasons but the trade itself operates under different mechanics and documentation.[6] A stock loan is just that, a borrowing of stock against a fee. Long-term holders of stock will therefore enter into stock loans simply to enhance their portfolio returns. We will look at the motivations behind the total return swap in a later chapter.

Note that during the interbank liquidity crisis from September 2008 to well into 2009, when unsecured inter-bank markets dried up, repo was the only funding mechanism still available to many banks.

Definition

A repo agreement is a transaction in which one party sells securities to another, and at the same time and as part of the same transaction commits to repurchase identical securities on a specified date at a specified price. The seller delivers securities and receives cash from the buyer. The cash is supplied at a predetermined rate – *the repo rate* – that remains constant during the term of the trade. On maturity the original seller receives back collateral of equivalent type and quality, and returns the cash plus repo interest. One party to the repo requires either the cash or the securities and provides *collateral* to the other party, as well as some form of compensation for the temporary use of the desired asset. Although legal title to the securities is transferred, the seller retains both the economic benefits and the market risk of owning them. This means that the 'seller' will suffer if the market value of the collateral drops during the term of the repo, as she still retains beneficial ownership of the collateral. The 'buyer' in a repo is not affected in P&L account terms if the value of the collateral drops, although there are other concerns for the buyer if this happens.

---

[6] We shall use the term 'sell/buyback' throughout this book. A repo is still a repo whether it is cash-driven or stock-driven, and one person's stock-driven trade may well be another's cash-driven one.

We have given here the legal definition of repo. However, the purpose of the transaction as we have described above is to borrow or lend cash, which is why we have used inverted commas when referring to sellers and buyers. The 'seller' of stock is really interested in borrowing cash, on which (s)he will pay interest at a specified interest rate. The 'buyer' requires security or *collateral* against the loan he has advanced, and/or the specific security to borrow for a period of time. The first and most important thing to state is that repo is a secured loan of cash, and would be categorized as a money market yield instrument.[7]

The classic repo

The *classic repo* is the instrument encountered in the US, UK and other markets. In a classic repo one party will enter into a contract to sell securities, simultaneously agreeing to purchase them back at a specified future date and price. The securities can be bonds or equities but can also be money market instruments, such as T-bills. The buyer of the securities is handing over cash, which on the termination of the trade will be returned to him, and on which he will receive interest.

The seller in a classic repo is selling or *offering* stock, and therefore receiving cash, whereas the buyer is buying or *bidding* for stock, and consequently paying cash. So, if the 1-week repo interest rate is quoted by a market-making bank as '$5\frac{1}{2}$–$5\frac{1}{4}$', this means that the market-maker will bid for stock – that is, lend the cash – at 5.50% and offers stock or pays interest on cash at 5.25%.

Illustration of classic repo

There will be two parties to a repo trade, let us say Bank A (the seller of securities) and Bank B (the buyer of securities). On the trade date the two banks enter into an agreement whereby on a set date – the *value or settlement* date – Bank A will sell to Bank B a nominal

---

[7] That is, a money market instrument quoted on a yield instrument, similar to a bank deposit or a CD. The other class of money market products are *discount* instruments such as T-bills or CP.

amount of securities in exchange for cash.[8] The price received for the securities is the market value of the stock on the value date. The agreement also demands that on the termination date Bank B will sell identical stock back to Bank A at the previously agreed price, and, consequently, Bank B will have its cash returned with interest at the agreed repo rate.

In essence, a repo agreement is a secured loan (or *collateralized* loan) in which the repo rate reflects the interest charged.

On the value date, stock and cash change hands. This is known as the start date, *first leg* or *opening leg*, while the termination date is known as the *second leg* or *closing leg*. When the cash is returned to Bank B, it is accompanied by the interest charged on the cash during the term of the trade. This interest is calculated at a specified rate known as the *repo rate*. It is important to remember that, although in legal terms the stock is initially 'sold' to Bank B, the economic effects of ownership are retained with Bank A. This means that if the stock falls in price it is Bank A that will suffer a capital loss. Similarly, if the stock involved is a bond and there is a coupon payment during the term of trade, this coupon is to the benefit of Bank A and, although Bank B will have received it on the coupon date, it must be handed over on the same day or immediately after to Bank A. This reflects the fact that, although legal title to the collateral passes to the repo buyer, the economic costs and benefits of the collateral remain with the seller.

A classic repo transaction is subject to a legal contract signed in advance by both parties. A standard document will suffice; it is not necessary to sign a legal agreement prior to each transaction.

Note that, although we have called the two parties in this case 'Bank A' and 'Bank B', it is not only banks that get involved in repo transactions – we have used these terms for the purposes of illustration only.

The basic mechanism is illustrated in Figure 2.9.

---

[8] The two terms are not necessarily synonymous. The value date in a trade is the date on which the transaction acquires value – for example, the date from which accrued interest is calculated. As such it may fall on a non-business day – such as a weekend or public holiday. The settlement date is the day on which the transaction settles or *clears*, and so can only fall on a working day.

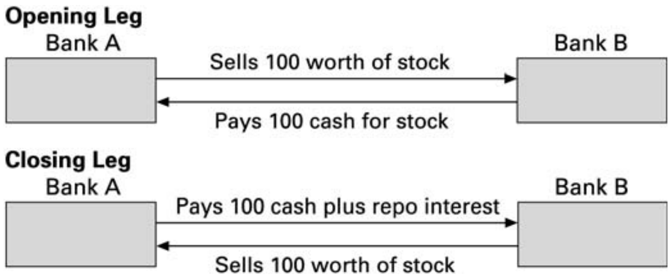


Figure 2.9 Classic repo transaction.

A seller in a repo transaction is entering into a repo, whereas a buyer is entering into a *reverse repo*. In Figure 2.9 the repo counterparty is Bank A, while Bank B is entering into a reverse repo. That is, a reverse repo is a purchase of securities that are sold back on termination. As is evident from Figure 2.9, every repo is a reverse repo, and the name given is dependent on from whose viewpoint one is looking at the transaction.[9]

Examples of classic repo

The basic principle is illustrated with the following example. This considers a *specific* repo – that is, one in which the collateral supplied is specified as a particular stock – as opposed to a *general collateral* (GC) trade in which a basket of collateral can be supplied, of any particular issue, as long as it is of the required type and credit quality.

We first consider a classic repo in the UK gilt market between two market counterparties, in the 5.75% Treasury 2012 gilt stock as at 2 December 2005. The terms of the trade are given in Table 2.2 and the trade is illustrated in Figure 2.10.

[9] Note that the guidelines to the syllabus for the Chartered Financial Analyst examination, which is set by the Association for Investment Management and Research, defines repo and reverse repo slightly differently. Essentially, a 'repo' is conducted by a bank counterparty and a 'reverse repo' is conducted by an investment counterparty or non-financial counterparty. Another definition states that a 'repo' is any trade where the bank counterparty is offering stock (borrowing cash) and a 'reverse repo' is any trade where the non-bank counterparty is borrowing cash. The author does not make this distinction; by definition every repo is a 'reverse repo' for the other side.

Table 2.2 Terms of a classic repo trade

Trade date	2 December 2005
Value date	5 December 2005
Repo term	1 month
Termination date	5 January 2006
Collateral (stock)	UKT 5% 2012
Nominal amount	£10,000,000
Price	104.17
Accrued interest (89 days)	1.229 281 8
Dirty price	105.3993
Haircut	0%
Settlement proceeds (*wired amount*)	£10,539,928.18
Repo rate	4.50%
Repo interest	£40,282.74
Termination proceeds	£10,580,210.92

The repo counterparty delivers to the reverse repo counterparty £10 million nominal of the stock, and in return receives the purchase proceeds. In this example no margin has been taken, so the start proceeds are equal to the market value of the stock which is £10,539,928. It is common for a rounded sum to be transferred on the opening leg. The repo interest is 4.50%, so the repo interest charged for the trade is:

$$10{,}539{,}928 \times 4.50\% \times \frac{7}{365}$$

or £40,282.74. The sterling market day-count basis is actual/365, so the repo interest is based on a 7-day repo rate of 4.50%. Repo rates are agreed at the time of the trade and are quoted, like all interest rates, on an annualized basis. The settlement price (dirty price) is used

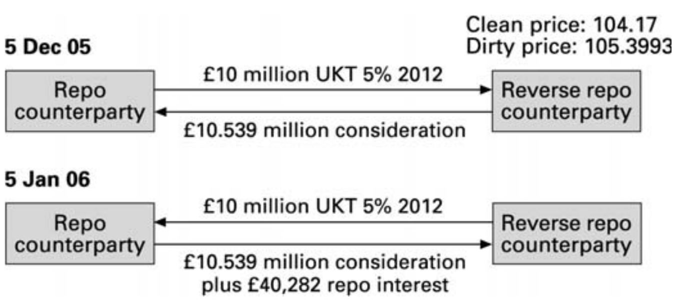


Figure 2.10 Classic repo trade.

because it is the market value of the bonds on the particular trade date and therefore indicates the cash value of the gilts. By doing this, the cash investor minimizes credit exposure by equating the value of the cash and the collateral.

On termination the repo counterparty receives back its stock, for which it hands over the original proceeds plus the repo interest calculated above.

Market participants who are familiar with the Bloomberg LP trading system will use screen RRRA for a classic repo transaction. For this example the relevant screen entries are shown at Figure 2.11. This screen is used in conjunction with a specific stock, so in this case it would be called up by entering:

UKT 5 12 <GOVT> RRRA <GO>

where 'UKT' is the ticker for UK gilts. Note that the date format for Bloomberg screens is mm/dd/yy. The screen inputs are relatively self-explanatory, with the user entering the terms of the trade that are detailed in Table 2.2. There is also a field for calculating margin, labelled 'collateral' on the screen. As no margin is involved in this example, it is left at its default value of 100.00%. The bottom of the

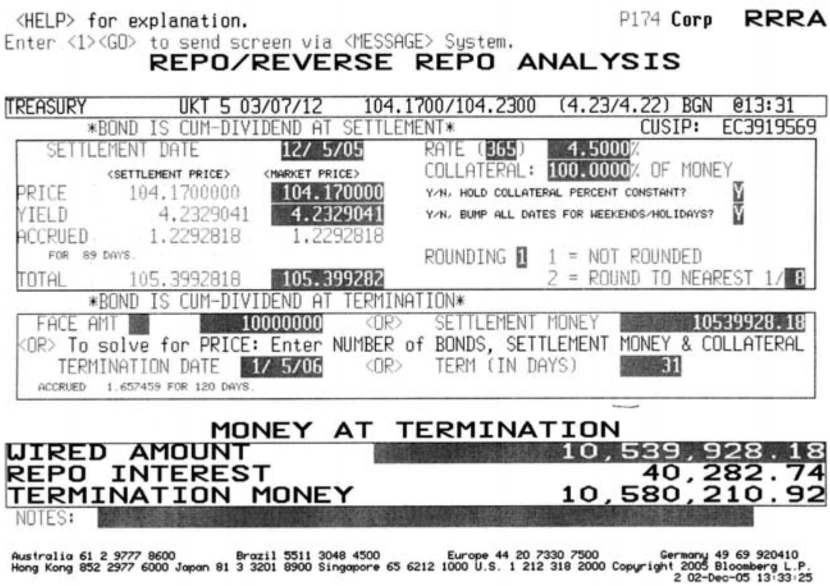


Figure 2.11 Bloomberg screen RRRA for classic repo.

200<GO>to view this page in Launchpad P122 a Govt **HBOS**
HBOS Treasury Services

Page 1 of 1
13:31 GMT
02-Dec-05

	EUR Bid / Offer		GBP Bid / Offer
TN	2.09 / 2.04	1W	4.55 / 4.45
SN	2.34 / 2.30	2W	4.50 / 4.40
SW	2.32 / 2.29	3W	4.50 / 4.40
1MTH	2.33 / 2.30	1M	4.50 / 4.40
2MTH	2.32 / 2.29	2M	4.50 / 4.40
3MTH	2.35 / 2.32	3M	4.48 / 4.38
4MTH	2.38 / 2.35	4M	4.47 / 4.37
5MTH	2.42 / 2.39	5M	4.45 / 4.35
6MTH	2.45 / 2.42	6M	4.43 / 4.33
7MTH	2.49 / 2.46	9M	4.40 / 4.30
8MTH	2.52 / 2.49	1Y	4.38 / 4.28
9MTH	2.55 / 2.52		
10MTH	2.57 / 2.54		
11MTH	2.59 / 2.56		
YR	2.61 / 2.58		

Figure 2.12 HBOS repo rates screen as at 2 December 2005.

screen shows the opening leg cash proceeds or 'wired amount', the repo interest and the termination proceeds.

The repo rate for the trade is the 1-month rate of 4.50%, as shown in Figure 2.12, which is the HBOS repo rates screen as at 2 December 2005.[10]

What if a counterparty is interested in investing £10 million against gilt collateral? Let us assume that a corporate treasury function with surplus cash wishes to invest this amount in repo for a 1-week term. It invests this cash with a bank that deals in gilt repo. We can use Bloomberg screen RRRA to calculate the nominal amount of collateral required. Figure 2.13 shows the screen for this trade, again against the 5.75% Treasury 2012 stock as collateral. We see from Figure 2.13 that the terms of the trade are identical to those in Table 2.2, including the tenor and the repo rate; however, the opening leg wired amount is entered as £10 million, which is the cash being

[10] The author used to deal with Leeds Permanent Building Society, whose rates screen he made use of in the early 1990s. This became Halifax plc and then HBOS. Sadly, these entities are no longer with us, but the HBOS screen has been retained for nostalgic reasons.

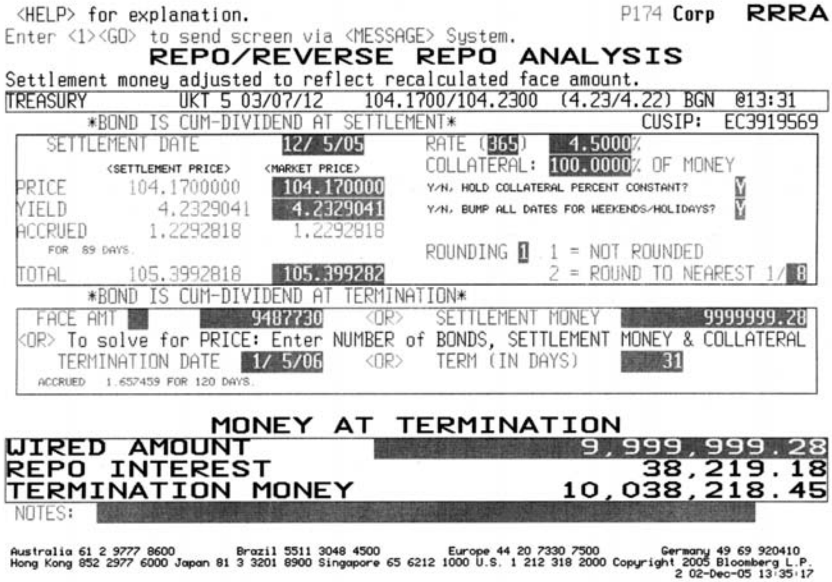


Figure 2.13 Bloomberg screen for classic repo trade described on this page.

invested. Therefore, the nominal value of the gilt collateral required will be different, as we now require a market value of this stock of £10 million. From the screen we see that this is £9,487,773.00. The cash amount is different from the example at Figure 2.14, so of course the repo interest charged is different and is £38,219.18 for the 1-month term.

The diagram at Figure 2.14 illustrates the transaction.

The sell/buyback

In addition to classic repo, there exists *sell/buyback*. A sell/buyback is defined as an outright sale of a bond on the value date, and an outright repurchase of that bond for value on a *forward* date. The cashflows therefore become a sale of the bond at the *spot* price, followed by repurchase of the bond at the *forward* price. The forward price calculated includes interest on the repo, and is therefore a different price to the spot price. That is, repo interest is realized as the difference between the spot price and forward price of the collateral at the start and termination of the trade. The sell/

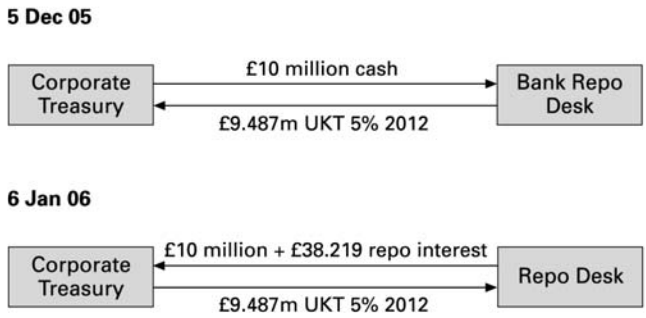


Figure 2.14 Corporate treasury classic repo, as illustrated in Figure 2.13.

buyback is entered into for the same considerations as a classic repo, but was developed initially in markets where there is no legal agreement to cover repo transactions, and where the settlement and IT systems of individual counterparties were not equipped to deal with repo. Over time sell/buybacks have become the convention in certain markets, most notably Italy, and so the mechanism is still retained. In many markets, therefore, sell/buybacks are not covered by a legal agreement, although the standard legal agreement used in classic repo now includes a section that describes them.[11]

A sell/buyback is a spot sale and forward repurchase of bonds transacted simultaneously, and the repo rate is not explicit, but is implied in the forward price. Any coupon payments during the term are paid to the seller; however, this is done through incorporation into the forward price, so the seller will not receive it immediately, but on termination. This is a disadvantage when compared with classic repo. However, there will be compensation payable if a coupon is not handed over straight away, usually at the repo rate implied in the sell/buyback. As sell/buybacks are not subject to a legal agreement in most cases, in effect the seller has no legal right to any coupon, and there is no provision for marking to market and *variation margin*. This makes the sell/buyback a higher risk transaction when compared with classic repo, even more so in volatile markets.

A general diagram for the sell/buyback is given at Figure 2.15.

---

[11] This is the PSA/ISMA Global Master Repurchase Agreement, which is reviewed in the author's book *Introduction to Repo Markets*, 3rd edition, part of this series by John Wiley & Sons.

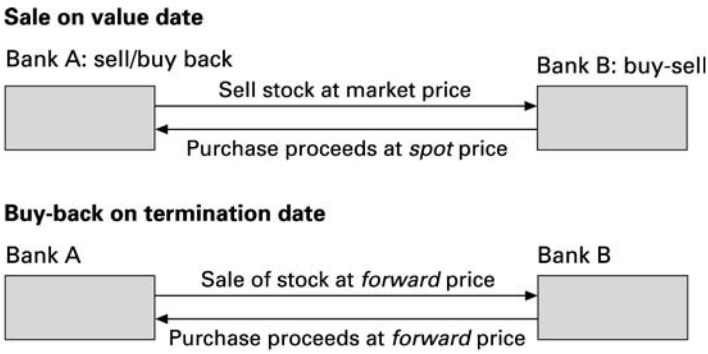


Figure 2.15 Sell/buy-back transaction.

Examples of sell/buyback

We use the same terms of trade given in the previous section, but this time the trade is a sell/buyback.[12] In a sell/buyback we require the forward price on termination, and the difference between the spot and forward price incorporates the effects of repo interest. It is important to note that this forward price has nothing to do with the actual market price of the collateral at the time of forward trade. It is simply a way of allowing for the repo interest that is the key factor in the trade. Thus, in sell/buyback the repo rate is not explicit (although it is the key consideration in the trade), rather it is implicit in the forward price.

In this example, one counterparty sells £10 million nominal of the UKT 5% 2012 at the spot price of 104.17, this being the market price of the bond at the time. The consideration for this trade is the market value of the stock, which is £10,539,928.18 as before. Repo interest is calculated on this amount at the rate of 4.50% for 1 month, and from this the termination proceeds are calculated. The termination proceeds are divided by the nominal amount of stock to obtain the forward dirty price of the bond on the termination date. For various reasons – the main one being that settlement systems deal in clean prices – we require the forward clean price, which is obtained by subtracting the accrued interest on the bond on the termination date

[12] The Bank of England discourages sell/buybacks in the gilt repo and it is unusual to observe them in this market. However, we use these terms of trade for comparison with the classic repo example given in the previous section.

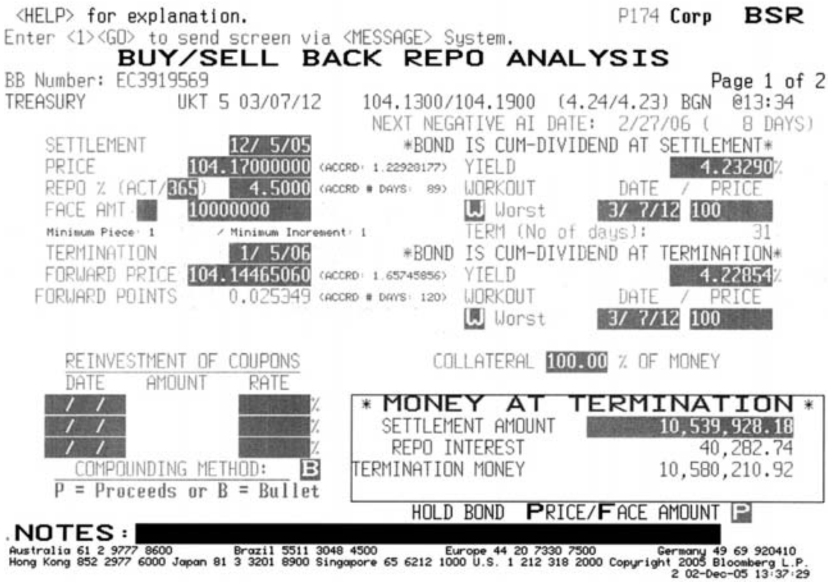


Figure 2.16 Bloomberg screen BSR for sell/buyback trade in 5% 2012.

from the forward dirty price. At the start of the trade, the 5% 2012 had 89 days' accrued interest, therefore on termination this figure will be 89 + 31 or 120 days.

Bloomberg users access a different screen for sell/buybacks, which is BSR. This is shown at Figure 2.16. Entering in the terms of the trade, we see from Figure 2.16 that the forward price is 104.144. However, the fundamental element of this transaction is evident from the bottom part of the screen: the settlement amount ('wired amount'), repo interest and termination amount are identical to the classic repo trade described earlier. This is not surprising; the sell/buyback is a loan of £10.539 million for 1 month at an interest rate of 4.50%. The mechanics of the trade do not impact on this key point.

Screen BSR on Bloomberg has a second page, which is shown at Figure 2.17. This screen summarizes the cash proceeds of the trade at start and termination. Note how repo interest is termed 'funding cost'. This is because the trade is deemed to have been entered into by a bond-trader who is funding his book. This will be considered

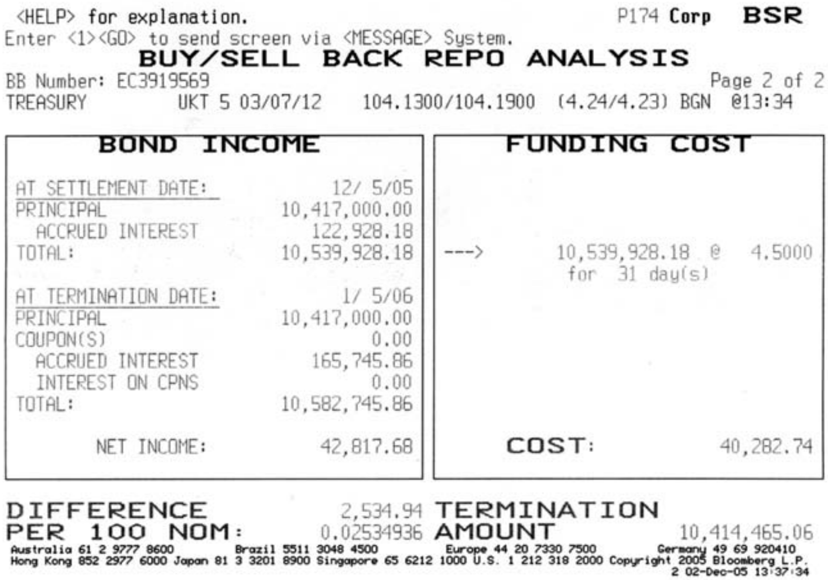


Figure 2.17 Bloomberg screen BSR page 2 for sell/buyback trade in 5.75% 2009.

later, but we can see from the screen details that during the 1 month of the trade the bond position has accrued interest of £165,745.00. This compares favourably with the repo funding cost of £122,928.18. The funding cost is therefore below the accrued interest gained on the bondholding, as shown in the screen.

If there is a coupon payment during a sell/buyback trade and it is not paid over to the seller until termination, a compensating amount is also payable on the coupon amount, usually at the trade's repo rate. When calculating the forward price on a sell/buyback where a coupon will be paid during the trade, we must subtract the coupon amount from the forward price. Note also that sell/buybacks are not possible on an open basis, as no forward price can be calculated unless a termination date is known.

Repo collateral

The collateral in a repo trade is the security passed to the lender of cash by the borrower of cash. It is not always secondary to the transaction; in stock-driven transactions the requirement for specific collateral is the motivation behind the trade. However, in a classic repo or sell/buyback, the collateral is always the security handed over against cash.[13] In a stock loan transaction, the collateral against stock lent can be either securities or cash. Collateral is used in repo to provide security against default by the cash borrower. Therefore, it is protection against counterparty risk or *credit risk*, the risk that the cash-borrowing counterparty defaults on the loan. A secured or *collateralized* loan is theoretically lower credit risk exposure for a cash lender compared with an unsecured loan.

The most commonly encountered collateral is government bonds, and the repo market in government bonds is the largest in the world. Other forms of collateral include Eurobonds, other forms of corporate and supranational debt, asset-backed bonds, mortgage-backed bonds, money market securities such as T-bills, and equities.

In any market where there is a defined class of collateral of identical credit quality, this is known as *general collateral* (*GC*). So, for example, in the UK gilt market a GC repo is one where any gilt will be acceptable as repo collateral. Another form of GC might be 'AA-rated sterling Eurobonds'. In the US market the term *stock collateral* is sometimes used to refer to GC securities. In equity repo it is more problematic to define GC and by definition almost all trades are specifics; however, it is becoming more common for counterparties to specify any equity being acceptable if it is in an established index – for example, a FTSE 100 or a CAC 40 stock – and this is perhaps the equity market equivalent of GC. If a specific security is required in a reverse repo or as the other side of a sell/buyback, this is known as a *specific* or *specific collateral*. A specific stock that is in high demand in the market, such that the repo rate against it is significantly different from the GC rate, is known as a *special*.

Where a coupon payment is received on collateral during the term of a repo, it is to the benefit of the repo seller. Under the standard repo legal agreement, legal title to collateral is transferred to the buyer during the term of the repo, but it is accepted that the economic benefits remain with the seller. For this reason, coupon is returned to the seller. In classic repo (and in stock lending) the coupon is

---

[13] So that even in a stock-driven reverse repo the collateral is the security handed over against the borrowing of cash by the repo seller.

returned to the seller on the dividend date, or in some cases on the following date. In a sell/buyback the effect of the coupon is incorporated in the repurchase price. This includes interest on the coupon amount that is payable by the buyer during the period from the coupon date to the buyback date.

Legal treatment

Classic repo is carried out under a legal agreement that defines the transaction as a full transfer of the title to the stock. The standard legal agreement is the PSA/ISMA GRMA, which we review in the sister book in this series, *An Introduction to Repo Markets*. It is now possible to trade sell/buybacks under this agreement as well. This agreement was based on the PSA standard legal agreement used in the US domestic market, and was compiled because certain financial institutions were not allowed to legally borrow or lend securities. By transacting repo under the PSA agreement, these institutions were defined as legally buying and selling securities rather than borrowing or lending them.

Margin

To reduce the level of risk exposure in a repo transaction, it is common for the lender of cash to ask for a margin, which is where the market value of collateral is higher than the cash value of cash lent out in the repo. This is a form of protection, should the cash-borrowing counterparty default on the loan. Another term for margin is *overcollateralization* or a *haircut*. There are two types of margin: *initial margin* taken at the start of the trade and *variation margin* which is called if required during the term of the trade.

Initial margin

The cash proceeds in a repo are typically no more than the market value of the collateral. This minimizes credit exposure by equating the value of the cash to that of the collateral. The market value of the collateral is calculated at its *dirty* price, not *clean* price – that is, including accrued interest. This is referred to as *accrual pricing*. To calculate the accrued interest on the (bond) collateral we require the day-count basis for the particular bond.

The start proceeds of a repo can be less than the market value of the collateral by an agreed amount or percentage. This is known as the *initial margin* or *haircut*. The initial margin protects the buyer against

- a sudden fall in the market value of the collateral;
- illiquidity of collateral;
- other sources of volatility of value (e.g., approaching maturity);
- counterparty risk.

The margin level of repo varies from 0%–2% for collateral such as UK gilts to 5% for cross-currency and equity repo, to 10%–35% for emerging market debt repo.

In both classic repo and sell/buyback, any initial margin is given to the supplier of cash in the transaction. This remains the case in the case of specific repo. For initial margin the market value of the bond collateral is reduced (or given a *haircut*) by the percentage of the initial margin and the nominal value determined from this reduced amount. In a stock loan transaction the lender of stock will ask for margin.

There are two methods for calculating margin; for a 2% margin this could be one of the following:

- the dirty price of the bonds $\times$ 0.98;
- the dirty price of the bonds $\div$ 1.02.

The two methods do not give the same value! The RRRA repo page on Bloomberg uses the second method for its calculations, and this method is turning into something of a convention.

For a 2% margin level the PSA/ISMA GRMA defines a 'margin ratio' as:

$$\frac{\text{Collateral value}}{\text{Cash}} = 102\%$$

The size of margin required in any particular transaction is a function of the following:

- the credit quality of the counterparty supplying the collateral – for example, a central bank counterparty, interbank counterparty and corporate will all suggest different margin levels;

- the term of the repo – an overnight repo is inherently lower risk than a 1-year repo;
- the duration (price volatility) of the collateral – for example, a T-bill against the long bond;
- the existence or absence of a legal agreement – a repo traded under a standard agreement is considered lower risk.

However, in the final analysis, margin is required to guard against market risk, the risk that the value of collateral will drop during the course of the repo. Therefore, the margin call must reflect the risks prevalent in the market at the time; extremely volatile market conditions may call for large increases in initial margin.

Variation margin

The market value of collateral is maintained through the use of *variation margin*. So, if the market value of collateral falls, the buyer calls for extra cash or collateral. If the market value of collateral rises, the seller calls for extra cash or collateral. In order to reduce the administrative burden, margin calls can be limited to changes in the market value of collateral in excess of an agreed amount or percentage, which is called a *margin maintenance limit*.

The standard market documentation that exists for the three structures covered so far includes clauses that allow parties to a transaction to call for variation margin during the term of a repo. This can be in the form of extra collateral, if the value of collateral has dropped in relation to the asset exchanged, or a return of collateral, if the value has risen. If the cash-borrowing counterparty is unable to supply more collateral where required, he will have to return a portion of the cash loan. Both parties have an interest in making and meeting margin calls, although there is no obligation. The level at which variation margin is triggered is often agreed beforehand in the legal agreement put in place between individual counterparties. Although primarily viewed as an instrument used by the supplier of cash against a fall in the value of the collateral, variation margin can of course also be called by the repo seller if the value of the collateral has risen.

CURRENCIES USING MONEY MARKET YEAR BASE OF 365 DAYS

- Sterling;
- Hong Kong dollar;
- Malaysian ringgit;
- Singapore dollar;
- South African rand;
- Taiwan dollar;
- Thai baht.

In addition, the domestic markets, but not the international markets, of the following currencies also use a 365-day base:

- Australian dollar;
- Canadian dollar;
- Japanese yen;
- New Zealand dollar.

To convert an interest rate i quoted on a 365-day basis to one quoted on a 360-day basis (i^*) use the expressions given at (2.15):

$$\left.\begin{aligned} i &= i^* \times \frac{365}{360} \\ i^* &= i \times \frac{360}{365} \end{aligned}\right\} \qquad (2.15)$$

Chapter 3

THE YIELD CURVE

Understanding and appreciating the yield curve is important to all capital market participants. It is especially important to debt capital market participants, and even more especially important to bank ALM practitioners. So for anyone reading this book it is safe to assume that the yield curve is a very important subject! This is a long chapter but well worth getting to grips with. In it, we discuss the basic concepts of the yield curve, as well as its uses and interpretation. We show how to calculate the zero-coupon (or spot) and forward yield curve, and present the main theories that seek to explain its shape and behaviour. We will see that the spread of one different curve to another, such as the swap curve compared with the government curve, is itself important. We begin with an introduction to the curve and interest rates.

Importance of the yield curve

Banks deal in interest rates and credit risk. These are the two fundamental tenets of banking – just as fundamental today as they were when banking first began. The first of these – interest rates – is an explicit measure of the cost of borrowing money and is encapsulated in the yield curve. For bankers, understanding the behaviour and properties of the yield curve is an essential part of the ALM process. The following are some, but not all, of the reasons that this is so:

- changes in interest rates have a direct impact on bank revenue; the yield curve captures the current state of term interest rates and also presents the current market expectation of future interest rates;
- the interest rate gap reflects the state of bank borrowing and lending; gaps along the term structure are sensitive to changes in the shape and slope of the yield curve;
- current and future trading strategy, including the asset allocation and credit policy decision, will impact interest rate risk exposure and therefore will take into account the shape and behaviour of the yield curve.

We can see then that understanding and appreciating the yield curve is a vital part of ALM operations. This chapter is a detailed look at the curve from the banker's viewpoint.

The yield curve is an important indicator and knowledge source of the state of a debt capital market. It is sometimes referred to as the *term structure of interest rates*, but strictly speaking this is not correct, as this term should be reserved for the zero-coupon yield curve only. But we don't need to worry about this.

The analysis and pricing activity that takes place in financial markets revolves around the yield curve. The yield curve describes the relationship between a particular yield and its term to maturity. So, plotting yields of a set of bonds along the maturity structure will give us our yield curve. The primary yield curve in any domestic capital market is the government bond yield curve – for example, in the US market it is the US Treasury yield curve. Outside government bond markets, yield curves are plotted for Eurobonds, money market instruments, off-balance-sheet instruments – in fact, virtually all debt market instruments. So, it is always important to remember to compare like for like when analysing yield curves across markets.

Using the yield curve

The yield curve tells us where the bond market is trading now. It also implies the level of trading for the future, or at least what the market thinks will be happening in the future. In other words, it is a good indicator of the future level of the market. It is also a much more reliable indicator than any other used by private investors, and we can prove this empirically. But, for the moment take my word for it!

As an introduction to yield curve analysis, let us first consider its main uses. All participants in debt capital markets will be interested in the current *shape* and level of the yield curve, as well as what this information implies for the future. The main uses are summarized below.

Setting the yield for all debt market instruments. The yield curve essentially fixes the price of money over the maturity structure. The yields of government bonds from the shortest maturity instrument to the longest set the benchmark for yields for all other debt instruments in the market, around which all debt instruments are priced. What does this mean? Essentially, it means that if a government 5-year bond is trading at a yield of 5.00%, all other 5-year bonds, whoever they are issued by, will be issued at a yield over 5.00%. The amount over 5.00% that the other bond trades is known as the spread. Therefore, issuers of debt use the yield curve to price bonds and all other debt instruments. Generally, the zero-coupon yield curve is used to price new-issue securities, rather than the redemption yield curve.

Acting as an indicator of future yield levels. As we discuss later in this chapter, the yield curve assumes certain shapes in response to market expectations of future interest rates. Bond market participants analyse the present shape of the yield curve in an effort to determine implications regarding the direction of market interest rates. This is perhaps one of the most important functions of the yield curve. Interpreting it is a mixture of art and science. The yield curve is scrutinized for its information content not just by bond traders and fund managers but also by corporate financiers as part of their project appraisals. Central banks and government Treasury departments also analyse the yield curve for its information content, not just regarding forward interest rates but also inflation levels. They then use this information when setting interest rates.

Measuring and comparing returns across the maturity spectrum. Portfolio managers use the yield curve to assess the relative value of investments across the maturity spectrum. The yield curve indicates returns that are available at different maturity points and is therefore very important to fixed interest fund managers, who can use it to assist them to assess which point of the curve offers the best return relative to other points.

Indicating the relative value between different bonds of similar maturity. The yield curve can be analysed to indicate which bonds are 'cheap' or 'dear' (expensive) to the curve. Placing bonds relative to the *zero-coupon yield curve* helps to highlight which bonds should be bought or sold, either outright or as part of a bond spread trade.

Pricing interest rate derivative instruments. The price of derivatives such as futures and swaps revolves around the yield curve. At the shorter end, products such as forward rate agreements are priced off the futures curve, but futures rates reflect the market's view on forward 3-month cash deposit rates. At the longer end, interest rate swaps are priced off the yield curve, while hybrid instruments that incorporate an option feature such as convertibles and callable bonds also reflect current yield curve levels. The 'risk-free' interest rate – one of the parameters used in option pricing – is the T-bill rate or short-term government repo rate, both constituents of the money market yield curve.

Yield-to-maturity yield curve

Yield curve shapes

The most commonly occurring yield curve is the yield-to-maturity yield curve. The process of calculating a debt instrument's yield to maturity is described in countless finance textbooks. The curve itself is constructed by plotting yield to maturity against term to maturity for a group of bonds of the same class.

Curves assume many different shapes; Figure 3.1 shows three hypothetical types. Bonds used in constructing the curve will only rarely have an exact number of whole years to redemption; however, it is often common to see yields plotted against whole years on the x-axis. This is because once a bond is designated the *benchmark* for that term, its yield is taken to be the representative yield. A bond loses benchmark status once a new benchmark for that maturity is issued.

The yield-to-maturity yield curve is the most commonly observed curve simply because yield to maturity is the most frequent measure of return used. The business sections of daily newspapers – if they quote bond yield at all – usually quote bond yields to maturity.

The yield-to-maturity yield curve contains some inaccuracies. This is because the yield-to-maturity measure has one large weakness: the

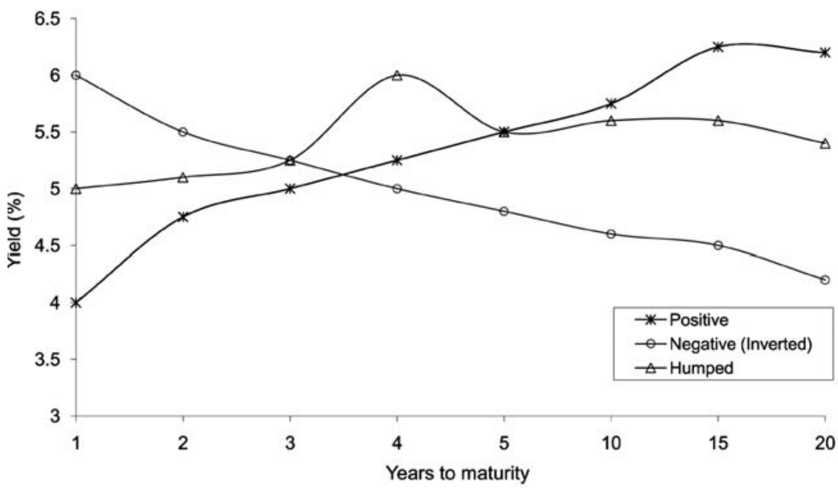


Figure 3.1 Yield-to-maturity yield curves.

assumption of a constant discount rate for coupons during the bond's life at the redemption yield level. In other words, we discount all the cashflows of the bond at one discount rate. This is not a realistic assumption to make because we know, just as night follows day, that interest rates in 6 month's time (used to discount the coupon due in 6 months) will not be the same as the interest rate prevailing in 2 years' time (used to discount the 2-year coupon). But we make this assumption, nevertheless – for the sake of convenience. However, the upshot of all this is that redemption yield is not the true interest rate for its particular maturity.

By the way, this gives rise to a feature known as *reinvestment risk*: the risk that – when we reinvest each bond coupon as it is paid – the interest rate at which we invest it will not be the same as the redemption yield prevailing on the day we bought the bond. We must accept this risk, unless we buy a *strip* or *zero-coupon bond*. Only zero-coupon bondholders avoid reinvestment risk as no coupon is paid during the life of their bond.

For the reasons we have discussed, the professional wholesale market often uses other types of yield curve for analysis when the yield-to-maturity yield curve is deemed unsuitable – usually, the zero-coupon yield curve. This is the yield curve constructed from zero-coupon yields; it is also known as the term structure of interest rates. We construct a zero-coupon curve from bond prices and redemption yields.

Analysing and interpreting the yield curve

From observing yield curves in different markets at any time, we notice that a yield curve can adopt one of four basic shapes:

- *normal or conventional* – in which yields are at 'average' levels and the curve slopes gently upwards as maturity increases;
- *upward-sloping* or *positive* or *rising* – in which yields are at historically low levels, with long rates substantially greater than short rates;
- *downward-sloping* or *inverted* or *negative* – in which yield levels are very high by historical standards, but long-term yields are significantly lower than short rates;
- *humped* – where yields are high with the curve rising to a peak in the medium-term maturity area, and then sloping downwards at longer maturities.

Sometimes yield curves incorporate a mixture of the above features. A great deal of effort is spent by bond analysts and economists analysing and interpreting yield curves. There is considerable information content associated with any curve at any time.

The very existence of a yield curve indicates that there is a cost associated with funds of different maturities, otherwise we would observe a flat yield curve. The fact that we very rarely observe anything approaching a flat yield curve suggests that investors require different rates of return depending on the maturity of the instrument they are holding. In the next section we will consider the various explanations that have been put forward to explain the shape of the yield curve at any one time. Why do we need to do this? Because an understanding of why the yield curve assumes certain shapes will help us understand the information that a certain shape implies.

None of the theories can adequately explain everything about yield curves and the shapes they assume at any time, so generally observers seek to explain specific curves using a combination of accepted theories.

Theories of the yield curve

No one mathematical explanation of the yield curve explains its shape at all times. At the same time, some explanations are mutually exclusive. That said, practitioners often seek to explain the shape of a curve by recourse to a mixture of theories.

The expectations hypothesis

The *expectations hypothesis* suggests that bondholder expectations determine the course of future interest rates. There are two main competing versions of this hypothesis, the *local expectations hypothesis* and the *unbiased expectations hypothesis*. The *return-to-maturity expectations* hypothesis and *yield-to-maturity expectations* hypothesis are also quoted (see Ingersoll, 1987). The local expectations hypothesis states that all bonds of the same class – but differing in term to maturity – will have the same expected holding period rate of return. This suggests that a 6-month bond and a 20-year bond will produce the same rate of return, on average, over the stated holding period. So, if we intend to hold a bond for 6 months, we will get the same return no matter what specific bond we buy. The author feels that this theory is not always the case, despite being mathematically neat; however, it is worth spending a few moments discussing it and related points. Generally, *holding period returns* from longer dated bonds are on average higher than those from short-dated bonds. Intuitively, we would expect this, with longer dated bonds offering higher returns to compensate for their higher price volatility (risk). The local expectations hypothesis would not agree with the conventional belief that investors, being risk-averse, require higher returns as a reward for taking on higher risk; in addition, it does not provide any insight into the shape of the yield curve. Essentially though, in theory one should expect that the return from holding any bond for a 6-month period will be the same irrespective of the term to maturity and yield that the bond has at time of purchase.

In his excellent book *Modelling Fixed Income Securities* Professor Robert Jarrow (1996, p. 50) states

> '. . . in an economic equilibrium, the returns on similar maturity zero-coupon bonds cannot be too different. If they were too different, no investor would hold the bond with the smaller return. This difference could not persist in an economic equilibrium.'

This is true, but in practice other factors can impact holding period returns between bonds that do not have similar maturities. For instance, investors have restrictions as to which bonds they can hold – for example, banks and building societies are required to hold short-dated bonds for liquidity purposes. In an environment of economic disequilibrium, these investors would still have to hold shorter dated bonds, even if the holding period return was lower.

This is noted by Mark Rubinstein (1999, pp. 84–85) who states in his book *Rubinstein on Derivatives*,

> 'In the real world . . . it is usually the case that annualised shorter-term riskless returns are lower than longer-term riskless returns . . . Real assets with shorter-term payouts will tend to have a "liquidity" advantage. In aggregate this advantage will be passed on to shorter-term financial claims on real assets [which results in them having a lower return].'

A related theory is the *pure* or *unbiased expectations hypothesis*, which states that current implied forward rates are unbiased estimators of future spot interest rates.[1] It assumes that investors act in a way that eliminates any advantage of holding instruments of a particular maturity. Therefore, if we have a positive-sloping yield curve, the unbiased expectations hypothesis states that the market expects spot interest rates to rise. Equally, an inverted yield curve is an indication that spot rates are expected to fall. If short-term interest rates are expected to rise, then longer yields should be higher than shorter ones to reflect this. If this were not the case, investors would only buy the shorter dated bonds and roll over the investment when they matured. Likewise if rates are expected to fall then longer yields should be lower than short yields. The unbiased expectations hypothesis states that the long-term interest rate is a geometric average of expected future short-term rates.

Using elementary mathematics we can prove this theory. Indeed, its premise must be so, to ensure no *arbitrage* opportunities exist in the market. The hypothesis can be used to explain any shape in the yield curve.

Therefore, a rising yield curve is explained by investors expecting short-term interest rates to rise. A falling yield curve is explained by investors expecting short-term rates to be lower in the future. A humped yield curve is explained by investors expecting short-term interest rates to rise and long-term rates to fall. *Expectations*, or views on the future direction of the market, are a function mainly of the expected rate of inflation. If the market expects inflationary pressures in the future, the yield curve will be positively shaped, while if inflation expectations are inclined towards disinflation, then the yield curve will be negative. Several empirical studies including one by Fama (1976) have shown that forward rates are essentially biased predictors of future spot interest rates, and often overestimate future levels of spot rates. The unbiased hypothesis has also been criticized for suggesting that investors can forecast (or have a view on) very long-dated spot interest rates, which might be considered slightly unrealistic. As yield curves in most developed country markets exist to a maturity of up to 30 years or longer, such criticisms may have some substance. Are investors able to forecast interest rates 10, 20 or 30 years into the future? Perhaps not, nevertheless this is indeed the information content of, say, a 30-year bond; since the yield on the bond is set by the market, it is valid to suggest

---

[1] For the original discussion, see Lutz (1940) and Fisher (1986), although the latter formulated his ideas earlier.

that the market has a view on inflation and future interest rates for up to 30 years forward.

The expectations hypothesis is stated in more than one way; we have already encountered the local expectations hypothesis. Other versions include the *return-to-maturity* expectations hypothesis, which states that total return from holding a zero-coupon bond to maturity will be equal to total return that is generated by holding a short-term instrument and continuously rolling it over the same maturity period. A related version – the *yield-to-maturity* hypothesis – states that the periodic return from holding a zero-coupon bond will be equal to the return from rolling over a series of coupon bonds, but refers to annualized return earned each year rather than total return earned over the life of the bond. This assumption enables a zero-coupon yield curve to be derived from the redemption yields of coupon bonds. The unbiased expectations hypothesis of course states that forward rates are equal to the spot rates expected by the market in the future. Cox, Ingersoll and Ross (1981) suggest that only the local expectations hypothesis describes a model that is purely arbitrage-free, as under the other scenarios it would be possible to employ certain investment strategies that would produce returns in excess of what was implied by today's yields. Although it has been suggested[2] that differences between the local and unbiased hypotheses are not material a model that describes such a scenario would not reflect investors' beliefs, which is why further research is required in this area.

The unbiased expectations hypothesis does not in itself explain all the shapes of the yield curve or the information content contained within it, which is why it is often combined with other explanations when seeking to explain the shape of the yield curve, including the liquidity preference theory.

Liquidity preference theory

Intuitively, we might feel that longer maturity investments are more risky than shorter ones. An investor lending money for a 5-year term will usually demand a higher rate of interest than if she were to lend the same customer money for a 5-week term. This is because the borrower may not be able to repay the loan over the longer time

[2] For example, Campbell (1986) and Livingstone (1990).

period as he may, for instance, have gone bankrupt in that period. For this reason longer dated yields should be higher than short-dated yields, to recompense the lender for higher risk exposure during the term of the loan.[3]

We can consider this theory in terms of inflation expectations as well. Where inflation is expected to remain roughly stable over time, the market would anticipate a positive yield curve. However, the expectations hypothesis cannot in itself explain this phenomenon, as under stable inflationary conditions one would expect a flat yield curve. The risk inherent in longer dated investments, or the *liquidity preference theory*, seeks to explain a positive-shaped curve. Generally, borrowers prefer to borrow over as long a term as possible, while lenders will wish to lend over as short a term as possible. Therefore, as we first stated, lenders have to be compensated for lending over the longer term; this compensation is considered a premium for a loss in *liquidity* for the lender. The premium is increased the further the investor lends across the term structure, so that longest dated investments will, all else being equal, have the highest yield. So, the liquidity preference theory states that the yield curve should almost always be upward-sloping, reflecting bondholders' preference for the liquidity and lower risk of shorter dated bonds. An inverted yield curve could still be explained by the liquidity preference theory when it is combined with the unbiased expectations hypothesis. A *humped* yield curve might be viewed as a combination of an inverted yield curve together with a positive-sloping liquidity preference curve.

The difference between a yield curve explained by unbiased expectations and an actual observed yield curve is sometimes referred to as the *liquidity premium*. This refers to the fact that in some cases short-dated bonds are easier to transact in the market than long-term bonds. It is difficult to quantify the effect of the liquidity premium, because it is not static and fluctuates over time. The liquidity premium is so called because, in order to induce investors to hold longer dated securities, the yields on such securities must be higher than those available on short-dated securities, which are more liquid and may be converted into cash more easily. The liquidity premium is the compensation required for holding less liquid instruments. If longer dated securities then provide higher yields, as is suggested by the existence of the liquidity

[3] For original discussion, see Hicks (1946).

premium, they should generate on average higher total returns over an investment period. This is not consistent with the local expectations hypothesis.

Segmentation hypothesis

Capital markets are made up of a wide variety of users, each with different requirements. Certain classes of investors will prefer dealing at the shorter end of the yield curve, while others will concentrate on the longer end of the market. The *segmented markets* theory suggests that activity is concentrated in certain specific areas of the market and that there are no interrelationships between these parts of the market; the relative amounts of funds invested in each of the maturity spectra causes differentials in supply and demand, which results in humps in the yield curve. That is, the shape of the yield curve is determined by supply and demand for certain specific maturity investments, each of which has no reference to any other part of the curve.

For example, banks and building societies concentrate a large part of their activity at the short end of the curve, as part of daily cash management (known as *asset and liability management*) and for regulatory purposes (known as *liquidity* requirements). However, fund managers such as pension funds and insurance companies are active at the long end of the market. But, few institutional investors have any preference for medium-dated bonds. This behaviour on the part of investors will lead to high prices (low yields) at both the short and long ends of the yield curve and lower prices (higher yields) in the middle of the term structure.

According to the segmented markets hypothesis a separate market exists for specific maturities along the term structure, hence interest rates for these maturities are set by supply and demand.[4] Where there is no demand for a particular maturity, the yield will lie above other segments. Market participants do not hold bonds in any other area of the curve outside their area of interest[5] so that short-dated and long-dated bond yields exist independently of each other. The segmented markets theory is usually illustrated by reference to banks and life assurance companies. Banks and building societies usually hold

[4] See Culbertson (1957).

[5] For example, retail and commercial banks hold bonds for short dates, while life assurance companies hold long-dated bonds.

their funds in short-dated instruments for no longer than 5 years in maturity. This is because of the nature of retail banking operations, with a large volume of instant access funds being deposited at banks, and also for regulatory purposes. Holding short-term, liquid bonds enables banks to meet any sudden or unexpected demand for funds from customers. The classic theory suggests that – as banks invest their funds in short-dated bonds – the yields on these bonds are driven down. When they then liquidate part of their holding, perhaps to meet higher demand for loans, the yields are driven up and the prices of the bonds fall. This affects the short end of the yield curve but not the long end.

The segmented markets theory can be used to explain any particular shape of the yield curve, although it perhaps fits best with positive-sloping curves. However, it cannot be used to interpret the yield curve whatever shape it may be, and therefore offers no information content during analysis. By definition, the theory suggests that – for investors – bonds with different maturities are not perfect substitutes for each other. This is because different bonds would have different holding period returns, making them imperfect substitutes for one another.[6] As a result of bonds being imperfect substitutes, markets are segmented according to maturity.

The segmentations hypothesis is a reasonable explanation of certain features of a conventional positive-sloping yield curve, but by itself is not sufficient. There is no doubt that banks and building societies have a requirement to hold securities at the short end of the yield curve, as much for regulatory purposes as for yield considerations; however, other investors are probably more flexible and will place funds where value is deemed to exist. Nevertheless, the higher demand for benchmark securities does drive down yields along certain segments of the curve.

A slightly modified version of the market segmentation hypothesis is known as the *preferred habitat theory*. This suggests that different market participants have an interest in specified areas of the yield curve, but can be induced to hold bonds from other parts of the maturity spectrum if there is sufficient incentive. Hence, banks may at certain times hold longer dated bonds once the price of these bonds falls to a certain level, making the return on the bonds worth the risk involved in holding. Similar considerations

[6] *Ibid.*

may persuade long-term investors to hold short-dated debt. So, higher yields will be required to make bondholders shift out of their usual area of interest. This theory essentially recognizes the flexibility that investors have – outside regulatory or legal constraints (such as the terms of an institutional fund's objectives) – to invest in whatever area of the yield curve they identify value.

The flat yield curve

Conventional theories do not seek to explain a flat yield curve. Although it is rare – certainly for any length of time – to observe flat curves in a market, at times they do emerge in response to peculiar economic circumstances. In conventional thinking, a flat curve is not tenable because investors should in theory have no incentive to hold long-dated bonds over shorter dated bonds when there is no yield premium, so that the yield at the long end should rise as they sell off long-dated paper, producing an upward-sloping curve. In previous occurrences of a flat curve, analysts have produced different explanations for their existence. In November 1988 the US Treasury yield curve was flat relative to the recent past; researchers contended that this was the result of the market's view that long-dated yields would fall as bond prices rallied upwards.[7] One recommendation is to buy longer maturities when the yield curve is flat, in anticipation of lower long-term interest rates, which is diametrically opposite to the view that a flat curve is a signal to sell long bonds. In the case of the US market in 1988, long bond yields did in fact fall by approximately 2% in the following 12 months. This would seem to indicate that one's view of future long-term rates should be behind the decision to buy or sell long bonds, rather than the shape of the yield curve itself. A flat curve may well be more heavily influenced by supply and demand factors than anything else, with the majority opinion eventually winning out and forcing the curve to change into a more conventional shape.

Further views on the yield curve

In this discussion we have assumed the economist's world of a *perfect market* (also sometimes called a *frictionless* financial market). Such a perfect capital market is characterized by

[7] See Levy (1999).

- perfect information;
- no taxes;
- bullet maturity bonds;
- no transaction costs.

Of course, markets are not perfect in practice. However, assuming perfect markets makes the discussion of the term structure easier to handle. When we analyse yield curves for their information content, we have to remember that the markets that they represent are not perfect, and that frequently we observe anomalies that cannot be explained by conventional theories.

At any one time it is probably more realistic to suggest that a range of factors contribute to the yield curve being a particular shape. For instance, short-term interest rates are greatly influenced by the availability of funds in the money market. The slope of the yield curve (usually defined as 10-year yield minus 3-month interest rate) is also a measure of the degree of tightness of government monetary policy. A low, upward-sloping curve is often thought to be a sign that an environment of cheap money, due to looser monetary policy, is to be followed by a period of higher inflation and higher bond yields. Equally, a high downward-sloping curve is taken to mean that a situation of tight credit, due to stricter monetary policy, will result in falling inflation and lower bond yields. Inverted yield curves have often preceded recessions; for instance, an article in *The Economist* in April 1998 remarked that in the United States every recession since 1955 bar one has been preceded by a negative yield curve. The analysis is the same: if investors expect a recession they also expect inflation to fall, so the yields on long-term bonds will fall relative to short-term bonds. So, the conventional explanation of an inverted yield curve is that the markets and the investment community expect either a slowdown of the economy – if not an outright recession.[8] In this case one would expect monetary policy to ease the money supply by reducing the base interest rate in the near future: hence, an inverted curve. At the same time, a reduction in short-term interest rates will affect short-dated bonds, which are then sold off by investors, further raising their yield.

While the conventional explanation for negative yield curves is expectation of economic slowdown, on occasion other factors are

---

[8] A recession is formally defined as two successive quarters of falling output in the domestic economy.

involved. In the UK between July 1997 and June 1999 the gilt yield curve was inverted. However, there was no general view that the economy was heading for recession; in fact, the new Labour government (or should that be New Labour?) inherited an economy believed to be in good health. Instead, the explanation behind the inverted shape of the gilt yield curve focused on two other factors: first, the handing of responsibility for setting interest rates to the Monetary Policy Committee (MPC) of the Bank of England and, second, the expectation that the UK would abandon sterling over the medium term and adopt the euro. The yield curve at this time suggested that the market expected the MPC to be successful and keep inflation at a level around 2.5% over the long term (its target is actually the 1% range either side of 2.5%); it also suggested that sterling interest rates would need to come down over the medium term as part of *convergence* with conditions in Europe's euro currency area. However, these were both medium-term expectations and in the author's view not tenable at the short end of the yield curve. In fact, the term structure moved to a positive-sloped shape up to the 6-to-7-year area, before inverting out to the long end of the curve, in June 1999. By the beginning of 2002 it had assumed a conventional positive-sloping shape. This is a more logical shape for the curve to assume.

There is therefore significant information content in the yield curve, and economists and bond analysts will consider the shape of the curve as part of their policy-making and investment advice. The shape of parts of the curve, whether the short end or long end, as well as that of the entire curve, can serve as useful predictors of future market conditions. As part of an analysis it is also worthwhile considering yield curves across several different markets and currencies. For instance, the interest rate swap curve, and its position relative to that of the government bond yield curve, is also regularly analysed for its information content. In developed country economies the interest rate swap market is invariably as liquid as the government bond market – if not more so – hence, it is common to see the swap curve analysed when making predictions about, say, the future level of short-term interest rates.[9]

---

[9] Interest rate swaps are derivative instruments used in professional wholesale markets to change the basis of an interest rate liability; they are also used for speculative trading purposes. We don't need to worry about them.

Government policy will influence the shape and level of the yield curve, including its policy on public sector borrowing, debt management and open-market operations. The market's perception of the size of public sector debt will influence bond yields – for instance, an increase in the level of debt can lead to an increase in bond yields across the maturity range. Open-market operations – that is, the Bank of England's daily operations to control the money supply (to which end the Bank purchases short-term bills and also engages in repo dealing) – can have a number of effects. In the short term they can tilt the yield curve both upwards and downwards; in the longer term, changes in the level of the base rate will affect yield levels. An anticipated rise in base rates can lead to a drop in prices for short-term bonds, whose yields will be expected to rise; this can lead to a temporary inverted curve. Finally, debt management policy will influence the yield curve. Much government debt is rolled over as it matures, but the maturity of the replacement debt can have a significant influence on the yield curve in the form of humps in the market segment in which the debt is placed, as long as the debt is priced by the market at a relatively low price and hence high yield.

The zero-coupon yield curve

The *zero-coupon* (or *spot*) *yield curve* plots zero-coupon yields (or spot yields) against the term to maturity. A zero-coupon yield is the yield prevailing on a bond that has no coupons. In the first instance – as long as there is a liquid zero-coupon bond market – we can plot the yields from these bonds if we wish to construct this curve. However, it is not necessary to have a set of zero-coupon bonds in order to construct this curve, as we can derive it from a coupon or par yield curve; in fact, in many markets where zero-coupon bonds are not traded, a spot yield curve is derived from the conventional-yield-to-maturity-yield curve. This is of course a *theoretical* zero-coupon (spot) yield curve, as opposed to a *market* or *observed* spot curve that can be constructed using the yields of actual zero-coupon bonds trading in the market.

Spot yields must comply with equation (3.1). This equation assumes annual coupon payments and that the calculation is carried out on a coupon date such that accrued interest is zero:

$$P_d = \sum_{n=1}^{N} \frac{C}{(1 + rs_n)^n} + \frac{M}{(1 + rs_T)^N}$$
$$= \sum_{n=1}^{N} C \times Df_n + M \times Df_N \qquad (3.1)$$

where

$rs_n =$ Spot or zero-coupon yield on a bond with t years to maturity;
$Df_n \equiv 1/(1 + rs_n)^n =$ Corresponding *discount factor*.

In equation (3.1), rs_1 is the current 1-year spot yield, rs_2 the current 2-year spot yield and so on. Theoretically, the spot yield for a particular term to maturity is the same as the yield on a zero-coupon bond of the same maturity, which is why spot yields are also known as zero-coupon yields.

This last result is important. It means spot yields can be derived from redemption yields that have been observed in the market.

As with the yield-to-redemption yield curve the spot yield curve is commonly used in the market. It is viewed as the true term structure of interest rates because there is no reinvestment risk involved; the stated yield is equal to actual annual return. That is, the yield on a zero-coupon bond of n years maturity is regarded as the true n-year interest rate. Because the observed government bond redemption yield curve is not considered to be the true interest rate, analysts often construct a theoretical spot yield curve. Essentially, this is done by breaking down each coupon bond being observed into its constituent cashflows, which become a series of individual zero-coupon bonds. For example, £100 nominal of a 5% 2-year bond (paying annual coupons) is considered equivalent to £5 nominal of a 1-year zero-coupon bond and £105 nominal of a 2-year zero-coupon bond.

Let us assume that there are 30 bonds in the market all paying annual coupons. The first bond has a maturity of 1 year, the second bond of 2 years, and so on out to 30 years. We know the price of each of these bonds, but we wish to determine what the prices imply about the market's estimate of future interest rates. We naturally expect interest rates to vary over time and that all payments being made on the same date are valued using the same rate. For the 1-year bond we know its current price and the amount of the payment (comprising one coupon payment and the redemption proceeds) we will receive at the end of the year; therefore, we can calculate the interest rate for the first year. Assume the 1-year bond has a coupon of 5%. If the bond is priced at par and we invest £100 today we will receive £105 in one year's time, hence the rate of interest is apparent and is 5%. For the 2-year bond we use this interest rate to calculate the future value of its current price in 1 year's time: *this is how much we would receive if we had invested the same amount in the 1-year bond*. However, the 2-year bond pays a coupon at the end of the first year; if we subtract this amount from the future value of the current price, the net amount is what we should be giving up in 1 year in return for the one remaining payment. From these numbers we can calculate the interest rate in Year 2.

Assume that the 2-year bond pays a coupon of 6% and is priced at 99.00. If 99.00 was invested at the rate we calculated for the 1-year bond (5%), it would accumulate £103.95 in 1 year, made up of the £99 investment and interest of £4.95. On the payment date in 1 year's time, the 1-year bond matures and the 2-year bond pays a coupon of 6%. If everyone expected the 2-year bond at this time to be priced at more than 97.95 (which is 103.95 minus 6.00), then no investor would buy the 1-year bond, since it would be more advantageous to buy the 2-year bond and sell it after 1 year for a greater return. Similarly, if the price was less than 97.95 no investor would buy the 2-year bond, as it would be cheaper to buy the shorter bond and then buy the longer dated bond with the proceeds received when the 1-year bond matures. Therefore, the 2-year bond must be priced at exactly 97.95 in 12 months' time. For this £97.95 to grow to £106.00 (the maturity proceeds from the 2-year bond, comprising the redemption payment and coupon interest), the interest rate in Year 2 must be 8.20%. We can check this using the present value formula covered earlier. At these two interest rates, the two bonds are said to be in equilibrium.

This is an important result and shows that there can be no arbitrage opportunity along the yield curve; using interest rates available today the return from buying the 2-year bond must equal the return from buying the one-year bond and rolling over the proceeds (or *reinvesting*) for another year. This is the known as the *breakeven principle.*

Using the price and coupon of the 3-year bond we can calculate the interest rate in Year 3 in precisely the same way. Using each of the bonds in turn, we can link together the *implied 1-year rates* for each year up to the maturity of the longest dated bond. The process is known as *boot-strapping*. The 'average' rate over a given period is the spot yield for that term: in the example given above, the rate in Year 1 is 5%, and in Year 2 is 8.20%. An investment of £100 at these rates would grow to £113.61. This gives a total percentage increase of 13.61% over 2 years, or 6.588% per annum. The average rate is not obtained by simply dividing 13.61 by 2, but – using our present value relationship again – by calculating the square root of '1 plus the interest rate' and then subtracting 1 from this number. Thus, the 1-year yield is 5% and the 2-year yield is 8.20%.

In real-world markets it is not necessarily as straightforward as this; for instance, on some dates there may be several bonds maturing, with different coupons, and on some dates there may be no bonds maturing. It is most unlikely that there will be a regular spacing of bond redemptions exactly 1 year apart. For this reason it is common for analysts to use a software model to calculate the set of implied spot rates which best fits the market prices of the bonds that do exist in the market. For instance, if there are several 1-year bonds, each of their prices may imply a slightly different rate of interest. We choose the rate which gives the smallest average price error. In practice, all bonds are used to find the rate in Year 1, all bonds with a term longer than 1 year are used to calculate the rate in Year 2, and so on. The zero-coupon curve can also be calculated directly from the coupon yield curve using a method similar to that described above; in this case, the bonds would be priced at par and their coupons set to par yield values.

The zero-coupon yield curve is ideal to use when deriving implied forward rates, which we consider next, and when defining the term structure of interest rates. It is also the best curve to use when determining the *relative value*, whether cheap or dear, of bonds trading in the market, and when pricing new issues, irrespective of their coupons.

Arithmetic

Having introduced the concept of the zero-coupon curve in the previous section, we can illustrate the mathematics involved more formally. When deriving spot yields from redemption yields, we view conventional bonds as being made up of an *annuity* (the stream of fixed coupon payments) and a zero-coupon bond (the redemption payment on maturity). To derive the rates we can use equation (3.1), setting $P_d = M = 100$ and $C = rm_N$, as shown in equation (3.2). This has coupon bonds trading at par, so that the coupon is equal to the yield:

$$\begin{aligned} 100 &= rm_N \times \sum_{n=1}^{N} Df_n + 100 \times D_N \\ &= rm_N \times A_N + 100 \times D_N \end{aligned} \tag{3.2}$$

where rm_N is par yield for a term to maturity of N years, the discount factor Df_N is the fair price of a zero-coupon bond with a par value of £1 and a term to maturity of N years, and

$$A_N = \sum_{n=1}^{N} Df_n = A_{N-1} + Df_N \tag{3.3}$$

is the fair price of an annuity of £1 per year for N years (with $A_0 = 0$ by convention). Substituting equation (3.3) into equation (3.2) and re-arranging will give us the expression for the N-year discount factor shown in equation (3.4):

$$Df_N = \frac{1 - rm_N \times A_{N-1}}{1 + rm_N} \tag{3.4}$$

If we assume 1-year, 2-year and 3-year redemption yields for bonds priced at par to be 5%, 5.25% and 5.75%, respectively, we will obtain the following solutions for the discount factors:

$$\begin{aligned} Df_1 &= \frac{1}{1 + 0.05} = 0.95238 \\ Df_2 &= \frac{1 - (0.0525)(0.95238)}{1 + 0.0525} = 0.90261 \\ Df_3 &= \frac{1 - (0.0575)(0.95238 + 0.90261)}{1 + 0.0575} = 0.84476 \end{aligned}$$

We can confirm that these are the correct discount factors by substituting them back into equation (3.2); this gives us the following results for the 1-year, 2-year and 3-year par value bonds (with coupons of 5%, 5.25% and 5.75%, respectively):

$$\begin{aligned} 100 &= 105 \times 0.95238 \\ 100 &= 5.25 \times 0.95238 + 105.25 \times 0.90261 \\ 100 &= 5.75 \times 0.95238 + 5.75 \times 0.90261 + 105.75 \times 0.84476 \end{aligned}$$

Now that we have found the correct discount factors it is relatively straightforward to calculate the spot yields using equation (3.1):

$$Df_1 = \frac{1}{(1+rs_1)} = 0.95238 \quad \text{which gives} \quad rs_1 = 5.0\%$$
$$Df_2 = \frac{1}{(1+rs_2)^2} = 0.90261 \quad \text{which gives} \quad rs_2 = 5.269\%$$
$$Df_3 = \frac{1}{(1+rs_3)^3} = 0.84476 \quad \text{which gives} \quad rs_3 = 5.778\%$$

Equation (3.1) discounts the n-year cashflow (comprising the coupon payment and/or principal repayment) by the corresponding n-year spot yield. In other words rs_n is the *time-weighted rate of return* on a n-year bond. Thus, as we said in the previous section the spot yield curve is the correct method for pricing or valuing any cashflow, including an irregular cashflow, because it uses the appropriate discount factors. That is, it matches each cashflow to the discount rate that applies to the time period in which the cashflow is paid. Compare this with the approach for calculating the yield-to-maturity, which discounts all cashflows by the same yield to maturity. This neatly illustrates why the n-period zero-coupon interest rate is the true interest rate for an N-year bond.

The expressions above are solved algebraically in the conventional manner, although those wishing to use a spreadsheet application such as Microsoft Excel® can input the constituents of each equation into individual cells and solve using the 'Tools' and 'Goal Seek' functions.

There is a very large literature on the zero-coupon yield curve. A small fraction of it – as referred to in this chapter – is given in the Bibliography at the end of the chapter.

Example calculation illustrations

In this section we illustrate some elementary uses of the yield curve by providing some example calculations.

Forward rates: Breakeven principle

Consider the following spot yields :

1-year	10%
2-year	12%

Assume that a bank's client wishes to lock in *today* the cost of borrowing 1-year funds in 1 year's time. The solution for the bank (and the mechanism to enable the bank to quote a price to the client) involves raising 1-year funds at 10% and investing the proceeds for 2 years at 12%. The no-arbitrage principle means that the same return must be generated from both fixed rate and reinvestment strategies.

In effect, we can look at the issue in terms of two alternative investment strategies, both of which must provide the same return:

Strategy 1	Invest funds for 2 years at 12%.
Strategy 2	Invest funds for 1 year at 10%, and reinvest the proceeds for a further year at the forward rate calculated today.

The forward rate for Strategy 2 is the rate that will be quoted to the client. Using the present value relationship we know that the proceeds from Strategy 1 are:

$$FV = (1 + r_2)^2$$

while the proceeds from Strategy 2 would be:

$$FV = (1 + r_1) \times (1 + R)$$

We know from the no-arbitrage principle that the proceeds from both strategies will be the same, therefore this enables us to set:

$$(1 + r_2)^2 = (1 + r_1)(1 + R)$$

$$R = \frac{(1 + r_2)^2}{(1 + r_1)} - 1$$

This enables us to calculate the forward rate that can be quoted to the client (together with any spread that the bank might add) as follows:

$$\begin{aligned}(1 + 0.12)^2 &= (1 + 0.10) \times (1 + R)\\ (1 + R) &= (1 + 0.12)^2/(1 + 0.10)\\ (1 + R) &= 1.14036\\ R &= 14.04\%\end{aligned}$$

This rate is the 1-year forward–forward rate, or the implied forward rate.

Further examples

If a 1-year AAA Eurobond trading at par yields 10% and a 2-year Eurobond of similar credit quality, also trading at par, yields 8.75%, what should the price of a 2-year AAA zero-coupon bond be? Note that Eurobonds pay coupon annually:

(a)	Cost of 2-year bond (per cent nominal)	100
(b)	*less* amount receivable from sale of first coupon on this bond (i.e., its present value)	$= 8.75/1 + 0.10$ $= 7.95$
(c)	*equals* amount that must be received on sale of second coupon plus principal in order to break even	92.05
(d)	calculate the yield implied in the cashflows below (i.e., the 2-year zero-coupon yield) – receive 92.05 – pay out on maturity 108.75 Therefore Gives R equal to 8.69%	$92.05 = 108.75/(1 + R)^2$
(e)	What is the price of a 2-year zero-coupon bond with nominal value 100, to yield 8.69%?	$= (92.05/108.75) \times 100$ $= 84.64$

A highly-rated customer asks you to fix a yield at which he could issue a 2-year zero-coupon USD Eurobond in 3 years' time. At this time the US Treasury zero-coupon rates were:

1 year	6.25%
2 year	6.75%
3 year	7.00%
4 year	7.125%
5 year	7.25%

(a) Ignoring borrowing spreads over these benchmark yields, as a market-maker you could cover the exposure created by borrowing funds for 5 years on a zero-coupon basis and placing these funds in the market for 3 years before lending them on to your client. Assume annual interest compounding (even if none is actually paid out during the life of the loans):

$$\text{Borrowing rate for 5 years } \left[\frac{R_5}{100}\right] = 0.0725$$

$$\text{Lending rate for 3 years } \left[\frac{R_3}{100}\right] = 0.0700$$

(b) The key arbitrage relationship is:

Total cost of funding = Total return on investments

$$(1 + R_5)^5 = (1 + R_3)^3 \times (1 + R_{3\times5})^2$$

Therefore, breakeven forward yield is :

$$(1 + R_{3\times5})^2 = \frac{(1 + 0.0725)^5}{(1 + 0.0700)^3}$$

$$(1 + R_{3\times5}) = \sqrt{\left[\frac{(1 + 0.0725)^5}{(1 + 0.0700)^3}\right]}$$

$$R_{3\times5} = \sqrt{\left[\frac{(1 + 0.0725)^5}{(1 + 0.0700)^3}\right]} - 1$$

$$= 7.63\%$$

FORWARD RATE CALCULATION FOR MONEY MARKET TERM

Consider two positions:

Borrowing	£100 million today for 30 days at 5.875%
Lending	£100 million today for 60 days at 6.125%

The two positions can be viewed as a 30-day forward 30-day interest rate exposure (a 30-day versus 60-day forward rate). It is usually referred to as an interest rate *gap* position. What forward rate must be used if the trader wished to hedge this exposure?

The 30-day by 60-day forward rate can be calculated using the following formula:

$$rf_i = \left[\left(\frac{1 + \left(rs_L\% \times \dfrac{n_L}{B}\right)}{1 + \left(rs_S\% \times \dfrac{n_S}{B}\right)}\right) - 1\right] \times \frac{B}{n_L - n_S} \qquad (3.5)$$

where

$$
\begin{aligned}
rf_i &= \text{Forward rate;} \\
rs_L\% &= \text{Long-period rate;} \\
rs_S\% &= \text{Short-period rate;} \\
n_L &= \text{Long-period term in days;} \\
n_S &= \text{Short-period term in days;} \\
B &= \text{Day-count base, either 360 or 365 (in this case 365).}
\end{aligned}
$$

Using this formula we obtain a 30-day versus 60-day forward rate of 6.3443%.

This interest rate exposure can be hedged using interest rate futures or forward rate agreements (FRAs). Either method is an effective hedging mechanism, although the trader must be aware of

- the *basis* risk that exists between cash market rates and the forward rates implied by futures and FRAs;
- date mismatches between expiry of futures contracts and the maturity dates of cash market transactions.

Understanding forward rates

Spot and forward rates calculated from current market rates follow mathematical principles to establish what the arbitrage-free rates for dealing *today* will be at some point in the future. In other words, forward rates and spot rates are actually saying the same thing. However, as we have already noted, forward rates are not a prediction of future rates. It is important to be aware of this distinction. If we were to plot the forward rate curve for the term structure in 3 months' time, and then compare it in 3 months with the actual term structure prevailing at the time, the curves would certainly not match. However, this has no bearing on our earlier statement: that forward rates are the mathematical *expectation* of future rates. The main point to bear in mind is that we are not comparing like for like when plotting forward rates against actual current rates at a future date. When we calculate forward rates, we use the current term structure. The current term structure incorporates all known information, both economic and political, and reflects the market's views. This is exactly the same as when we say that a company's share price reflects all that is known about the company and all that is expected to happen with regard to the company in the near future, including expected future earnings. The term structure of interest rates reflects everything the market knows about relevant domestic and international factors. It is this information, then, that goes into forward rate calculation. An instant later, though, there will be new developments that will alter the market's view and therefore alter the current term structure; these developments and events were (by definition, as we cannot know what lies in the future!) not known at the time we calculated and used 3-month forward rates. This is why rates actually turn out to be different from what the term structure mathematically constructed at an earlier date. However, for dealing today we use today's forward rates, which reflect everything we know about the market today.

BIBLIOGRAPHY

Campbell, J. (1986) 'A defence of traditional hypotheses about the term structure of interest rates,' *Journal of Finance*, March, 183–193.

Choudhry, M. (1998) 'The information content of the United Kingdom gilt yield curve,' unpublished MBA assignment, Henley Management College.

Choudhry, M. (2001) *The Bond and Money Markets*, Butterworth Heinemann, Chapters 51–53.

Choudhry, M. (2009) 'The value of introducing structural reform to improve bond market liquidity: Experience from the U.K. gilt market,' *European Journal of Finance and Banking Research*, **2**(2).

Cox, J., Ingersoll, J.E., and Ross, S.A. (1981) 'A re-examination of traditional hypotheses about the term structure of interest rates,' *Journal of Finance*, **36**, September, 769–799.

Culbertson, J.M. (1957) 'The term structure of interest rates,' *Quarterly Journal of Economics*, **71**, November, 485–517.

The Economist (1998) 'Admiring those shapely curves,' 4 April, p.117.

Fama, E.F. (1976) 'Forward rates as predictors of future spot interest rates,' *Journal of Financial Economics*, **3**(4), October, 361–377.

Fama, E.F. (1984) 'The information in the term structure,' *Journal of Financial Economics*, **13**, December, 509–528.

Fisher, I. (1986) 'Appreciation of interest,' *Publications of the American Economic Association*, August, 23–39.

Hicks, J. (1946) *Value and Capital*, Oxford University Press, 1946.

Ingersoll, J. (1987) *Theory of Financial Decision Making*, Rowman & Littlefield, Chapter 18.

Jarrow, R. (1996) *Modelling Fixed Income Securities and Interest Rate Options*, McGraw-Hill.

Levy, H. (1999) *Introduction to Investments*, Second Edition, South-Western.

Livingstone, M. (1990) *Money and Capital Markets*, Prentice Hall.

Lutz, F. (1940) 'The structure of interest rates,' *Quarterly Journal of Economics*, November, 36–63.

McCulloch, J.H. (1975) 'An estimate of the liquidity premium,' *Journal of Political Economy*, **83**, January/February, 95–119.

Meiselman, D. (1962) *The Term Structure of Interest Rates*, Prentice Hall.

Rubinstein, M. (1999) *Rubinstein on Derivatives*, RISK Publishing.

Chapter 4

INTRODUCTION TO TRADING AND HEDGING

In this chapter we introduce the basics of trading and hedging as employed by a bank asset–liability management (ALM) desk. The instruments and techniques used form the fundamental building blocks of ALM, so the reader can imagine that a full and comprehensive treatment of this subject would require a book in its own right.[1] Our purpose here is to acquaint the newcomer to the market with the essentials, with further recommended reading suggested in the Bibliography.

The ALM and money market desk has a vital function in a bank, funding all the business lines in the bank. In some banks and securities houses it will be placed within the Treasury or money market areas, whereas other firms will organize it as an entirely separate function. Wherever it is organized, the need for clear and constant communication between the ALM desk and the other operating areas of the bank is paramount. We present an overview of ALM, liquidity and interest rate strategy in the next chapter; here we look at specific uses of money market products like deposits and repo in the context of yield enhancement and market-making.

TRADING APPROACH

The yield curve and interest rate expectations

When the yield curve is positively sloped, the conventional approach is to fund the book at the short end of the curve and lend at the long end. In essence, therefore, if the yield curve resembled that shown in Figure 4.1 a bank would borrow, say, 1-week funds while simultaneously lending out at, say, 3-month maturity. This is known as *funding short*. A bank can effect the economic equivalent of borrowing at the short end of the yield curve and lending at the longer end through repo transactions – in our example, a 1-week repo and a 3-month reverse repo. The bank then continuously rolls over its funding at 1-week intervals for the 3-month period. This is also known as *creating a tail*; here the 'tail' is the gap between 1 week and 3 months – the interest rate 'gap' that the bank is exposed to. During the course of the trade – as the reverse repo has locked in a loan for 6 months – the bank is exposed to interest rate risk should

[1] See Choudhry (2007).

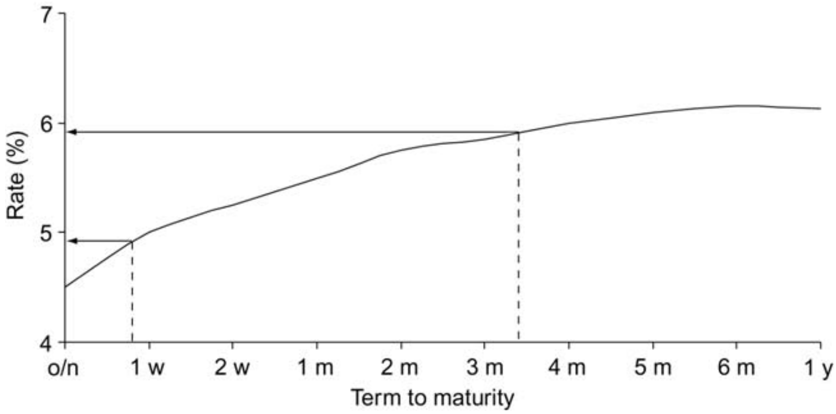


Figure 4.1 Positive yield curve funding.

the slope or shape of the yield curve change. In this case the bank may see its profit margin shrink or turn into a funding loss if short-dated interest rates rise.

As we noted in Chapter 3, a number of hypotheses have been advanced to explain the shape of the yield curve at any particular time. A steep positive-shaped curve may indicate that the market expects interest rates to rise over the longer term, although this is also sometimes given as the reason for an inverted curve with regard to shorter term rates. Generally speaking, trading volumes are higher in a positive-sloping yield curve environment, compared with a flat or negative-shaped curve.

In the case of an inverted yield curve, a bank will (all else being equal) lend at the short end of the curve and borrow at the longer end. This is known as *funding long* and is shown in Figure 4.2.

The example in Figure 4.2 shows a short cash position of 2-week maturity against a long cash position of 4-month maturity. The interest rate *gap* of 10 weeks is the book's interest rate exposure. The inverted shape of the yield curve may indicate market expectations of a rise in short-term interest rates. Further along the yield curve, the market may expect a benign inflationary environment, which is why the premium on longer term returns is lower than normal.

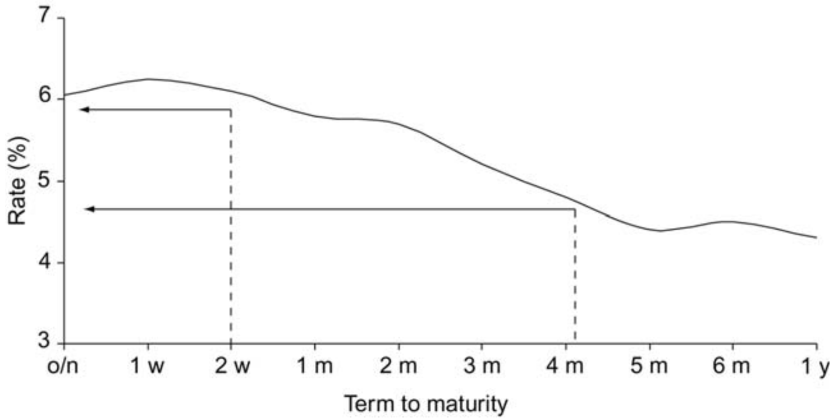


Figure 4.2 Negative yield curve funding.

Credit intermediation by the repo desk

The government bond repo market will trade at a lower rate than other money market instruments, reflecting its status as a secured instrument with the best credit. This allows spreads between markets of different credits to be exploited. The following are examples of credit intermediation trades:

- a repo dealer lends general collateral currently trading at a spread below Libor and uses the cash to buy CDs trading at a smaller spread below Libor;
- a repo dealer borrows specific collateral in the stock-lending market – paying a fee – and sells the stock in the repo market at the GC rate; the cash is then lent in the interbank market at a higher rate – for instance, through the purchase of a clearing bank certificate of deposit. The CD is used as collateral in the stock loan transaction. A bank must have dealing relationships with both the stock loan and repo markets to effect this trade. An example of the trade that could be put on using this type of intermediation is shown in Figure 4.3 for the UK gilt market. The details are given below and show that the bank would stand to gain 17 basis points over the course of the 3-month trade;
- a repo dealer trades repo in the GC market, and using the cash from this repo invests in emerging market collateral at a spread, say, 400 basis points higher.

These are but three examples of the way that repo can be used to

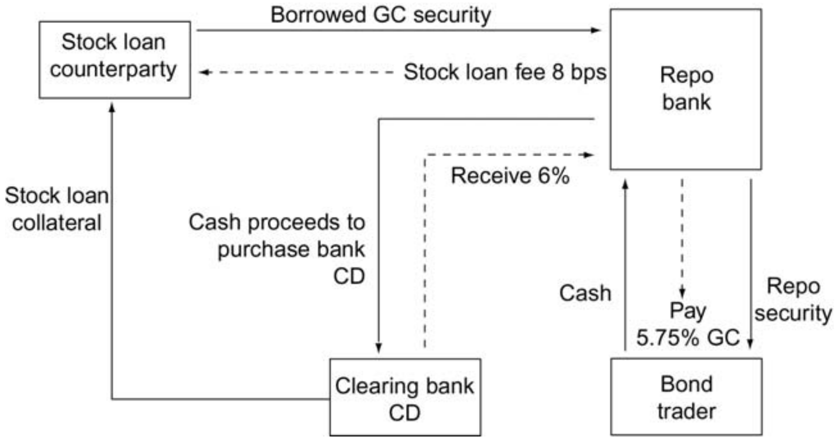


Figure 4.3 Intermediation between stock loan and repo markets; an example using UK gilts.

exploit the interest rate differentials that exist between markets of varying credit qualities and between secured and unsecured markets.

Figure 4.3 shows potential gains that can be made by a repo-dealing bank (market-maker) that has access to both the stock loan and general collateral repo market. It illustrates the rates available in the gilt market on 31 October 2000 for 3-month maturities, which were

3-month GC repo	5.83–5.75%
3-month clearing bank CD	$6\frac{1}{32}$–6.00%

The stock loan fee for this term was quoted at 510 basis points, with the actual fee paid being 8 basis points. Therefore, the repo trader borrows GC stock for 3 months and offers this in repo at 5.75%;[2] the cash proceeds are then used to purchase a clearing bank CD at 6.00%. This CD is used as collateral in the stock loan. The profit is market risk-free as the terms are locked, although there is an element of

[2] A repo dealer is a market-maker, and so offers stock in repo at the offered side, which is 5.75%. However, this trade still turns in a profit if the bank dealt at another market-maker's bid side of 5.83%, with a profit of 9 basis points on the cash sum. Rates are quoted from King & Shaxson Bond Brokers Limited.

credit risk in holding the CD. On these terms, the profit in £100 million stock for the 3-month period is approximately £170,000.

The main consideration for the dealing bank is the capital requirements of the trade. Gilt repo is zero-weighted for capital purposes; indeed, clearing bank CDs are accepted by the Bank of England for liquidity purposes, so the capital cost is not onerous. The bank will need to ensure that it has sufficient credit lines for the repo and CD counterparties.

SPECIALS TRADING

The existence of an open repo market allows the demand for borrowing and lending stocks to be cleared by the price mechanism – in this case the repo rate. This facility also measures supply and demand for stocks more efficiently than traditional stock lending. It is to be expected that – when specific stocks are in demand – the premium on obtaining them rises for a number of reasons. This is reflected in the repo rate associated with the specific stock in demand, which falls below the same maturity GC repo rate. The repo rate falls because the entity repoing out stock – that is, borrowing cash – is in possession of the desired asset: the specific bond. So, the interest rate payable by this counterparty falls as compensation for lending out the desired bond.

The factors contributing to individual securities becoming *special* include

- government bond auctions; the bond to be issued is shorted by market-makers in anticipation of a new supply of stock and due to client demand;
- outright short-selling, whether deliberate position-taking on the trader's view, or market-makers selling stock on client demand;
- hedging, including bond underwriters who will short the benchmark government bond that the corporate bond is priced against;
- derivatives trading such as basis ('cash-and-carry') trading creating demand for a specific stock.

Natural holders of government bonds can benefit from issues *going special*, which is when the demand for specific stocks is such that the rate for borrowing them is reduced. The lower repo rate reflects the premium for borrowing the stock. Note that the party borrowing

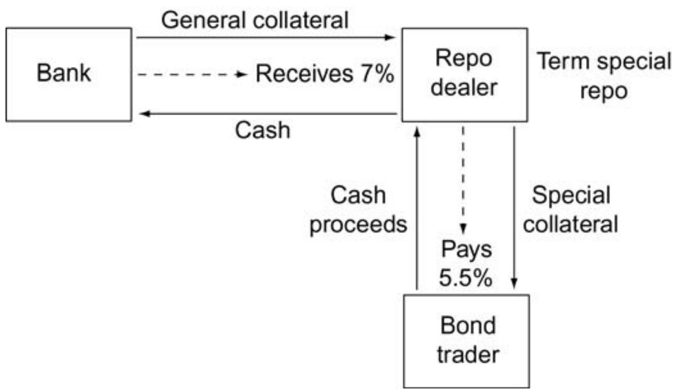


Figure 4.4 Funding gain from repo of a special stock.

the special stock is lending cash; it is the rate payable on the cash that they have lent which is depressed.

The holder of a stock that has gone special can obtain cheap funding for the issue itself by lending it out. Alternatively, the holder can lend the stock and obtain cash in exchange in a repo, for which the rate payable is lower than the interbank rate. These funds can then be lent out as either secured funding (in a repo), or as unsecured funding, enabling the specials holder to lock in a funding profit. For example, consider a situation where a repo dealer holds an issue that is trading at 5.5% in 1-week repo. The equivalent GC rate is 7%, making the specific issue very special. By lending the stock out the dealer can lock in the profit by lending 1-week cash at 7% or at a higher rate in the interbank market. This is illustrated in Figure 4.4.

There is a positive correlation between changes in a stock trading expensive to the yield curve and changes in the degree to which it trades special. Theory would predict this, since traders will maintain short positions for bonds with high funding (repo) costs only if the anticipated fall in the price of the bond is large enough to cover this funding premium. When stock is perceived as being expensive – for example, after an auction announcement – this creates a demand for short positions and hence greater demand for the paper in a repo. At other times the stock may go tight in the repo market, following which it will tend to be bid higher in the *cash* market as traders close out existing shorts (which had become expensive to finance). At the same time traders and investors may attempt to buy the stock outright since it will now be cheap to finance in a repo. The link between dearness in the cash market and special status in the repo market flows both ways.

MATCHED BOOK TRADING

The growth and development of repo markets has led to repo matched-book-trading desks. Essentially, this is market-making in repo; dealers make two-way trading prices in various securities, irrespective of their underlying positions. The term 'matched book' is in fact a misnomer; most matched books are deliberately mismatched as part of a view on the short-term yield curve. Another commonly encountered definition of the term is of a bank that trades repo solely to cover its long and short bond positions and does not enter into trades for other reasons.[3] However, it is *not* matching cash lent and borrowed, nor trading to profit from the bid–offer spread, nor any of the sundry other definitions that have been given in previous texts.

Traders running a matched book put on positions to take advantage of (i) short-term interest rate movements and (ii) anticipated supply and demand in the underlying stock. Many of the trading ideas and strategies described in this book are examples of matched book trading. It can involve the following types of trade:

- taking a view on interest rates – for example, the dealer bids for 1-month GC and offers 3-month GC, expecting the yield curve to invert;
- taking a view on specials – for example, the trader borrows stock in the stock-lending market for use in repo once it goes *special* (as the trader expects);
- credit intermediation – for example, a dealer reverses in Brady bonds from a Latin American bank, at a rate of Libor + 200 and offers this stock to a US money market investor at a rate of Libor + 20.

Principals and principal intermediaries with large volumes of repos and reverse repos, such as the market-makers mentioned above, are said to be running matched books. An undertaking to provide two-way prices is made to provide customers with a continuous financing

[3] Thanks to Del Boy at King & Shaxson Bond Brokers Ltd for pointing this out, although I still reckon that my definition is the right one!

service for long and short positions and also as part of proprietary trading. Traders will mismatch positions in order to take advantage of a combination of two factors: short-term interest rate movements and anticipated supply/demand in the underlying bond.

INTEREST-RATE-HEDGING TOOLS

For bank dealers who are not looking to trade around term mismatch or other spreads, but who will run a tenor mismatch between assets and liabilities (which is, after all, what banking is: the practice of maturity transformation), there are a number of instruments we can use to hedge the resulting interest rate risk exposure. We briefly consider them here. They are covered in greater depth in Choudhry (2007).

Interest rate futures

A forward term interest rate gap exposure can be hedged using interest rate futures. These are standardized exchange-traded derivative contracts, and represent a forward-starting 90-day time deposit. In the sterling market the instrument will be typically the 90-day short sterling future traded on the LIFFE futures exchange. A strip of futures can be used to hedge the term gap. The trader buys futures contracts to the value of the exposure and for the term of the gap. Any change in cash rates should be hedged by offsetting moves in futures prices.

Description

A *futures* contract is a transaction that fixes the price today for a commodity that will be delivered at some point in the future. Financial futures fix the price for interest rates, bonds, equities and so on, but trade in the same manner as commodity futures. Contracts for futures are standardized and traded on recognized exchanges. In London the main futures exchange is LIFFE, although other futures are also traded on, for example, the International Petroleum Exchange and the London Metal Exchange. Money markets trade short-term interest rate futures that fix the rate of interest on a notional fixed term deposit of money (usually for 90 days or 3 months) for a specified period in the future. The sum is notional because no actual sum of money is deposited when buying

Table 4.1 Description of LIFFE short sterling future contract

Name	90-day sterling Libor interest rate future
Contract size	£500,000
Delivery months	March, June, September, December
Delivery date	First business day after the last trading day
Last trading day	Third Wednesday of delivery month
Price	100 minus interest rate
Tick size	0.01
Tick value	£12.50
Trading hours	LIFFE CONNECT™ 07:30–18:00 hours

Source: LIFFE.

or selling futures – the instrument being off balance sheet. Buying such a contract is equivalent to making a notional deposit, while selling a contract is equivalent to borrowing a notional sum.

The 3-month interest rate future is the most widely used instrument for hedging interest rate risk.

The LIFFE exchange in London trades short-term interest rate futures for major currencies including sterling, euros, yen and the Swiss franc. Table 4.1 summarizes the terms for the short sterling contract as traded on LIFFE.

Futures contracts originally related to physical commodities, which is why we speak of *delivery* when referring to the expiry of financial futures contracts. Exchange-traded futures such as those on LIFFE are set to expire every quarter during the year. The short sterling contract is a deposit of cash, so as its price refers to the rate of interest on this deposit the price of the contract is set as $P = 100 - r$ where P is the price of the contract and r is the rate of interest at the time of expiry implied by the futures contract. This means that if the price of the contract rises the rate of interest implied goes down and vice versa. For example, the price of the June 2011 short sterling future (written as Jun11 or M11, from the futures identity letters of H, M, U and Z for contracts expiring in March, June, September and December, respectively) at the start of trading on 22 September 2010 was 99.05, which implied a 3-month Libor rate of 0.95% on expiry of the contract in June 2011. If a trader bought 20 contracts at this price and then sold them just before the close of trading that day, when the price had risen to 99.08, an implied rate of 0.92%, she would have made 3 ticks profit or £750. That is, a 3-tick upward price movement in a long position of 20 contracts is equal to £750. This is calculated as follows:

$$\text{Profit} = \text{Ticks gained} \times \text{Tick value} \times \text{Number of contracts}$$
$$\text{Loss} = \text{Ticks lost} \times \text{Tick value} \times \text{Number of contracts}$$

The tick value for the short sterling contract is straightforward to calculate. Since we know that the contract size is £500,000, there is a minimum price movement (tick movement) of 0.01% and the contract has a 3-month 'maturity':

$$\text{Tick value} = 0.01\% \times £500{,}000 \times \frac{3}{12} = £12.50$$

The profit made by the trader in our example is logical because if we buy short sterling futures we are depositing (notional) funds and if the price of the futures rises, it means the interest rate has fallen. We profit because we have 'deposited' funds at a higher rate beforehand. If we expected sterling interest rates to rise, we would sell short sterling futures, which is equivalent to borrowing funds and locking in the loan rate at a lower level.

Note how the concept of buying and selling interest rate futures differs from FRAs: if we buy a FRA we are borrowing notional funds, whereas if we buy a futures contract we are depositing notional funds. If a position in an interest rate futures contract is held to expiry, cash settlement will take place on the delivery day for that contract.

Short-term interest rate contracts in other currencies are similar to the short sterling contract and trade on exchanges such as Deutsche Terminbörse in Frankfurt and MATIF in Paris.

In practice, futures contracts do not provide a precise tool for locking into cash market rates today for a transaction that takes place in the future, although this is what they are theoretically designed to do. Futures do allow a bank to lock in a rate for a transaction to take place in the future; this rate is the *forward rate*. The basis is the difference between today's cash market rate and the forward rate on a particular date in the future. As a futures contract approaches expiry, its price and the rate in the cash market will converge (the process is given the name *convergence*). This is given by the exchange delivery settlement price, and the two prices (rates) will be exactly in line at the precise moment of expiry.

Example 4.1 The Eurodollar futures contract

The Eurodollar futures contract is traded on the Chicago Mercantile Exchange. The underlying asset is a deposit of US dollars in a bank outside the US, and the contract is at the rate of dollar 90-day Libor. The Eurodollar future is cash-settled on the second business day before the third Wednesday of the delivery month (London business day). The final settlement price is used to set the price of the contract, given by

$$10{,}000(100 - 0.25r)$$

where r is the quoted Eurodollar rate at the time. This rate is the actual 90-day Eurodollar deposit rate.

The longest dated Eurodollar contract has an expiry date of 10 years. The market assumes that futures prices and forward prices are equal; this is indeed the case under conditions where the risk-free interest rate is constant and the same for all maturities. In practice, it also holds for short-dated futures contracts, but does not for longer dated futures contracts. Therefore, using futures contracts with a maturity greater than 5 years to calculate zero-coupon rates or implied forward rates will produce errors in results, which need to be taken into account if the derived rates are used to price other instruments such as swaps.

Figure 4.5 shows the Bloomberg description page for the Eurodollar contract.

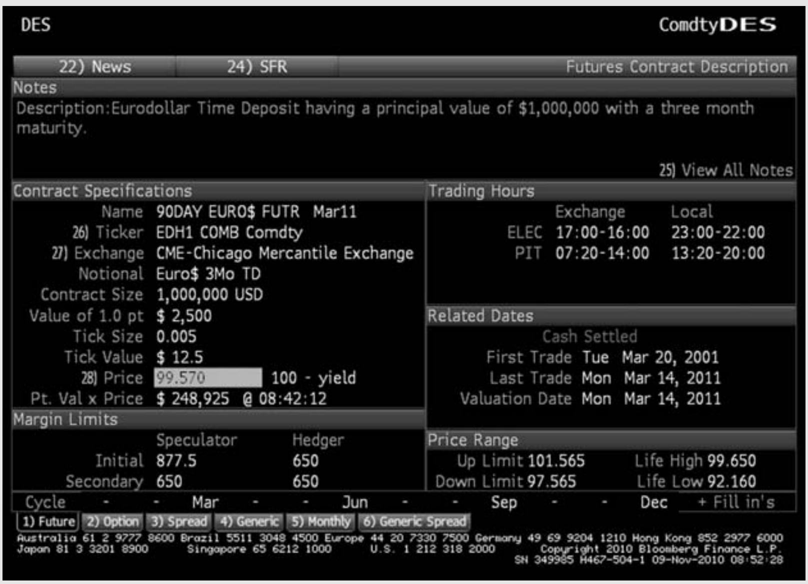


Figure 4.5 Bloomberg page DES for Eurodollar contract.

Hedging using interest rate futures

Banks use interest rate futures to hedge interest rate risk exposure in cash and OBS instruments. Bond-trading desks often use futures to hedge positions in bonds of up to 2 or 3 years' maturity, as contracts are traded up to 3 years' maturity. The liquidity of such 'far month' contracts is considerably lower than for 'near month' contracts and the 'front month' contract (the current contract, for the next maturity month). When hedging a bond with a maturity of say 2 years' maturity, the trader will put on a *strip* of futures contracts that matches as near as possible the expiry date of the bond.

The purpose of a hedge is to protect the value of a current or anticipated cash market or OBS position from adverse changes in interest rates. The hedger will try to offset the effect of the change in interest rate on the value of his cash position with the change in value of his hedging instrument. If the hedge is an exact one the loss on the main position should be compensated by a profit on the hedge position. If the trader is expecting a fall in interest rates and wishes to protect against such a fall he will buy futures (known as a long hedge) and will sell futures (a short hedge) if wishing to protect against a rise in rates.

Bond traders also use 3-month interest rate contracts to hedge positions in short-dated bonds; for instance, a market-maker running a short-dated bond book would find it more appropriate to hedge his book using short-dated futures rather than the longer dated bond futures contract. When this happens it is important to accurately calculate the correct number of contracts to use for the hedge. To construct a bond hedge it will be necessary to use a strip of contracts, thus ensuring that the maturity date of the bond is covered by the longest dated futures contract. The hedge is calculated by finding the sensitivity of each cashflow to changes in each of the relevant forward rates. Each cashflow is considered individually and hedge values are then aggregated and rounded to the nearest whole number of contracts.

Examples 4.2 and 4.3 illustrate hedging with short-term interest-rate contracts.

Example 4.2 Hedging a forward 3-month lending requirement

On 1 June a corporate treasurer is expecting a cash inflow of £10 million in 3 months' time (1 September), which he will then invest for 3 months. The treasurer expects interest rates will fall over the next few weeks and wishes to protect himself against such a fall. This can be done using short sterling futures. The market rates on 1 June are as follows:

3-month Libor	$6\frac{1}{2}\%$
Sep futures price	93.220

The treasurer buys 20 September short sterling futures at 93.220, this number being exactly equivalent to a sum of £10 million. This allows him to lock in a forward *lending* rate of 6.78%, on the assumption there is no bid–offer quote spread:

$$\begin{aligned}\text{Expected lending rate} &= \text{Rate implied by futures price}\\ &= 100 - 93.220\\ &= 6.78\%.\end{aligned}$$

On 1 September the market rates are as follows:

3-month Libor	$6\frac{1}{2}\%$
Sep futures price	93.705

The treasurer unwinds the hedge at this price.

$$\text{Futures P\&L} = +97 \text{ ticks}(93.705 - 93.22), \quad \text{or} \quad 0.485\%$$

$$\begin{aligned}\text{Effective lending rate} &= \text{3-month Libor} + \text{Futures profit}\\ &= 6.25\% + 0.485\%\\ &= 6.735\%.\end{aligned}$$

The treasurer was quite close to achieving his target lending rate of 6.78% and the hedge has helped to protect against the drop in Libor rates from $6\frac{1}{2}\%$ to $6\frac{1}{4}\%$, as a result of the profit from the futures transaction.

In the real world the cash market bid–offer spread will impact the amount of profit/loss from the hedge transaction. Futures generally trade and settle near the offered side of the market rate (Libor) whereas lending, certainly by corporates, will be nearer the Libid rate.

Example 4.3 Hedging a forward 6-month borrowing requirement

A Treasury dealer has a 6-month borrowing requirement for EUR30 million in 3 months' time, on 16 September. He expects interest rates to rise by at least $\frac{1}{2}$% before that date and would like to lock in a future borrowing rate. The scenario is:

Date	16 June
3-month LIBOR	6.0625%
6-month LIBOR	6.25
Sep futures contract	93.66
Dec futures contract	93.39

In order to hedge a 6-month DEM30 million exposure the dealer needs to use a total of 60 futures contracts, as each has a nominal value of EUR1 million, and corresponds to a 3-month notional deposit period. The dealer decides to sell 30 September futures contracts and 30 December futures contracts. This is referred to as a *strip* hedge. The expected forward borrowing rate that can be achieved by this strategy, where the expected borrowing rate is *rf*, is calculated as follows:

$$1 + rf \times \frac{\text{Days in period}}{360} = \left(1 + \text{Sep implied rate} \times \frac{\text{Sep days period}}{360}\right) \times \left(1 + \text{Dec implied rate} \times \frac{\text{Dec days period}}{360}\right)$$

Therefore, we have:

$$1 + rf \times \frac{180}{360} = \left(1 + 0.0634 \times \frac{90}{360}\right) \times \left(1 + 0.0661 \times \frac{90}{360}\right)$$
$$= 6.53\%$$

The rate *rf* is sometimes referred to as the 'strip rate'.

The hedge is unwound upon expiry of the September futures contract. Assume the following rates now prevail:

3-month LIBOR	6.4375%
6-month LIBOR	6.8125
Sep futures contract	93.56
Dec futures contract	92.93

The futures P&L is:

September contract	+10 ticks
December contract	+46 ticks

This represents a 56-tick or 0.56% profit in 3-month interest rate terms, or 0.28% in 6-month interest rate terms. The effective borrowing rate is the 6-month LIBOR rate minus the futures profit, or:

$$6.8125\% - 0.28\% \quad \text{or} \quad 6.5325\%$$

In this case the hedge has proved effective because the dealer has realized a borrowing rate of 6.5325%, which is close to the target strip rate of 6.53%.

The dealer is still exposed to the basis risk when the December contracts are bought back from the market at the expiry date of the September contract. If, for example, the future was bought back at 92.73, the effective borrowing rate would only be 6.4325%, and the dealer would benefit. Of course, the other possibility is that the futures contract could be trading 20 ticks more expensive, which would give a borrowing rate of 6.6325%, which is 10 basis points above the target rate. If this happened, the dealer may elect to borrow in the cash market for 3 months, maintain the December futures position until the December contract expiry date, and roll over the borrowing at that time. The profit (or loss) on the December futures position will compensate for any change in 3-month rates at that time.

Forward rate agreements

Forward rate agreements (FRAs) are similar in concept to interest rate futures and like them are off-balance-sheet instruments. Under a FRA a buyer agrees notionally to borrow and a seller to lend a specified notional amount at a fixed rate for a specified period – the contract to commence on an agreed date in the future. On this date (the 'fixing date') the actual rate is taken and, according to its position versus the original trade rate, the borrower or lender will receive an interest payment on the notional sum equal to the difference between the trade rate and the actual rate. The sum paid over is present-valued as it is transferred at the start of the notional loan period, whereas in a cash market trade interest would be handed over at the end of the loan period. As FRAs are off-balance-sheet contracts no actual borrowing or lending of cash takes place, hence the use of the term 'notional'. In hedging an interest rate gap in the cash period, the trader will buy a FRA contract that equates to the term gap for a nominal amount equal to his exposure in the cash market. Should rates move against him in the cash market, the gain on the FRA should (in theory) compensate for the loss in the cash trade.

Definition of a FRA

A FRA is an agreement to borrow or lend a *notional* cash sum for a period of time lasting up to 12 months, starting at any point over the next 12 months, at an agreed rate of interest (the FRA rate). The 'buyer' of a FRA is borrowing a notional sum of money while the 'seller' is lending this cash sum. Note how this differs from all other money market instruments. In the cash market, the party buying a CD or bill, or bidding for stock in the repo market, is the lender of funds. In the FRA market, to 'buy' is to 'borrow'. Of course, we use the term 'notional' because with a FRA no borrowing or lending of cash actually takes place. The notional sum is simply the amount on which interest payment is calculated.

So, when a FRA is traded, the buyer is borrowing (and the seller is lending) a specified notional sum at a fixed rate of interest for a specified period – the 'loan' to commence at an agreed date in the future. The *buyer* is the notional borrower, and so she will be protected if there is a rise in interest rates between the date that the FRA is traded and the date that the FRA comes into effect. If there is a fall in interest rates, the buyer must pay the difference between the rate at which the FRA was traded and the actual rate, as a percentage of the notional sum. The buyer may be using the FRA to hedge an actual exposure – that is, an actual borrowing of money – or simply speculating on a rise in interest rates. The counterparty to the transaction, the *seller* of the FRA, is the notional lender of funds, and has fixed the rate for lending funds. If there is a fall in interest rates the seller will gain, and if there is a rise in rates the seller will pay. Again, the seller may have an actual loan of cash to hedge or be a speculator.

In FRA trading only the payment that arises as a result of the difference in interest rates changes hands. There is no exchange of cash at the time of the trade. The cash payment that does arise is the difference in interest rates between that at which the FRA was traded and the actual rate prevailing when the FRA matures, as a percentage of the notional amount. FRAs are traded by both banks and corporates and between banks. The FRA market is very liquid in all major currencies and rates are readily quoted on screens by both banks and brokers. Dealing is over the telephone or over a dealing system such as Reuters.

The terminology quoting FRAs refers to the borrowing time period and the time at which the FRA comes into effect (or matures). Hence, if a buyer of a FRA wished to hedge against a rise in rates to cover a 3-month loan starting in 3 months' time, she would transact a '3-against-6-month' FRA, more usually denoted as a 3×6 or 3v6 FRA. This is referred to in the market as a 'threes–sixes' FRA, and means a 3-month loan beginning in 3 months' time. So, correspondingly, a 'ones–fours' FRA (1v4) is a 3-month loan in 1 month's time, and a 'threes–nines' FRA (3v9) is a 6-month loan in 3 months' time.

Remember that when we buy a FRA we are 'borrowing' funds. This differs from cash products such as CD or repo, as well as interest rate futures, where to 'buy' is to lend funds.

Example 4.4 FRA hedging

A company knows that it will need to borrow £1 million in 3 months' time for a 12-month period. It can borrow funds today at Libor + 50 basis points. Libor rates today are at 5% but the company's treasurer expects rates to go up to about 6% over the next few weeks. So, the company will be forced to borrow at higher rates unless some sort of hedge is transacted to protect the borrowing requirement. The treasurer decides to buy a 3v15 ('threes–fifteens') FRA to cover the 12-month period beginning 3 months from now. A bank quotes $5\frac{1}{2}\%$ for the FRA which the company buys for a notional £1 million. After 3 months the rates have indeed gone up to 6%, so the treasurer must borrow funds at $6\frac{1}{2}\%$ (the Libor rate plus spread); however, she will receive a settlement amount which will be the difference between the rate at which the FRA was bought and today's 12-month Libor rate (6%) as a percentage of £1 million, which will compensate for some of the increased borrowing costs.

FRA mechanics

In virtually every market FRAs trade under a set of terms and conventions that are identical. The British Bankers Association (BBA) has compiled standard legal documentation to cover FRA trading. The following standard terms are used in the market:

- *Notional sum* – the amount for which the FRA is traded.
- *Trade date* – the date on which the FRA is dealt.
- *Settlement date* – the date on which the notional loan or deposit

of funds becomes effective; that is, is said to begin. This date is used, in conjunction with the notional sum, for calculation purposes only as no actual loan or deposit takes place.

- *Fixing date* – this is the date on which the *reference rate* is determined; that is, the rate with which the FRA dealing rate is compared.
- *Maturity date* – the date on which the notional loan or deposit expires.
- *Contract period* – the time between the settlement date and maturity date.
- *FRA rate* – the interest rate at which the FRA is traded.
- *Reference rate* – the rate used as part of the calculation of the settlement amount, usually the Libor rate on the fixing date for the contract period in question.
- *Settlement sum* – the amount calculated as the difference between the FRA rate and the reference rate as a percentage of the notional sum, paid by one party to the other on the settlement date.

These dates are illustrated in Figure 4.6.

The spot date is usually two business days after the trade date; however, it can by agreement be sooner or later than this. The settlement date will be the time period after the spot date referred to by FRA terms – for example, a 1×4 FRA will have a settlement date one calendar month after the spot date. The fixing date is usually two business days before the settlement date. The settlement sum is paid on the settlement date and, as it refers to an amount over a period of time that is paid upfront at the start of the contract period, the calculated sum is a discounted present value. This is because a normal payment of interest on a loan/deposit is paid at the end of the time period to which it relates. Because a FRA makes this payment at the *start* of the relevant period, the settlement amount is also a discounted present value sum.

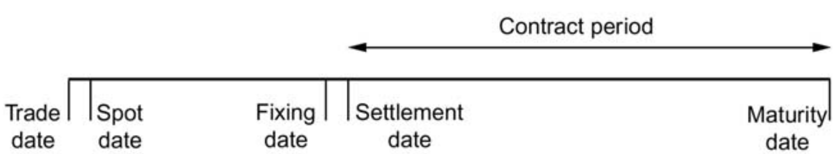


Figure 4.6 Key dates in a FRA trade.

With most FRA trades the reference rate is the LIBOR setting on the fixing date.

The settlement sum is calculated after the fixing date, for payment on the settlement date. We may illustrate this with a hypothetical example. Consider the case where a corporate has bought £1 million notional of a 1v4 FRA and dealt at 5.75%, and that the market rate is 6.50% on the fixing date. The contract period is 90 days. In the cash market the extra interest charge that the corporate would pay is a simple interest calculation:

$$\frac{6.50 - 5.75}{100} \times 1{,}000{,}000 \times \frac{91}{365} = £1{,}869.86$$

The extra interest that the corporate is facing would be payable with the interest payment for the loan, which (as it is a money market loan) is when the loan matures. Under a FRA then, the settlement sum payable should be exactly equal to this if it was paid on the same day as the cash market interest charge. This would make it a perfect hedge. However, as we noted above, the FRA settlement value is paid at the start of the contract period – that is, at the beginning of the underlying loan and not the end. Therefore, the settlement sum has to be adjusted to account for this, and the amount of the adjustment is the value of the interest that would be earned if the unadjusted cash value was invested for the contract period in the money market. The settlement value is given by equation (4.1):

$$\text{Settlement} = \frac{(r_{\text{ref}} - r_{\text{FRA}}) \times M \times \dfrac{n}{B}}{1 + \left(r_{\text{ref}} \times \dfrac{n}{B}\right)} \tag{4.1}$$

where

r_{ref} = Reference interest fixing rate;
r_{FRA} = FRA rate or *contract rate*;
M = Notional value;
n = Number of days in the contract period;
B = Day-count base (360 or 365).

Equation (4.1) simply calculates the extra interest payable in the cash market, resulting from the difference between the two interest rates, and then discounts the amount because it is payable at the start of the period and not, as would happen in the cash market, at the end of the period.

In our hypothetical illustration, the corporate buyer of the FRA receives the settlement sum from the seller as the fixing rate is higher than the dealt rate. This then compensates the corporate for the higher borrowing costs that he would have to pay in the cash market. If the fixing rate had been lower than 5.75%, the buyer would pay the difference to the seller, because cash market rates will mean that he is subject to a lower interest rate in the cash market. What the FRA has done is hedge the interest rate, so that whatever happens in the market, it will pay 5.75% on its borrowing.

A market-maker in FRAs is trading short-term interest rates. The settlement sum is the value of the FRA. The concept is exactly the same as with trading short-term interest rate futures; a trader who buys a FRA is running a long position, so that if $r_{\text{ref}} > r_{\text{FRA}}$ on the fixing date the settlement sum is positive and the trader realizes a profit. What has happened is that the trader, by buying the FRA, 'borrowed' money at an interest rate that subsequently rose. This is a gain, exactly like a *short* position in an interest rate future, where if the price goes down – that is, interest rates go up – the trader realizes a gain. Equally a 'short' position in a FRA, put on by selling a FRA, realizes a gain if $r_{\text{ref}} < r_{\text{FRA}}$ on the fixing date.

FRA pricing

As their name makes clear, FRAs are forward rate instruments and are priced using standard forward rate principles.[4] Consider an investor who has two alternatives: either a 6-month investment at 5% or a 1-year investment at 6%. If the investor wishes to invest for 6 months and then roll over the investment for a further 6 months, what rate is required for the rollover period such that the final return equals the 6% available from the 1-year investment? If we view a FRA rate as the breakeven forward rate between the two periods, we simply solve for this forward rate. The result is our approximate FRA rate.

We can use the standard forward rate breakeven formula to solve for the required FRA rate. The relationship given in equation (4.2) connects simple (bullet) interest rates for periods of time up to 1 year, where no compounding of interest is required. As FRAs are money market instruments we are not required to calculate rates for periods

[4] An introduction to the basics of spot and forward rates can be found in any number of finance textbooks; the author particularly likes Windas (1993) and Fabozzi and Mann (2001), both of which are highly suitable for beginners.

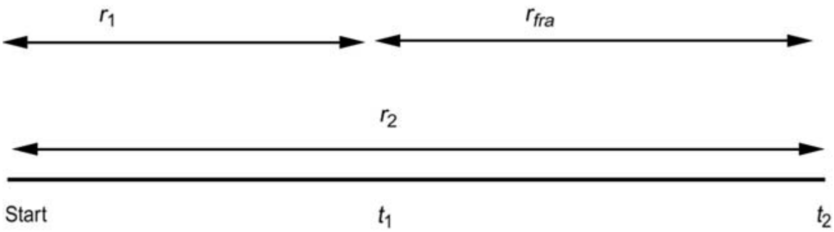


Figure 4.7 Rates used in FRA pricing.

in excess of 1 year,[5] where compounding would need to be built into the equation. The expression is:

$$(1 + r_2 t_2) = (1 + r_1 t_1)(1 + r_f t_f) \tag{4.2}$$

where

r_2 = Cash market interest rate for the long period;
r_1 = Cash market interest rate for the short period;
r_f = Forward rate for the gap period;
t_2 = Time period from today to the end of the long period;
t_1 = Time period from today to the end of the short period;
t_f = Forward gap time period, or the contract period for the FRA.

This is illustrated diagrammatically in Figure 4.7.

The time period t_1 is the time from the dealing date to the FRA settlement date, while t_2 is the time from the dealing date to the FRA maturity date. The time period for the FRA (contract period) is t_2 minus t_1. We can replace the symbol 't' for time period with 'n' for the actual number of days in the time periods themselves. If we do this and then rearrange the equation to solve for r_{FRA} (the FRA rate) we obtain:

$$r_{\text{FRA}} = \frac{r_2 n_2 - r_1 n_1}{n_{\text{FRA}}\left(1 + r_1 \dfrac{n_1}{365}\right)} \tag{4.3}$$

where

n_1 = Number of days from the dealing date or spot date to the settlement date;
n_2 = Number of days from the dealing date or spot date to the maturity date;

[5] Although it is of course possible to trade FRAs with contract periods greater than 1 year, for which a different pricing formula must be used.

$r_1 =$ Spot rate to the settlement date;
$r_2 =$ Spot rate from the spot date to the maturity date;
$n_{\text{FRA}} =$ Number of days in the FRA contract period;
$r_{\text{FRA}} =$ FRA rate.

If the formula is applied to, say, US dollar money markets, the 365 in the equation is replaced by 360, the day-count base for that market.

In practice, FRAs are priced off the exchange-traded short-term interest rate future for that currency, so that sterling FRAs are priced off LIFFE short sterling futures. Traders normally use a spreadsheet pricing model that has futures prices directly fed into it. FRA positions are also usually hedged with other FRAs or short-term interest rate futures.

Interest rate swaps

An interest rate swap is an off-balance-sheet agreement between two parties to make periodic interest payments to each other. Payments are on a predetermined set of dates in the future, based on a notional principal amount; one party is the *fixed rate payer*, the rate agreed at the start of the swap, and the other party is the *floating rate payer*, the floating rate being determined during the life of the swap by reference to a specific market rate or index. There is no exchange of principal, only of the interest payments on this principal amount. Note that our description is for a plain vanilla swap contract; it is common to have variations on this theme – for instance, *floating–floating* swaps where both payments are floating rate, as well as *cross-currency* swaps where there is an exchange of an equal amount of different currencies at the start dates and end dates of the swap.

An interest rate swap can be used to hedge the fixed rate risk arising from originating a loan at a fixed interest rate, such as a fixed rate mortgage. The terms of the swap should match the payment dates and maturity date of the loan. The idea is to match the cashflows from the loan with equal and opposite payments in the swap contract, which will hedge the mortgage position. For example, if the retail bank has advanced a fixed rate mortgage, it will be receiving fixed rate coupon payments on the nominal value of the loan (together with a portion of the capital repayment if it is a repayment mortgage and not an interest-only mortgage). To hedge this position the trader buys a swap contract for the same nominal value in which he will be paying the same fixed rate payment; net cashflow is a receipt of floating interest rate payments.

A borrower, on the other hand, may issue bonds of a particular type because of investor demand for such paper, but prefer to have the interest exposure on the debt in some other form. So, for example, a UK company issues fixed rate bonds denominated in, say, Australian dollars, swaps the proceeds into sterling and pays floating rate interest on the sterling amount. As part of the swap the company will be receiving fixed rate Australian dollars which neutralizes the exposure arising from the bond issue. On termination of the swap (which must coincide with the maturity of the bond) the original currency amounts are exchanged back, enabling the issuer to redeem the holders of the bond in Australian dollars.

For detailed coverage of interest rate swaps and their application see Choudhry (2007).

Description

Swaps are derivative contracts involving combinations of two or more interest rate bases or other building blocks. Most swaps currently traded in the market involve combinations of cash market securities – for example, a fixed interest rate security combined with a floating interest rate security, possibly also combined with a currency transaction. However, the market has also seen swaps that involve a futures or forward component, as well as swaps that involve an option component. The market for swaps is organized by the International Swaps and Derivatives Association (ISDA).

Example 4.5 Comparative advantage and interest rate swap structure

When entering into a swap either for hedging purposes or to alter the basis of an interest rate liability, the opposite of a current cashflow profile is required. Consider a homeowner with a variable rate mortgage. The homeowner is at risk from an upward move in interest rates, which will result in her being charged higher interest payments. She wishes to protect herself against such a move and in theory (Don't try this with your building society!), as she is *paying floating*, she must *receive floating* in a swap. Therefore, she will pay fixed in the swap. The floating interest payments cancel each other out, and the homeowner now has a fixed rate liability. The same applies in a hedging transaction: a bondholder *receiving fixed* coupons from the bond issuer – that is, the bondholder is a *lender* of funds – can hedge against a rise in interest rates that lowers the price of the bond by *paying fixed* in a swap with the same basis point value as the bond position; the bondholder receives floating interest. *Paying fixed* in a swap is conceptually the same as being a *borrower of funds*; this borrowing is the opposite of a loan of funds to the bond issuer and therefore the position is hedged. Consider two companies' borrowing costs for a 5-year loan of £50 million:

- *Company A* can pay fixed at 8.75% or floating at Libor. Its desired basis is floating.
- *Company B* can pay fixed at 10% or floating at Libor + 100 basis points. Its desired basis is fixed.

Without a swap:

Company A borrows fixed and pays 8.75%;
Company B borrows floating and pays Libor + 100 basis points.

Let us say that the two companies decide to enter into a swap, whereby Company A borrows floating rate interest and therefore receives fixed from Company B at the 5-year swap rate of 8.90%. Company B, which has borrowed at Libor + 100 basis points, pays fixed and receives Libor in the swap. Company A ends up paying floating rate interest, and company B ends up paying fixed.

The result after the swap:

$$\text{A pays } 8.75\% + \text{Libor} - 8.90\% = \text{Libor} - 15\text{ bp}$$

$$\text{B pays Libor} + 100\text{ bp} + 8.90\% - \text{Libor} = 9.90\%$$

Company A saves 15 basis points (pays L – 15 bp rather than L flat) and B saves 10 basis points (pays 9.90% rather than 10%).

Both parties benefit from the *comparative advantage* of A in the fixed rate market and B in the floating rate market (spread of B over A is 125 bp in the fixed rate market but 100 bp in the floating rate market). Originally swap banks were simply brokers, and charged a fee to both counterparties for bringing them together. In the example Company A deals direct with Company B, although it is more likely that an intermediary bank would have been involved.

As the market developed, banks became principals and dealt direct with counterparties, eliminating the need to find someone who had requirements that could be met by the other side of an existing requirement.

An interest rate swap is an agreement between two counterparties to make periodic interest payments to one another during the life of the swap, on a predetermined set of dates, based on a *notional* principal amount. One party is the fixed rate payer, and this rate is agreed at the time of trade of the swap; the other party is the floating rate payer, the floating rate being determined during the life of the swap by reference to a specific market index. The principal or notional amount is never physically exchanged, hence the term 'off balance sheet', but is used to calculate interest payments. The fixed rate payer receives floating rate interest and is said to be 'long' or to have 'bought' the swap. The long side has conceptually purchased a floating rate note (because it receives floating rate interest) and issued a fixed coupon bond (because it pays out fixed interest at intervals) – that is, it has in principle borrowed funds. The floating rate payer is said to be 'short' or to have 'sold' the swap. The short side has conceptually purchased a coupon bond (because it receives fixed rate interest) and issued a floating rate note (because it pays floating rate interest).

So, an interest rate swap is

> *an agreement between two parties to exchange a stream of cashflows calculated as a percentage of a* notional *sum and on different interest bases.*

For example, in a trade between Bank A and Bank B, Bank A may agree to pay fixed semi-annual coupons of 10% on a notional principal sum of £1 million, in return for receiving from Bank B the prevailing 6-month sterling Libor rate on the same amount. The known cashflow is the fixed payment of £50,000 every 6 months by Bank A to Bank B.

Like other financial instruments, interest rate swaps trade in a secondary market. The value of a swap moves in line with market interest rates, in exactly the same fashion as bonds. If a 5-year interest rate swap is transacted today at a rate of 5% and 5-year interest rates fall to 4.75% shortly thereafter, the swap will have decreased in value to the fixed rate payer, and correspondingly

Table 4.2 Impact of interest-rate changes

	Fall in rates	**Rise in rates**
Fixed rate payer	Loss	Profit
Floating rate payer	Profit	Loss

increased in value to the floating rate payer, who has now seen the level of interest payments fall. The opposite would be true if 5-year rates moved to 5.25%. Why is this? Consider the fixed rate payer in an IR swap to be a borrower of funds. If she fixes the interest rate payable on a loan for 5 years and then this interest rate decreases shortly afterwards, is she better off? No, because she is now paying above the market rate for the funds borrowed. For this reason a swap contract decreases in value to the fixed rate payer if there is a fall in rates. Equally, a floating rate payer gains if there is a fall in rates, as he can take advantage of the new rates and pay a lower level of interest; hence, the value of a swap increases to the floating rate payer if there is a fall in rates.

The P&L profile of a swap position is shown in Table 4.2.

Example of vanilla interest rate swap

The following swap cashflows are for a 'pay fixed, receive floating' interest rate swap with the following terms:

Trade date	3 December 2010
Effective date	7 December 2010
Maturity date	7 December 2015
Interpolation method	Linear
Day-count (fixed)	Semi-annual, act/365
Day-count (floating)	Semi-annual, act/365
Nominal amount	£10 million
Term	5 years
Fixed rate	4.73%

The interest payment dates of the swap fall on 7 June and 7 December; the coupon dates of benchmark gilts also fall on these dates, so even though the swap has been traded for conventional dates, it is safe to surmise that it was put on as a hedge against a long gilt position. Fixed rate payments are not always the same, because the actual/365 basis will calculate slightly different amounts.

The swap we have described is a plain vanilla swap, which means it has one fixed rate and one floating rate leg. The floating interest rate is set just before the relevant interest period and is paid at the end of the period. Note that both legs have identical interest dates and day-count bases, and the term to maturity of the swap is exactly 5 years. It is of course possible to ask for a swap quote where any of these terms have been set to customer requirements; for example, both legs may be floating rate, or the notional principal may vary during the life of the swap. Non-vanilla interest rate swaps are very common, and banks will readily price swaps where the terms have been set to meet specific requirements. The most common variations are different interest payment dates for the fixed rate leg and floating rate leg, on different day-count bases, as well as terms to maturity that are not whole years.

Swap spreads and the swap yield curve

In the market, banks will quote two-way swap rates – on screens, on the telephone or via a dealing system such as Reuters. Brokers will also be active in relaying prices in the market. The convention in the market is for the swap market-maker to set the floating leg at Libor and then quote the fixed rate that is payable for that maturity. So, for a 5-year swap a bank's swap desk might be willing to quote the following:

Floating rate payer:	pay 6-month Libor receive fixed rate of 5.19%
Fixed rate payer:	pay fixed rate of 5.25% receive 6-month Libor

In this case the bank is quoting an offer rate of 5.25%, which the fixed rate payer will pay in return for receiving Libor flat. The bid price quote is 5.19% which is what a floating rate payer will receive fixed. The bid–offer spread in this case is therefore 6 basis points. Fixed rate quotes are always at a spread above the government bond yield curve. Let us assume that the 5-year gilt yields 4.88%; in this case, then, the 5-year swap bid rate is 31 basis points above this yield. So, the bank's swap trader could quote swap rates as a spread above the benchmark bond yield curve, say 37-31, which is her swap spread quote. This means that the bank is happy to enter into a swap paying fixed 31

Table 4.3 Swap quotes.

1 year	4.50	4.45	+17
2 year	4.69	4.62	+25
3 year	4.88	4.80	+23
4 year	5.15	5.05	+29
5 year	5.25	5.19	+31
10 year	5.50	5.40	+35

basis points above the benchmark yield and receiving Libor, and receiving fixed 37 basis points above the yield curve and paying Libor. The bank's screen on, say, Bloomberg or Reuters might look something like Table 4.3, which quotes swap rates as well as the current spread over the government bond benchmark.

A swap spread is a function of the same factors that influence the spread over government bonds for other instruments. For shorter duration swaps – say, up to 3 years – there are other yield curves that can be used in comparison, such as the cash market curve or a curve derived from futures prices. For longer dated swaps the spread is determined mainly by the credit spreads that prevail in the corporate bond market. Because a swap is viewed as a package of long and short positions in fixed rate and floating rate bonds, it is the credit spreads in these two markets that will determine the swap spread. This is logical; essentially, it is the premium for greater credit risk involved in lending to corporates that dictates that a swap rate will be higher than same maturity government bond yield. Technical factors will be responsible for day-to-day fluctuations in swap rates, such as the supply of corporate bonds and the level of demand for swaps, plus the cost to swap traders of hedging their swap positions.

Overnight interest rate swaps

An interest rate swap contract, which is generally regarded as a capital market instrument, is an agreement between two counterparties to exchange a fixed interest rate payment in return for a floating interest rate payment, calculated on a notional swap amount, at regular intervals during the life of the swap. A swap may be viewed as being equivalent to a series of successive FRA contracts, with each FRA starting as the previous one matures. The basis of the floating interest rate is agreed as part of the contract terms at the inception of the trade. Conventional swaps index the floating interest rate to Libor; however, an exciting recent development in the sterling money market has been the sterling overnight interest rate average or SONIA. In this section we review SONIA swaps, which are extensively used by sterling market banks.

SONIA is the average interest rate of interbank (unsecured) overnight sterling deposit trades undertaken before 15:30 hours each day between members of the London Wholesale Money Brokers' Association. Recorded interest rates are weighted by volume. A SONIA swap is a swap contract that exchanges a fixed interest rate (the swap rate) against the geometric average of overnight interest rates that have been recorded during the life of the contract. Exchange of interest takes place on maturity of the swap. SONIA swaps are used to speculate on or to hedge against interest rates at the very short end of the sterling yield curve; in other words, they can be used to hedge an exposure to overnight interest rates.[6] The swaps themselves are traded in maturities of 1 week to 1 year, although 2-year SONIA swaps have also been traded.

Conventional swap rates are calculated off the government bond yield curve and represent the credit premium over government yields of interbank default risk. In essence, they represent average forward rates derived from the government spot (zero-coupon) yield curve. The fixed rate quoted on a SONIA swap represents the average level of overnight interest rates expected by market participants over the life of the swap. In practice, the rate is calculated as a function of the Bank of England's repo rate. This is the 2-week rate at which the Bank conducts reverse repo trades with banking counterparties as part of its open market operations. In other words, this is the Bank's base rate. In theory, we would expect the SONIA rate to follow the repo rate fairly closely, since the credit risk on an overnight deposit is low. However, in practice, the spread between the SONIA rate and the Bank repo rate is very volatile, and for this reason the swaps are used to hedge overnight exposures.

---

[6] Traditionally, overnight rates fluctuate widely during the day, depending on the day's funds shortage, and although volatility has reduced since the introduction of gilt repo it is still unpredictable on occasion.

Example 4.9 Using an OIS swap to hedge a funding requirement

A structured hedge fund derivatives desk at an investment bank offers a leveraged investment product to a client in the form of a participating interest share in a fund of hedge funds. The client's investment is made up partly of funds lent to it by the investment bank, for which the interest rate charged is overnight Libor (plus a spread).

This investment product has an expected life of at least 2 years. As part of its routine asset–liability management operations, the bank's Treasury desk has been funding this requirement by borrowing overnight each day. It now wishes to match the funding requirement raised by this product by matching the asset term structure to the liability term structure. Let us assume that this product creates a USD1 billion funding requirement for the bank.

Current market depo rates are shown in Figure 4.8. The Treasury desk therefore funds this requirement in the following way:

Assets	\$1 billion, >1-year term Receiving overnight Libor (plus spread)
Liabilities	\$350 million, 6-month loan Pay 1.22% \$350 million, 12-month loan Pay 1.50% \$300 million, 15-month loan Pay 1.70% (not shown in Figure 4.8)

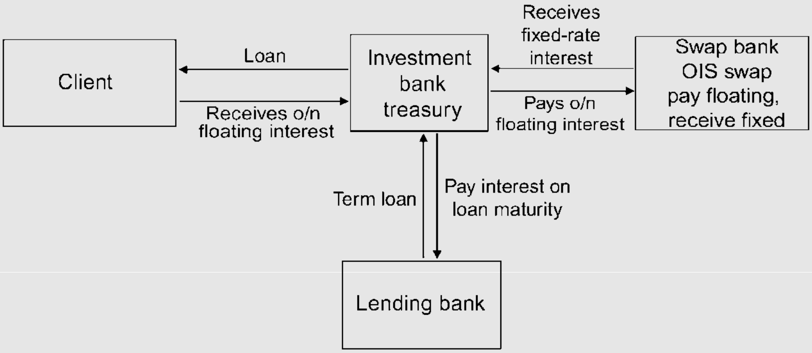


Figure 4.8 Illustration of interest basis mismatch hedging using the OIS instrument.

GRAB M-Mkt TTDE

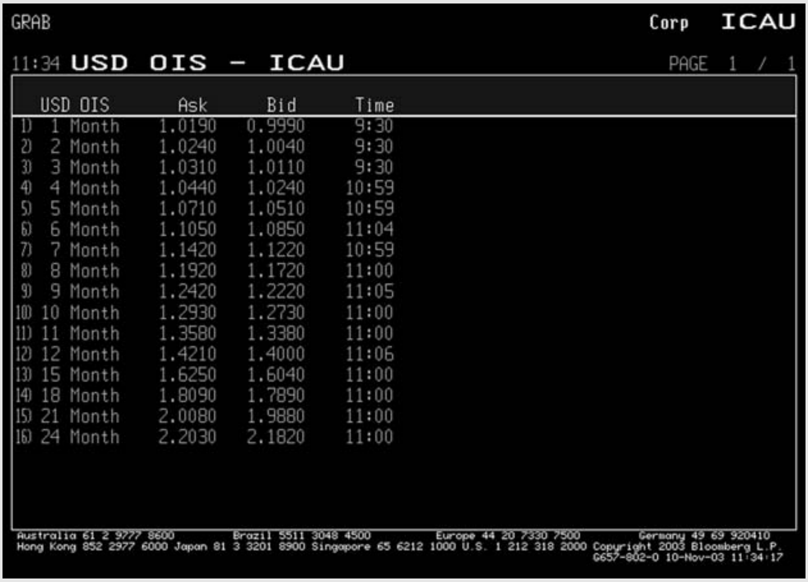
11:37 TULLETT & TOKYO PAGE 1 / 1

USD Cash Deposits	Non-Japanese Bid	Ask	Time	USD Cash Deposits	Japanese Bid	Ask	Time
1) Spot	1.0000	1.0200	9:33	18) T/N	1.0000	1.0300	11/07
2) T/N	1.0100	1.0300	11/07	19) 1 Week	1.0400	1.0600	9:33
3) 1 Week	1.0300	1.0500	9:33	20) 2 Week	1.0500	1.0700	9:33
4) 2 Week	1.0300	1.0500	9:33	21) 3 Week	1.0600	1.0800	9:33
5) 3 Week	1.0300	1.0500	9:33	22) 1 Month	1.0800	1.1000	9:33
6) 1 Month	1.0400	1.0500	9:33	23) 2 Month	1.1800	1.2100	9:33
7) 2 Month	1.1200	1.1400	9:33	24) 3 Month	1.1900	1.2200	9:33
8) 3 Month	1.1300	1.1500	9:33	25) 4 Month	1.2000	1.2300	9:33
9) 4 Month	1.1400	1.1700	9:33	26) 5 Month	1.2100	1.2400	9:33
10) 5 Month	1.1600	1.1900	9:33	27) 6 Month	1.2300	1.2600	9:33
11) 6 Month	1.2000	1.2200	9:33	28) 7 Month	1.2700	1.3000	9:33
12) 7 Month	1.2300	1.2500	9:33	29) 8 Month	1.3100	1.3400	9:33
13) 8 Month	1.2700	1.2900	9:33	30) 9 Month	1.3800	1.4100	9:33
14) 9 Month	1.3300	1.3600	9:33	31) 10 Month	1.4600	1.4900	9:33
15) 10 Month	1.3800	1.4100	9:33	32) 11 Month	1.5300	1.5600	9:33
16) 11 Month	1.4500	1.4800	9:33	33) 12 Month	1.5500	1.5800	9:33
17) 12 Month	1.5000	1.5300	9:33				

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
G657-802-0 10-Nov-03 11:37:50

Figure 4.9 Tullet US dollar depo rates, 10 November 2003.

This matches the asset structure more closely to the term structure of assets; however, it opens up an interest rate basis mismatch in that the bank is now receiving an overnight Libor-based income but paying a term-based liability. To remove this basis mismatch, the Treasury desk transacts an OIS swap to match the amount and term of each of the loan deals, paying overnight floating rate interest and receiving fixed rate interest. The rates for OIS swaps of varying terms are shown in Figure 4.9, which shows two-way prices for OIS swaps up to 2 years in maturity. So, for the 6-month OIS the hedger is receiving fixed interest at a rate of 1.085% and for the 12-month OIS he is receiving 1.40%. The difference between what he is receiving in the swap and what he is paying in term loans is the cost of removing the basis mismatch, but more fundamentally reflects a key feature of OIS swaps versus deposit rates: depo rates are Libor-related, whereas US dollar OIS rates are driven by the Fed Funds rate. On average, the Fed Funds rate lies approximately 8–10 basis points below the dollar deposit rate, and sometimes as much as 15 basis points below cash levels.



GRAB Corp ICAU

11:34 USD OIS – ICAU PAGE 1 / 1

USD OIS	Ask	Bid	Time
1) 1 Month	1.0190	0.9990	9:30
2) 2 Month	1.0240	1.0040	9:30
3) 3 Month	1.0310	1.0110	9:30
4) 4 Month	1.0440	1.0240	10:59
5) 5 Month	1.0710	1.0510	10:59
6) 6 Month	1.1050	1.0850	11:04
7) 7 Month	1.1420	1.1220	10:59
8) 8 Month	1.1920	1.1720	11:00
9) 9 Month	1.2420	1.2220	11:05
10) 10 Month	1.2930	1.2730	11:00
11) 11 Month	1.3580	1.3380	11:00
12) 12 Month	1.4210	1.4000	11:06
13) 15 Month	1.6250	1.6040	11:00
14) 18 Month	1.8090	1.7890	11:00
15) 21 Month	2.0080	1.9880	11:00
16) 24 Month	2.2030	2.1820	11:00

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2003 Bloomberg L.P.
G657-802-0 10-Nov-03 11:34:17

Figure 4.10 Garban ICAP OIS rates for USD, 10 November 2003.

This action hedges out the basis mismatch and also enables the Treasury desk to match its asset profile with its liability profile. The net cost to the Treasury desk represents its hedging costs.

Figure 4.10 illustrates the transaction.

Example 4.9 Cashflows on OIS

Table 4.4 shows daily rate fixes on a 6-month OIS that was traded for an effective date of 17 October 2003, at a fixed rate of 1.03%. The swap notional is USD200 million.

From Table 4.4 we see that the average rate for Fed Funds during this period was 0.99952%. Hence, on settlement the fixed rate payer would have passed over a net settlement amount of USD30,480.

Table 4.4 OIS cash flows

Fix date	Maturity	Rate fix	Fix date	Maturity	Rate fix
17/10/2003	20/10/2003	0.98	19/12/2003	22/12/2003	0.98
20/10/2003	21/10/2003	1.02	22/12/2003	23/12/2003	0.98
21/10/2003	22/10/2003	1.02	23/12/2003	24/12/2003	1.02
22/10/2003	23/10/2003	0.99	24/12/2003	26/12/2003	1
23/10/2003	24/10/2003	0.99	26/12/2003	29/12/2003	0.97
24/10/2003	27/10/2003	1.02	29/12/2003	30/12/2003	0.97
27/10/2003	28/10/2003	1.01	30/12/2003	31/12/2003	0.98
28/10/2003	29/10/2003	0.98	31/12/2003	02/01/2004	0.93
29/10/2003	30/10/2003	0.98	02/01/2004	05/01/2004	0.94
30/10/2003	31/10/2003	0.97	05/01/2004	06/01/2004	1.01
31/10/2003	03/11/2003	1.02	06/01/2004	07/01/2004	0.97
03/11/2003	04/11/2003	1.02	07/01/2004	08/01/2004	0.94
04/11/2003	05/11/2003	1.02	08/01/2004	09/01/2004	0.94
05/11/2003	06/11/2003	0.98	09/01/2004	12/01/2004	0.99
06/11/2003	07/11/2003	0.98	12/01/2004	13/01/2004	0.99
07/11/2003	10/11/2003	0.98	13/01/2004	14/01/2004	1
10/11/2003	12/11/2003	0.98	14/01/2004	15/01/2004	0.99
12/11/2003	13/11/2003	0.99	15/01/2004	16/01/2004	1.04
13/11/2003	14/11/2003	1	16/01/2004	20/01/2004	0.98
14/11/2003	17/11/2003	0.99	20/01/2004	21/01/2004	1.02
17/11/2003	18/11/2003	1.04	21/01/2004	22/01/2004	1
18/11/2003	19/11/2003	1.04	22/01/2004	23/01/2004	1.02
19/11/2003	20/11/2003	0.98	23/01/2004	26/01/2004	1
20/11/2003	21/11/2003	1	26/01/2004	27/01/2004	1
21/11/2003	24/11/2003	1	27/01/2004	28/01/2004	1.08
24/11/2003	25/11/2003	0.98	28/01/2004	29/01/2004	1.02
25/11/2003	26/11/2003	0.98	29/01/2004	30/01/2004	0.99
26/11/2003	28/11/2003	1.02	30/01/2004	02/02/2004	1.03
28/11/2003	01/12/2003	1.01	02/02/2004	03/02/2004	1.01
01/12/2003	02/12/2003	1.03	03/02/2004	04/02/2004	1.01
02/12/2003	03/12/2003	0.97	04/02/2004	05/02/2004	0.97
03/12/2003	04/12/2003	0.97	05/02/2004	06/02/2004	1
04/12/2003	05/12/2003	0.98	06/02/2004	09/02/2004	1.01
05/12/2003	08/12/2003	0.98	09/02/2004	10/02/2004	0.99
08/12/2003	09/12/2003	0.98	10/02/2004	11/02/2004	1
09/12/2003	10/12/2003	0.99	11/02/2004	12/02/2004	1
10/12/2003	11/12/2003	0.97	12/02/2004	13/02/2004	1.02
11/12/2003	12/12/2003	0.99	13/02/2004	17/02/2004	1.02
12/12/2003	15/12/2003	0.99	17/02/2004	18/02/2004	1.02
15/12/2003	16/12/2003	0.99	18/02/2004	19/02/2004	1
16/12/2003	17/12/2003	1.04	19/02/2004	20/02/2004	1
17/12/2003	18/12/2003	0.99	20/02/2004	23/02/2004	0.99
18/12/2003	19/12/2003	0.99	23/02/2004	24/02/2004	0.99

Fix date	Maturity	Rate fix	Fix date	Maturity	Rate fix
24/02/2004	25/02/2004	1	23/03/2004	24/03/2004	1.01
25/02/2004	26/02/2004	0.99	24/03/2004	25/03/2004	0.99
26/02/2004	27/02/2004	1.02	25/03/2004	26/03/2004	0.99
27/02/2004	01/03/2004	1.04	26/03/2004	29/03/2004	1.02
01/03/2004	02/03/2004	1.04	29/03/2004	30/03/2004	1
02/03/2004	03/03/2004	1.04	30/03/2004	31/03/2004	1
03/03/2004	04/03/2004	1	31/03/2004	01/04/2004	0.98
04/03/2004	05/03/2004	0.99	01/04/2004	02/04/2004	1.05
05/03/2004	08/03/2004	0.99	02/04/2004	05/04/2004	1.03
08/03/2004	09/03/2004	1	05/04/2004	06/04/2004	1.01
09/03/2004	10/03/2004	0.99	06/04/2004	07/04/2004	1.01
10/03/2004	11/03/2004	0.99	07/04/2004	08/04/2004	1
11/03/2004	12/03/2004	1	08/04/2004	09/04/2004	1
12/03/2004	15/03/2004	0.99	09/04/2004	12/04/2004	1.02
15/03/2004	16/03/2004	1.05	12/04/2004	13/04/2004	1.01
16/03/2004	17/03/2004	1.05	13/04/2004	14/04/2004	1
17/03/2004	18/03/2004	1	14/04/2004	15/04/2004	1
18/03/2004	19/03/2004	1	15/04/2004	16/04/2004	1.01
19/03/2004	22/03/2004	0.99	16/04/2004	19/04/2004	0.99
22/03/2004	23/03/2004	1.01	**Average rate**		**0.99952**

CREDIT RISK HEDGING

The business of banking – lending money to and trading with counterparties who carry default risk – creates credit risk exposure on the bank's balance sheet. This must be managed actively. In many cases, once a loan is originated, it cannot be removed from the balance sheet, so the act of risk management involves raising the capital base of the bank in anticipation of a deterioration in general economic conditions. Equally, the bank might raise its loan origination standards, and reduce the amount it lends to borrowers of lower credit quality.

The other side of the approach to credit risk management is to sell loans where possible, to remove them from the balance sheet via securitization or to use credit derivatives. This topic is covered in detail in Choudhry (2007).

Understanding credit risk

Credit risk management is a judgement call. The one single factor that most assists effective credit risk management is knowing one's market. Unfamiliarity with a particular market or customer set, or over-reliance on 'black box' models to assess loan origination quality, hampers the application of credit risk, because it renders it susceptible to the business cycle. So, beyond understanding the drivers of credit risk and their dynamics, the over-riding principle remains to understand the market we are operating in. Never originate loans or invest in assets that we do not understand. This principle does not change irrespective of the level of sophistication of the product or customer. In other words, the complexity of a product or transaction does not alter the requirement to understand the borrower and its business risks. That is what credit risk is. Even with sophisticated transactions or complex products, while the evaluation of the risk exposure may be more difficult, the need to understand the nature of the risk does not alter. Ultimately, the question of credit risk management remains the same: What is the chance that the investment will incur losses, and how much will the lender lose if the borrower is unable to repay? The answer to this question, which is dynamic, guides the approach to bank credit risk management.

Definition of credit risk

Credit risk is the risk of loss due to a 'credit event'. This was the case before the advent of the credit derivative market which placed this term into regular usage. A credit event can be a number of things, from outright default due to bankruptcy, liquidation or administration, or it can be something short of full default. It can also mean loss due to credit migration, such as a downgrade in credit rating. In the credit derivatives market, the range of credit events is defined in the legal documentation governing the market. In a full default, the extent of loss can be observed immediately to be the full notional amount of the loan; however, over time, the lender will typically receive an amount of the loan back from the administrators, known as the 'recovery value'. In a credit loss event short of default, the amount of loss is determined by applying mark-to-market (MtM) valuation.

Default itself is defined in more than one way. Generally, it is one or more of the following:

- non-payment of interest 90 days after the interest due date;
- non-payment of a loan 90 days after the loan maturity date;
- restructuring of the borrower's loans;
- filing for bankruptcy, the appointment of administrators, liquidation, and so on.

Late payment is often termed a non-performing loan (NPL) or a delinquent loan rather than a defaulted loan if the borrower is still undertaking business. However, at some point, irrespective of the state of the borrower, an NPL will be written off as a default loss. The write-down, which must be funded out of the bank's capital, is often at 100% of outstanding notional value, even though the bank will probably recover a percentage, however small, at some later date. Another definition of default is that presented by Merton in his 1974 paper. This states that default occurs when the value of a company falls below the value of its debts. The definition of default is relevant because for some models it is a driver of the calculation of default probability; it is also relevant to credit rating agencies when they compile the historical frequency of default. Rating agencies generally apply the delay-in-payment definition.

Asset exposure

The notional, or absolute, level of risk exposure is the first port of call. It is also the easiest to calculate. It is given by the amount of the loan or investment with the customer or 'counterparty'.[7] This amount may be fixed, sometimes called a 'bullet' loan, or it may reduce steadily, which is an amortising loan. If the exposure is a vanilla loan that is recorded in the bank's balance sheet, the amount will not change from the origination date to the maturity date. If it is a loan that is tradeable, such as a bond, or otherwise subject to MtM valuation, then the exposure amount will vary according to its valuation, but should always be 100% of notional by the maturity date. Figure 4.11 is a stylized representation of the behaviour of asset

[7] We have to be careful with the use of the word 'investment'. Here we mean investment from the viewpoint of the bank. In general conversation, investment is often used to mean an equity investment by a shareholder in the business. If a bank advances debt funds to a customer, this is of course also an investment in the future wellbeing of the company.

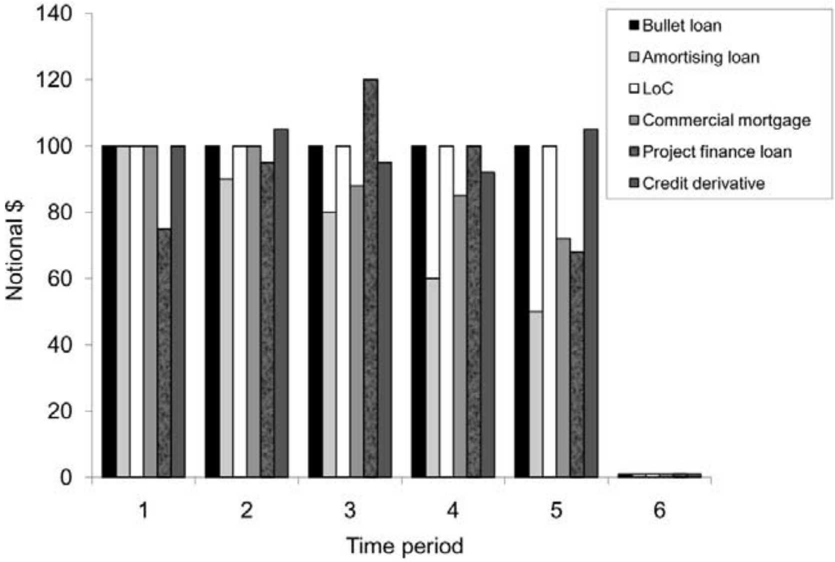


Figure 4.11 Notional value risk exposure profiles of different product types.

risk exposure by type of asset, each of which has the same maturity date.[8]

Trading book assets apply MtM. The value of a loan that is under MtM will change because of changes to the general level of interest rates, and/or changes to the credit standing of the borrower (or the borrower's industrial sector, or to credit conditions generally in the market). As such, trading book assets capture changes in value, at least theoretically, that arise due to, for instance, changes in credit rating. This is known as credit migration risk. The banking book, which does not apply MtM, cannot by definition capture the migration risk of its assets. It only captures the risk of loss due to default. This might be seen to be some sort of disadvantage, because changes in the credit standing of a borrower also change its probability of default. However, use of MtM in a trading book is less of an advantage than we might think, and in stressed market conditions it can be

[8] This is for illustration. It is highly uncommon to observe such a different range of asset types with identical maturity dates. Mortgage and project finance loans have the longest legal final maturity dates.

self-defeating (lower MtM values can generate a vicious circle of falling prices that impacts confidence and can itself lead to default).

Asset exposure on a balance sheet is not comprised solely of live loans. It also includes potential future liabilities, such as letters of credit, third-party liquidity lines and other guarantees. The notional amount of such off-balance-sheet exposures is also part of the bank's credit risk exposure.

The main risk management mechanism for asset exposure risk is by means of credit limits. This is the maximum amount that can be outstanding at any time to the individual customer, the industrial sector, the country, and so on. Limits can also be set by currency.

Credit rating rationale

Lenders and investors use a credit rating, often alphanumeric, to describe the credit risk of an obligor. They represent, either implicitly or explicitly, a default probability of the borrower over a specified time period. The ratings used can be those of an external agency or those internal to the bank. The Basel II regulatory capital methodology makes use of either formal external ratings, in its standardized approach, or of bank internal ratings, in its internal ratings-based approach.

The credit rating process for corporates applies a number of qualitative and quantitative factors, which we describe below. For SPV-type companies a quantitative approach can only be used, and therefore is used. A bank's internal ratings system uses the same sort of approach, making use of default probabilities and recovery rates.

Bank internal credit ratings

All banks employ some form of internal credit rating methodology for their customers. The rating criteria for bank internal systems are similar in concept to those of external agencies; that is, they include qualitative and quantitative factors. Criteria are tweaked in accordance with the type of borrower being assessed. For example, financial institutions will be assessed by bank-specific metrics such as the loan-to-deposit ratio or the level of loan loss reserves.

In recent years there has been a tendency for banks to adopt a 'black box' approach, in which loan agents input the required parameters into their system and model output either approved or disapproved the loan. A reduced level of human judgement in the loan origination process has limitations that are exposed during a recession or economic crash, mainly because black box models are not immune to being sucked into a bull market. For this reason, it is important that the loan approval process includes an element of operator judgement, which is of value when the operator is familiar with the market.

Internal ratings are similar to external ones in assigning an alphanumeric grade to borrowers that ranks their credit standing. For many banks, the customers in question will be small-and-medium-sized enterprises (SMEs) and so will not possess an external agency credit rating. For SMEs it is mainly the internal bank rating that will drive the loan approval process. A bank's credit analysis department will consider the obligor's risk of default, the credit quality of any parent or supporting company, the risk of the loan product itself and the backing of any other banking institution when calculating its internal rating. Assessment of the borrower's risk of default is similar to the qualitative and financial review used by external agencies.

A bank operating across more than one legal jurisdiction will also want to have an internal rating for each country. This is important because, depending on the country concerned, it may be difficult or impossible to recover cash or assets in the event of default or to enforce a legal ruling. Therefore, a foreign country rating is required as well. This remains important even if the obligor is rated higher than its domicile country, because of the potential legal problems just noted.

The Basel II rules crystallized the use of credit ratings by making explicit reference to them in its standardized approach (see Chapter 10). However, for many banks the standardized approach is no less risk insensitive than Basel I, because their customers are not externally rated. Such banks can map external ratings to their internal system and assign risk weights accordingly, providing they have obtained regulator approval for their internal model. Generally, this mapping process involves applying external ratings and their implied default probabilities to the internal rating and obtaining an external rating equivalent to the internal grade. This can be undertaken using an off-the-shelf credit model. Although this process is in common use, it is inherently flawed because of its reliance on the two usual parameters: default probability and recovery rate (RR).

Table 4.5 Moody's rating statistics 2007

Rating	Yearly average default rate (%)	Yearly volatility of default rate (1970–2007) (%)
Aaa	0.00	0.00
Aa	0.05	0.12
A	0.08	0.05
Baa	0.20	0.29
Ba	1.80	1.40
B	8.30	5.03

Source: Moody's Inc., reproduced with permission.

The rating criteria reflect the 'expected loss' (EL) of an asset, given by

$$\text{EL} = \text{DefaultProb} \times (1 - \text{RR}).$$

We see then that EL can alter significantly by changing RR, even if default probability stays unchanged. This in turn can change the external rating. Table 4.5 shows Moody's statistics for ratings and default, and the equivalent for each rating grade. It is possible to alter a ratings-equivalent default rate by changing the recovery rate, and thereby obtain a different rating. Business best practice and prudent risk management dictate, therefore, that banks assume a 0% recovery rate in their internal ratings systems.

Credit limit setting and rationale

For many commercial banks, and certainly all smaller banks, credit limits and credit exposure on a day-to-day basis are perhaps the most important aspects of the risk management process, given that such institutions should not be running much market risk. The latter is more of an issue for larger banks, multinational banks and market-making banks. While liquidity risk management is universal to all banks, maintaining effective credit risk origination standards and a limit-setting policy is essential for the vast majority of banks that do not carry material market risk. Smaller banks are less likely to be rescued by the central bank or the government if they fail, because they would not be deemed 'systemically important', so a prudent credit risk management culture and through-the-cycle macroprudential procedures are of primary importance for such firms.[9]

We now discuss the business best practice principles of credit limit setting and the loan origination process.

Credit process

Banks generally operate one of two types of approval process: (i) via a credit committee or (ii) via delegated authority from the credit committee to a business line head. The committee process is designed to ensure that there is proper scrutiny of any transaction that commits the bank's capital. The sponsor bringing the transaction to the committee is the front office business line; the committee will approve or decline based on the risk–reward profile of the transaction.

Procedure (ii) is common for high-volume business, for which the committee process as a consequence of it being time consuming would not be practical. As we note above, there is uncertainty that the 'know your risk' principle can be diluted, particularly in a competitive environment where a bank is trying to build volume. Given this uncertainty, 'market share' should not be a performance indicator, or target, for a bank's business line. Rather, performance should be measured only via the amount of genuine shareholder value added that the business generates.

Credit limit principles

The point of credit risk limits is to set an upper bound to the loss that can be suffered by a bank at any one time.

The basic principles of credit limit setting are universal for every bank and follow the essential requirements of prudence and concentration. In other words, an element of diversification in the

---

[9] In the US alone, according to the FDIC website, there were 25 bank failures in 2008, 140 in 2009 and 157 in 2010. This compares with just 11 bank failures during the period 2003–2007. With the exception of Washington Mutual Bank, these failing banks did not make the media headlines, due to their small size and domestic business base; nevertheless, a failed bank in any jurisdiction and of any size is a gross failure of management and corporate governance. Regulatory authorities should have the objective of treating all banks as systemically important.

loan portfolio is necessary, although at all times the bank should practice the basic principle of 'know your risk'. In other words, diversity as an end in itself is not recommended good practice; a bank should diversify only into sectors that it thoroughly understands and in which it has some competitive advantage or valuable skill base.

In standard textbooks on finance and banking, we read that it is the capital base that drives the limit-setting process. Essentially, what this is saying in practice is that we take the amount of capital available and allocate it as per credit limit buckets for each of the businesses. Actually, the proper and intellectually robust way to do this is the other way around: the bank should determine its strategy and business model, as well as preparing budgets based on the risk exposure that it considers it has the expertise to manage. This process then drives the level of capital and regulatory capital that the bank should then set up. Once this amount is known and achieved, it can then be allocated to specific business lines as lower level credit limits by geography, industry, product and so on.

The essential principles governing limit setting include the following:

- All single exposures should be sufficiently contained such that a complete default, running the risk of 0% recovery, can be contained within the existing capital base and does not endanger the bank as a going concern. In other words, after the loss the bank should still be within its regulatory capital limits.
- The loan portfolio should be diversified by industrial sector, geography and product line, within the knowledge base and expertise of the bank.
- Set minimum internal (and, if desired, external) rating criteria below which the bank will not lend. For example, this may be 'investment grade rated only' or 'no lending to entities with an internal rating equivalent to BB/Ba2'.
- Do not lend to obligors any amount that as a result overextends them and creates a situation in which repayment is put at risk. This requires that the 'know your risk' dictum be applied equally to understanding the customer's risks. This should be assessed via an analysis of the borrower's financial indicators, including leverage ratio, debt service coverage ratio, and so on.

- Set limit categories to avoid concentration, and also by borrower rating.

As part of a transaction origination process, reviewers must consider what 'ancillary business' can be generated from the same borrower. The bank must set a policy that dictates how much this ancillary business drives the origination process, whether the lending business can be a 'loss leader' to an extent or can create sufficient shareholder value added in its own right.

Credit limit setting

The process of setting credit limits is very important to all banks – vanilla commercial banks, in particular – in so far as credit risk exposure generates the highest losses for such institutions. The process should follow prudent and robust policy and be run according to cycle-proof principles to avoid getting overextended during a bull market, when loan origination standards are relaxed. Credit limits are set for a range of criteria, which are deliberately set as overlapping so as to ensure that all the various different categories of risk exposure are captured.

Macro-level credit limits are set per individual obligor, originated within the business lines but approved by the Executive Credit Committee and secondarily approved by ALCO. When necessary, if the size of a transaction dictates it, further approval may be needed by the Executive Management Committee (ExCo) and the board itself. The level of capital allocation required for a particular limit application determines how far up the governance structure it needs to go. Formal limits on capital allocation are therefore set at ExCo approval level.

The limit-setting process is designed to produce overlapping limits. Limits will be set in the following categories:

- *Individual obligor*. This is further split into limit by product class, limit globally and limit locally. Sub-limits do not necessarily aggregate to the overall obligor limit: this is to prevent excess exposure in one product class or geographical region. Sub-limits are also set per currency. At all times, the obligor's exposure cannot exceed its overall limit.
- *Geographical region*. This is further split into country limits and individual regions within a country.
- *Industrial sector*.

As no individual limit can be breached, any new capital-using transaction must fit into the capacity allowed by all three limit categories.

Limit excess is a serious breach of management governance and must be reported to ALCO (and, if necessary, ExCo) for corrective action. This can be one or more of the following: (i) cease further business with the specific obligor; (ii) transfer some of the exposure, either by secondary market sale, securitization, or hedging with credit derivatives; (iii) increase the limit; (iv) transfer some capacity from another part of the business and/or another obligor.

Loan origination process standards

The loan origination process differs across banks. The detail of an individual specific process is not of major interest to us. What is important is that this origination process adheres to basic principles of prudence, and that these are controlled and managed to ensure they are 'through the cycle'; that is, a reduction in standards, or a relaxation of them during a period of economic growth, is something that should require board approval. Enlarging the balance sheet during a bull market is a risky strategy, because it is during this time that standards are lowered and low-quality and/or underpriced assets are put on the book.

An example of this occurred at the failed UK banks Northern Rock and Bradford & Bingley, which originated large numbers of 100LTV and 125LTV mortgages, as well as more risky buy-to-let mortgages. The failed bank HBOS (in common with many banks at the time) operated a loan origination process for retail and corporate loans that delegated the approval decision to a black box computer model, which rated all applications in a tick box process that assigned a credit score and then approved on that basis. This is understandable for high-volume business models, but sacrifices a large element of 'know your customer' in the approval process.

The essential guidelines for a through-the-cycle asset origination standards process include:

- *Know your customer*. For one-off and/or big-ticket transactions this principle is straightforward to apply. It is more difficult for large-volume business, particularly when the bank has adopted a black box system in which approval is granted by a model (the applicant's details are input to the system and the system generates the approval without any loan officer or credit expert

reviewing the application). This is common practice for retail business such as credit card and mortgage applications, especially for business conducted over the telephone or internet. The danger is that, in a commoditized and competitive market, origination standards are lowered and the bank creates a pool of lower quality assets, the obligors for which it is not familiar with and whose financial strength it cannot be certain of. This was an acute problem for retail mortgage banks in the US, UK, Ireland and Spain (amongst others) during 2002–2007, all of whom experienced a housing boom and bust in this period. Business best practice dictates that for all origination business, banks must know their customer base at all times (see below on mortgages). This means that the black box application process must be supplemented with a review by an experienced loan analyst.
- *Loan security*. The collateral acceptable for a loan should at all times be of sufficient liquidity and value. The bank must be able to realize the collateral if the obligor defaults. Genuine liquidity through all market conditions is restricted to sovereign liabilities only, so to cover for the loss of liquidity in other types of collateral, the bank must ensure sufficient margin over and above the loan value.
- *Subprime-lending restrictions*. Assets against which no collateral or insufficient collateral is taken should at all times be subject to restrictions and severe limits because these types of assets are the first to experience default when the economy experiences a downturn. Mortgages that are not covered by sufficient collateral, such as 100LTV or 125LTV loans where the advance is greater than the value of the security, and other subprime mortgages or higher risk mortgages such as 'self-certified' loans should similarly be subject to restriction.

Excluding the peak of an overheating economy just about to enter a recession, loan defaults typically do not occur at the start or end of a loan's term. Another exception is right at the end of a bull market, when bank loan origination standards have been lowered and asset prices (credit spreads) are at their most undervalued, when banks write much low-quality business. Leaving that aside, the most common time of default is generally between 45 and 55 months after the loan start date. This means that default statistics considerably lag the actual state of the economy. Given historical default rates, which banks use to assist them in setting their credit limits, there is a danger that business continues to be written at lower credit standards at the time when the bank should be reigning in risky business. This is why the basic principles we summarize above should be observed at all times; they should act as a guiding light for a bank's Executive Credit Committee.

BIBLIOGRAPHY

Choudhry, M. (2007) *Bank Asset and Liability Management*, John Wiley Asia.

Cox, J., Ingersoll, J., and Ross, S. (1981) 'The relationship between forward prices and futures prices,' *Journal of Financial Economics*, **9**, December, 321–346.

Fabozzi, F. and Mann, S. (2001) *Introduction to Fixed Income Analytics*, FJF Associates, Chapter 2.

French, K. (1983) 'A comparison of futures and forwards prices,' *Journal of Financial Economics*, **12**, November, 311–342.

Hull, J. (1999) *Options, Futures and Other Derivatives*, Fourth Edition, Prentice-Hall.

Jarrow, R. and Oldfield, G. (1981) 'Forward contracts and futures contracts,' *Journal of Financial Economics*, **9**, December, 373–382.

Kimber, A. (2004) *Credit Risk*, Oxford: Elsevier.

Merton, R.C. (1974) 'On the pricing of corporate debt: The risk structure of interest rates,' *Journal of Finance*, **29**(2), May, 449–470.

Rubinstein, M. (1999) *Rubinstein on Derivatives*, RISK Publishing, Chapter 2.

Windas, T. (1993) *An Introduction to Option-Adjusted Spread Analysis*, Bloomberg Publishing, Chapter 3

This page intentionally left blank

Chapter

5

ASSET AND LIABILITY MANAGEMENT I

Asset–liability management (ALM) is a generic term that is used to refer to a number of things by different market participants. For bankers, the term is used to denote high-level management of a bank's assets and liabilities; as such it is a strategy level discipline but at the business line level it is also a tactical one. ALM policy may be set within a bank's Treasury division or more usually by its asset–liability committee (ALCO). The principle function of the ALM desk is to manage interest rate risk and liquidity risk. It will also set overall policy for credit risk and credit risk management, although tactical level credit policy is set at a lower level within credit committees. Although the basic tenets of ALM would seem to apply more to commercial banking than investment banking, in reality it is important that it is applied to both functions. A trading desk still deals in assets and liabilities, and these must be managed for interest rate risk and liquidity risk. In a properly integrated banking function the ALM desk will have a remit covering all aspects of a bank's operations.

We describe the ALM function in this chapter and Chapters 6 and 7. In this chapter we introduce the key ALM concepts of liquidity and ALM policy.

Basic concepts

In financial markets the two main strands of risk management are interest rate risk and liquidity risk. ALM practice is concerned with managing this risk. Interest rate risk exists in two strands. The first strand is the more obvious one: the risk of changes in asset–liability value due to changes in interest rates. Such a change impacts the cashflows of assets and liabilities as well as their present value, because financial instruments are valued with reference to market interest rates. The second strand is that associated with optionality, which arises with products such as early-redeemable loans. The other main type of risk that ALM seeks to manage is liquidity risk, which refers to both the liquidity of markets and the ease with which assets can be translated to cash.

ALM is conducted primarily at an overview, balance sheet level. The risk that is managed is an aggregate, group level risk. This makes sense because one could not manage a viable banking business by leaving interest rate and liquidity risk management at individual operating levels. We illustrate this at Figure 5.1, which illustrates the cornerstones of ALM. Essentially, interest rate risk exposure is

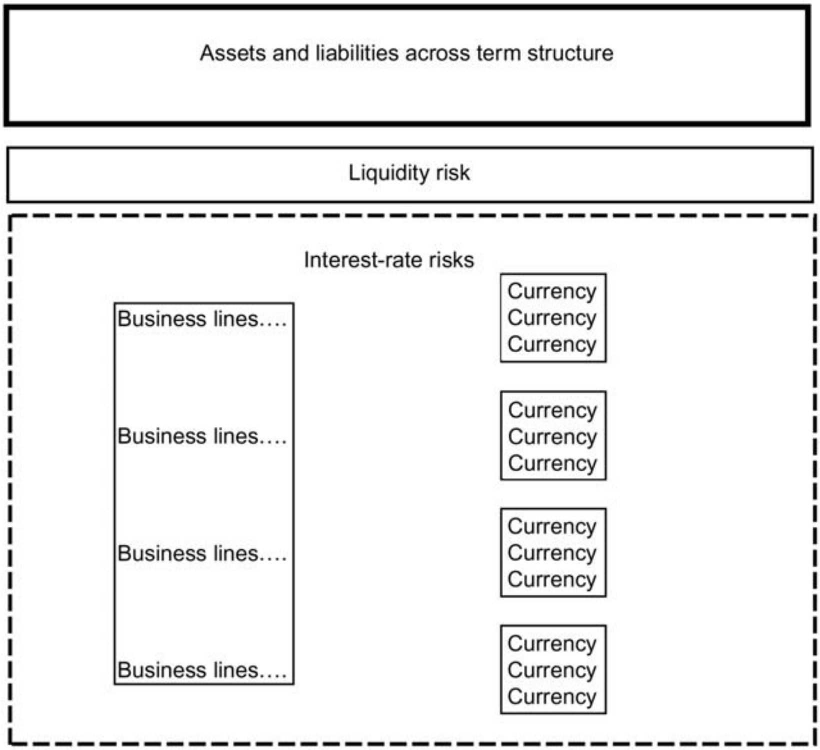


Figure 5.1 Cornerstone of ALM philosophy.

managed at the group level by the Treasury desk. The drivers are the different currency interest rates, with each exposure being made up of the net present value (NPV) of cashflow as it changes with changes in interest rates. The discount rate used to calculate NPV is the prevailing market rate for each time bucket in the term structure.

Interest rate exposure arises because rates fluctuate from day to day, and continuously over time. The primary risk is that of interest rate reset for floating rate assets and liabilities. The secondary risk is liquidity risk: unless assets and liabilities are matched by amount and term, assets must be funded on a continuous rolling basis. Equally, the receipt of funds must be placed on a continuous basis. Whether an asset carries a fixed or floating rate reset will determine its exposure to interest rate fluctuations. Where an asset is marked at a fixed rate, a rise in rates will reduce its NPV and so reduce its value to the bank. This is intuitively easy to grasp, even without recourse to financial arithmetic, because we can see that the asset is now paying a below-market rate of interest. Or we can think of it as a loss due to opportunity cost foregone, since the assets are earning below what they could earn if they were employed elsewhere in the market. The opposite applies if there is a fall in rates: this causes the NPV of the asset to rise. For assets marked at a floating rate of interest, the exposure to fluctuating rates is much less, because the rate receivable on the asset will reset at periodic intervals, which will allow for changes in market rates.

We speak of risk exposure as being for the group as a whole. This exposure must therefore aggregate the net risk of all the bank's operating business. Even for the simplest banking operation, we can see that this will produce a net mismatch between assets and liabilities, because different business lines will have differing objectives for their individual books. This mismatch will manifest itself in two ways:

- the mismatch between the different terms of assets and liabilities across the term structure;
- the mismatch between the different interest rates that each asset or liability contract has been struck at.

This mismatch is known as the ALM *gap*. The first type is referred to as the *liquidity gap*, while the second is known as the *interest rate gap*. We value assets and liabilities at their NPV; hence, we can measure the overall sensitivity of balance sheet NPV to changes in interest rates. As such, then, ALM is an art that encompasses aggregate balance sheet risk management at the group level.

Figure 5.2 shows the aggregate group level ALM profile for a derivatives trading house based in London. There is a slight term mismatch as no assets are deemed to have 'overnight' maturity whereas a significant portion of funding (liabilities) is in the overnight term. One thing we do not know from looking at Figure 5.2 is how this particular institution defines the maturity of its assets. To place them in the relevant maturity buckets, one can adopt one of two approaches, namely:

- actual duration of the assets;
- 'liquidity duration', which is the estimated time it would take the firm to dispose of its assets in an enforced or 'firesale' situation, such as a withdrawal from business.

Each approach has its adherents; there is no single 'right' way. It is up to the individual institution to adopt one method and then consistently adhere to it. The second approach has the disadvantage,

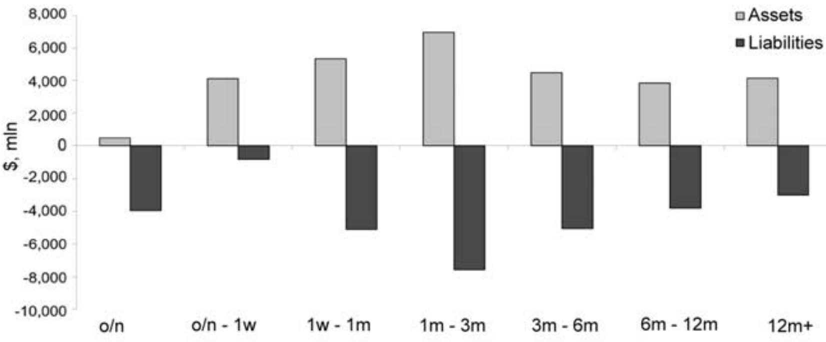


Figure 5.2 A derivatives trading house's ALM profile.

however, of being inherently subjective – estimating the time taken to dispose of an asset book is not an exact science and is little more than educated guesswork. Nevertheless, for long-dated and/or illiquid assets, it is at least a workable method that enables practitioners to work around a specified ALM framework with regard to structuring the liability profile.

Liquidity gap

There is clearly risk exposure as a result of liquidity mismatches between assets and liabilities. Maturity terms will not match, thereby creating a liquidity gap. The amount of assets and liabilities maturing at any one time will also not match (although overall, by definition, assets must equal liabilities). Liquidity risk is the risk that a bank will not be able to refinance assets as liabilities become due, for any reason.[1] To manage this, the bank will hold a large portion of assets in very liquid form.[2] A surplus of assets over

---

[1] The reasons could be macro-level ones, affecting most or all market participants, or more firm specific or sector specific. The former might be a general market correction that causes the supply of funds to dry up, and would be a near-catastrophic situation. The latter is best illustrated with the example of Barings plc in 1995: when it went bust overnight due to large, hitherto concealed losses on the Simex exchange, the supply of credit to similar institutions was reduced or charged at much higher rates – albeit only temporarily – as a result.
[3] Such assets would be very short-term, risk-free assets such as Treasury bills.

liabilities creates a funding requirement. If there is a surplus of liabilities, the bank will need to find efficient uses for these funds. In either case, the bank has a liquidity gap. This liquidity can be projected over time, so that one knows what the situation is each morning, based on net expiring assets and liabilities. The projection will change daily, of course, due to the new business undertaken each day.

We could eliminate liquidity gap risk by matching assets and liabilities across each time bucket. Actually, at the individual loan level this is a popular strategy: if we can invest in an asset paying 5.50% for 3 months and fund this with a 3-month loan costing 5.00%, we have locked in a 50 bp gain that is interest rate risk free. However, while such an approach can be undertaken at the individual asset level, it would not be possible at the aggregate level, or at least not possible without imposing severe restrictions on the business. Hence, liquidity risk is a key consideration in ALM. A bank with a surplus of long-term assets over short-term liabilities will have an ongoing requirement to fund the assets continuously, and there is the ever-present risk that funds may not be available as and when they are required. The concept of a future funding requirement is itself a driver of interest rate risk, because the bank will not know the future interest rates at which it will deal.[3] So a key part of ALM involves managing and hedging this forward liquidity risk.

Definition and illustration

To reiterate then, the liquidity gap is the difference in maturity between assets and liabilities at each point along the term structure. Because ALM in many banks concerns itself with medium-term management of risk, this will not be beyond a 5-year horizon – in many cases considerably less than this. Note from Figure 5.2 how the longest dated time bucket in the ALM profile extended out to only '12 months+', hence all liabilities longer than 1 year were grouped in one time bucket. This recognizes the fact that most liabilities are shorter than 1 year, although a proportion of funding will be longer term – an average of 5 years or so.

For each point along the term structure at which a gap exists, there is (liquidity) gap risk exposure. This is the risk that funds cannot

[3] It can of course lock in future funding rates with forward-starting loans, which is one way to manage liquidity risk.

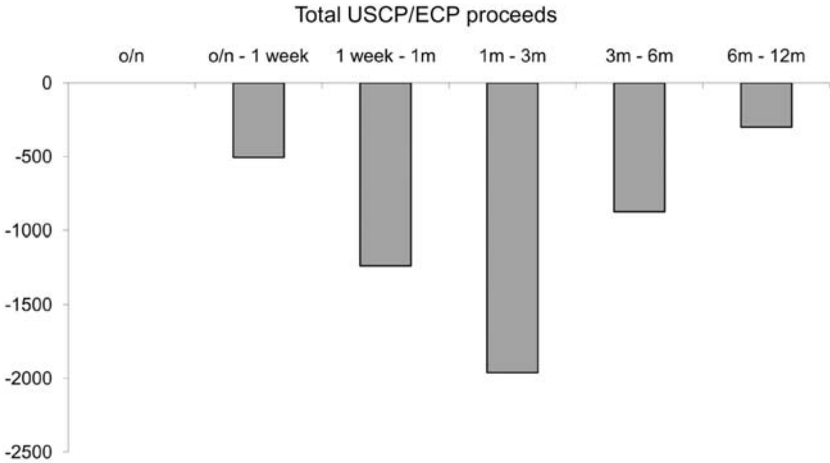


Figure 5.3 Commercial paper programme liability profile.

be raised as required, or that the rate payable on these funds is prohibitive.[4] To manage this risk, a bank must

- disperse the funding profile (the liability profile) over more than just a short period of time. For example, it would be excessively risky to concentrate funding in just the overnight to 1-week time bucket, so a bank will spread the profile across a number of time buckets. Figure 5.3 shows the liability profile for a European multi-currency asset-backed commercial paper programme, with liabilities extending from 1 month to 1 year;
- manage expectations such that large-size funding requirements are diarized well in advance – not planned for times of low liquidity such as the Christmas and New Year period;
- hold a significant proportion of assets in the form of very liquid instruments such as very-short-term cash loans, Treasury bills and high-quality short-term bank certificates of deposit (CDs).

Following these guidelines leads to a reserve of liquidity that can be turned into cash at very short notice in the event of a funding crisis.

The size of the liquidity gap at any one instant is never more than a snapshot in time, because it is constantly changing as new commit-

[4] Of course, the opposite applies when the gap risk refers to an excess of liabilities over assets.

Table 5.1 Simplified ALM profile for regional European bank

	1 week	1 month	3 month	6 month	9–12 month	>12 months	Total
Assets	10	90	460	710	520	100	1,890
Liabilities	100	380	690	410	220	90	1,890
Gap	−90	−290	−230	300	300	10	
Marginal gap		200	−60	−530	0	290	

ments are entered into on both the asset and liability size. For this reason some writers speak of a 'static' gap and a 'dynamic' gap, but in practice one recognizes that there is only ever a dynamic gap, because the position changes daily. Hence, we will refer only to a liquidity gap.

A further definition is the 'marginal' gap, which is the difference between the change in assets and liabilities during a specified time period. This is also known as the 'incremental' gap. If the change in assets is greater than the change in liabilities, this is a positive marginal gap, while if the opposite applies it is a negative marginal gap.[5]

We illustrate these values in Table 5.1. This is a simplified asset–liability profile from a regional European bank, showing gap and marginal gap at each time period. Note that liabilities have been structured to produce an 'ALM smile', which is recognized as following prudent business practice. Generally, no more than 20% of total funding should be in the overnight to 1-week time bucket – similarly for the 9-to-12-month bucket. The marginal gap is measured as the difference between the change in assets and liabilities from one period to the next.

Figure 5.4 shows the graphical profile of the numbers in Table 5.1.

[5] Note that this terminology is not universally held.

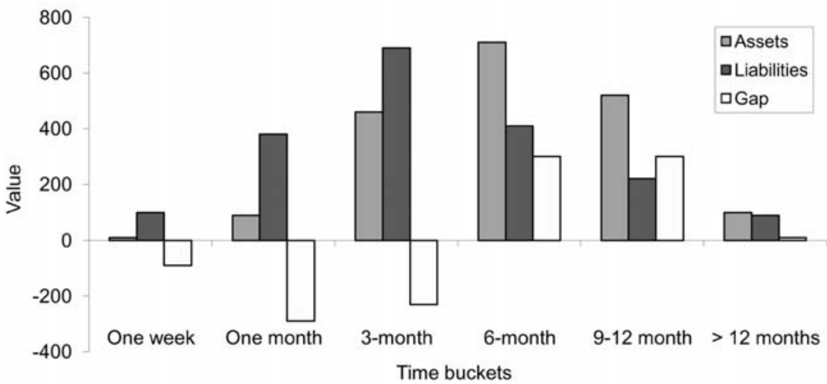


Figure 5.4 ALM time profile.

Liquidity risk

Liquidity risk exposure arises from normal banking operations. That is, it exists irrespective of the type of funding gap, be it excess assets over liabilities for any particular time bucket or an excess of liabilities over assets. In other words, there is a funding risk in any case: either funds must be obtained or surplus assets laid off. The liquidity risk in itself generates interest rate risk as a result of uncertainty about future interest rates. This can be managed through interest rate hedging, which was discussed in Chapter 4.

If assets are floating rate, there is less concern over interest rate risk because of the nature of interest rate reset. This also applies to floating rate liabilities, but only in so far as they match floating rate assets. Floating rate liabilities issued to fund fixed rate assets create forward risk exposure to rising interest rates. Note that even if both assets and liabilities are floating rate, they can still generate interest rate risk. For example, if assets pay 6-month Libor and liabilities pay 3-month Libor, there is an interest rate spread risk between the two terms. Such an arrangement has eliminated liquidity risk, but not interest rate spread risk.

Liquidity risk can be managed by matching assets and liabilities, or by setting a series of rolling term loans to fund a long-dated asset. Generally, however, banks have a particular view of future market conditions and manage the ALM book in line with this view. This would leave in place a certain level of liquidity risk.

Matched book

The simplest way to manage liquidity and interest rate risk is the matched book approach, also known as *cashflow matching*. This is actually very rare to observe in practice, even among conservative institutions such as the smaller UK building societies. In the matched book approach, assets and liabilities as well as their time profiles are matched as closely as possible. This includes allowing for amortization of assets.[6] As well as matching maturities and time profiles, the interest rate basis for both assets and liabilities will be matched. That is, fixed loans to fund fixed rate assets and the same for floating rate assets and liabilities. Floating rate instruments will further need to match the period of each interest rate reset to eliminate spread risk.

Under a matched book, there is theoretically no liquidity gap. Locking in terms and interest rate bases will also lock in profit. For instance, a 6-month fixed rate loan is funded by a 6-month fixed rate deposit. This would eliminate both liquidity and interest rate risk. In a customer-focused business it will not be possible to precisely match assets and liabilities, but from a macro-level it should be possible to match the profiles fairly closely, by netting total exposure on both sides and matching this. Of course, it may not be desirable to run a matched book, as this would mean the ALM book was not taking any view at all on the path of future interest rates. Hence, a part of the book is usually left unmatched, and this is the part that will benefit (or lose out) if rates go the way they are expected (or not!).

Managing the gap with undated assets and liabilities

We have described a scenario of liquidity management where the maturity date of both assets and liabilities is known with certainty. However, a large part of retail and commercial banking operations revolves around assets that do not have an explicit maturity date. These include current account overdrafts and credit card balances. They also include drawn and undrawn lines of credit. The volume of these is a function of general economic conditions, and can be difficult to predict. Banks will need to be familiar with their

---

[6] Many bank assets, such as residential mortgages and credit card loans, are repaid before their legal maturity date. Thus, the size of the asset book is constantly amortizing.

clients' behaviour and their requirements over time to be able to assess when and for how long these assets will be utilized.

Undated assets are balanced on the other side by undated liabilities, such as non-interest-bearing liabilities (NIBLs) which include cheque accounts and instant access deposit accounts. The latter frequently attract very low rates of interest – hence, they can be included in the NIBL total. Undated liabilities are treated in different ways by banks; the most common treatment places these funds in the shortest time bucket, the overnight to 1-week bucket. However, this means a bank's gap and liquidity profile can be highly volatile and unpredictable, which places greater strain on ALM management. For this reason some banks take the opposite approach and place these funds in the longest dated bucket, the >12-month bucket. A third approach is to split total undated liabilities into a 'core' balance and an 'unstable' balance, and place the first in the long-date bucket and the second in the shortest dated bucket. The amount recognized as the core balance will need to be analysed over time to make sure it is accurate.

Managing liquidity

Managing liquidity gaps and the liquidity process is both continuous and dynamic because the ALM profile of a bank changes on a daily basis. Liquidity management is the term used to describe this continuous process of raising and laying off funds, depending on whether one is long or short cash that day.

The basis premise is a simple one: the bank must be 'squared off' by the end of each day, which means ensuring the net cash position is zero. Thus, liquidity management is both very short term as well as projected over the long term, because every position put on today creates a funding requirement in the future on its maturity date. The ALM desk must be aware of its future funding or excess cash positions and act accordingly, whether this means raising funds now or hedging forward interest rate risk.

The basic case: the funding gap

A funding requirement is dealt with on the day it occurs. The decision on how it will be treated will factor the term that is put on – it has also to allow for any new assets put on that day. As funding is arranged, the gap on that day will be zero. The next day there will

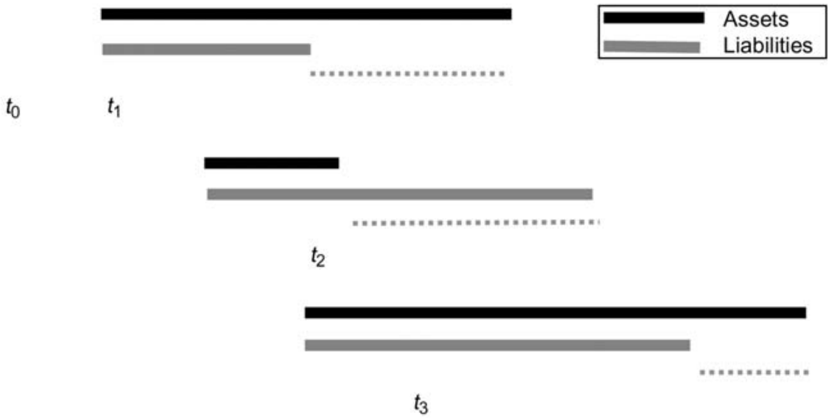


Figure 5.5 Funding position on a daily basis.

be a new funding requirement or a surplus depending on the net position of the book.

This is illustrated in Figure 5.5. Starting from a flat position on the first day (t_0) we observe a gap (the dotted line) on t_1 which is closed by putting on funding to match the asset maturity. The amount of funding to raise and the term for it to run will take into account the future gap as well as that day's banking activities. So, at t_2 we observe a funding excess, which is then laid off. We see at t_3 that invested assets run beyond the maturity of the liabilities at t_2, so we have a funding requirement again at t_3. The decision on the term and amount will be based on the market view of the ALM desk. A matched book approach may well be taken where the desk does not have a strong view or if its view is at odds with market consensus.

There are also external factors to take into account. For instance, the availability of funds in the market may be limited, due to both macro-level issues and to the bank's own ability to raise funds. The former might be during times of market correction or recession (a 'credit crunch'), while the latter might include the bank's credit lines with market counterparties. Moreover, some funds will have been raised in the capital markets and this cash will cover part of the funding requirement. In addition, the ALM desk must consider the cost of the funds it is borrowing – for example, if it thought that interest rates in the short term, or for short-term periods, was going to fall, it might cover the gap with only short-term funds so that it can then refinance at expected lower rates. The opposite might be done if the desk thought rates would rise in the near future.

Running a liquidity gap over time, beyond customer requirements, would reflect a particular view of the ALM desk. So, maintaining a consistently underfunded position suggests that interest rates are expected to decline, and so longer term funds can be taken at cost. Maintaining an overfunded gap would imply that the bank thinks rates will be rising, and so longer term funds are locked in now at lower interest rates. Even if the net position is dictated by customer requirements – for example, customers placing more on deposit than they take out in loans – the bank can still manage the resultant gap in the wholesale market.

Generally, excess liabilities at a bank are a rare occurrence and, under most circumstances, such a position is clearly undesirable. This is because the bank will have to achieve target return on capital ratios, and this requires funds to be put to work, so to speak, by acquiring assets. In the case of equity capital it is imperative that these funds are properly employed.[7] The exact structure of the asset book will depend on the bank's view on interest rates and the yield curve generally. The shape of the yield curve and expectations on this will also influence the structure and tenor of the asset book. The common practice is to spread assets across the term structure, with varying maturities. There will also be investments made with a forward start date, to lock in rates in the forward curve now. Equally, some investments will be made for very short periods so that if interest rates rise, when the funds are reinvested they will benefit from the higher rates.

The basic case: illustration

The basic case is illustrated in Table 5.2 in two scenarios. In the first scenario, the longest dated gap is -130, so the bank puts on funding for $+130$ to match this tenor of three periods. The gap at period t_2 is -410, so this is matched with a two-period tenor-funding position of $+280$. This leaves a gap of -180 at period t_1 which is then funded with a single-period loan. The net position is zero at each period ('squared off'), and the book has been funded by three bullet fixed-

[7] The bank's capital will be invested in risk-free assets such as government T-bills or, in some cases, bank CDs. It will not be lent out in normal banking operations because the ALM desk will not want to put capital in a credit-risky investment.

Table 5.2 Funding the liquidity gap: two examples

Time	t_1	t_2	t_3
Scenario (i)			
Assets	970	840	1,250
Liabilities	380	430	1,120
Gap	−590	−410	−130
Borrow 1: three-period tenor	130	130	130
Borrow 2: two-period tenor	280	280	
Borrow 3: single-period tenor	180		
Total funding	+590	+410	+130
Squared off	0	0	0
Scenario (ii)			
Assets	970	840	1,250
Liabilities	720	200	1,200
Gap	−250	−640	−50
Borrow 1: three-period tenor	50	50	130
Borrow 2: two-period tenor	200	200	
Borrow 3: single-period tenor	0	390	
Total funding	+250	+640	+50
Squared off	0	0	0

term loans. The position is not a matched book as such although there is now no liquidity risk exposure.

In the second case, the gap increases from Period 1 to Period 2. The first period is funded by a three-period and a two-period borrow of +50 and +200, respectively. The gap at t_2 needs to be funded by a position that is not needed *now*. The bank can cover this with a forward start loan of +390 at t_1 or can wait and act at t_2. If it does the latter it may still wish to hedge the interest rate exposure.[8]

The liquidity ratio

The *liquidity ratio* is the ratio of assets to liabilities. It is a short-term ratio that is up to 1 year, usually calculated for the money market

[8] We look at the mechanics of this, using different derivative instruments, in Chapter 4.

term only. Under most circumstances, and certainly under a positive yield curve environment, it would be expected to be above 1.00; however, this is less common at the very short end because the average tenor of assets is often greater than the average tenor of liabilities. So, in the 1-month to 3-month tenor period – and perhaps out to the 6-month tenor – the ratio may well be less than 1. This reflects the fact that short-term borrowing is used to fund longer term assets.

A ratio significantly below 1 is inefficient from an ROE point of view. It represents an opportunity cost of return foregone. To manage it, banks may invest more funds in the very short term, but this also presents its own problems because return on these assets may not be sufficient. This is especially true in a positive yield curve environment. This is one scenario where a matched book approach will be prudent, because the bank should be able to lock in a bid–offer spread at the very short end of the yield curve.[9] A more risky approach would be to lend in the short term and fund them in the long term, but this would create problems because the term premium in the yield curve will make borrowing in the long term expensive relative to the return on short-dated assets (unless we have an inverted yield curve). There is also the liquidity risk associated with the more frequent rolling over of assets than liabilities. We see then, that maintaining the liquidity ratio carries something of a cost for banks.

The liquidity portfolio

The basic business of banking is *maturity transformation*; this is the practice of lending long-dated assets that are funded by shorter dated liabilities. This is to be expected: a bank that lends 25-year money to a customer in the form of a retail mortgage would not expect and, indeed would not aim, to fund the asset with a borrowing of 25-year money. The business of banking assumes therefore the availability of continuous funding capability, or liquidity. To provide risk mitigation for the times when liquidity conditions deteriorate – the time period after the bankruptcy of Lehman Brothers in September 2008 is the best example – banks maintain a portfolio of liquid assets. This is

[9] In addition, the bank should be able to raise funds at Libor, while it should be able to lend at Libor plus a spread in short-dated interbank credit quality assets.

sometimes known as the 'liquid asset buffer' and is typically made up of AAA-rated government bonds.

Prior to the Lehman collapse, some banks had stopped following market best practice and had ceased to maintain a liquid portfolio of government bonds (which, being credit-risk-free assets, pay the lowest RoC), or had constructed the liquid portfolio out of bank-issued certificates of deposit (CDs) and floating rate notes (FRNs). However, these assets were shown to suffer from poor liquidity under the market crisis conditions that prevailed between October and December 2008, so business best practice philosophy has since changed and banks now maintain a government bond liquidity portfolio.

Example 5.1 Hypothetical bank (XYZ Securities) sovereign bond portfolio for repo and interest rate hedging

The Treasury desk maintains a liquidity book of US Treasury, German bund and UK gilts. This is also used to facilitate a repo business and reduce the quantity of interest rate futures needed as part of the interest rate exposure hedge.

Description of the product/business activity

XYZ's Treasury desk is required to fund a large part of the firm-wide funding requirement in term loans, as part of prudent asset–liability management. The resulting DV01 (dollar-value of loss for a 1 bp rise in yields) exposure is managed using Eurodollar futures. It has also established a US government bond portfolio as a lower cost means of managing DV01 risk. The objective is to manage the DV01 exposure of the Treasury book by buying very short-dated Treasury notes and strips, which sets up an income stream that is diversified from other sources and that represents zero credit risk. This is achieved by

- Establishing a portfolio of very-short-dated US Treasuries and Treasury strips on the balance sheet (maximum maturity recommended 1–1.5 years, the majority in 3 to 6 months). The composition of the book at May 2005 is
  - 200 million 3 month
  - 300 million 6 month
  - 50 million 1 year.
  - the average maturity of the portfolio in the first year is to be around 6 months.

- Funding these in Treasury repo under the standard GMRA.[10]
- Holding Treasury securities and Treasury strips to maturity to generate a steady income stream. With ultra-short-dated strips, this also benefits from the pull-to-par effect on mark to market.

All funding is locked in to maturity, thus there is no gap risk.

Objectives of the business

The sovereign bond book is business that

- allows XYZ to undertake cheaper hedging of its interest rate risk (DV01), complementing the current arrangement using Eurodollar and 90-day money futures;
- establishes a risk-free portfolio that generates a funding gain for XYZ;
- enables XYZ to use a AAA risk-free portfolio for use in setting up total return swap (TRS) and repo lines with market counterparties.

The benefits to XYZ of holding such a portfolio include

- earning the spread between yield and funding cost; a bonus that is not available when using Eurodollar futures for DV01 hedging, which do not earn any income. XYZ also saves on the commission and margin costs associated with maintaining Eurodollar futures positions;
- using the business to set up dealing relationships with bank counterparties that could then be used as sources of additional funding if required, adding to the diversity of funding (required as part of the Treasury desk's remit);
- assisting the Treasury desk in undertaking ALM objectives through lower cost hedging of DV01 risk, compared with futures which impose a cost on the book.

Expected return

The fundamental gain is removal of the requirement to hold Eurodollar futures. In a rising interest rate environment, this will significantly reduce hedging costs.

---

[10] See Chapter 2.

Net profit in the first full year is upwards of a \$250,000–\$280,000 funding gain on a £350 million average position (10–12 bp on average per trade). This does not take into account the mark-to-market profit that is realized on Treasury bonds and strips.

Capital and taxation issues

Treasury securities are 0% risk-weighted under Basel I (and II), except where they create DV01 risk when the charge is 0.7%. However, if held for interest-rate-risk-hedging purposes (as is the case here), they may actually reduce overall capital requirements.

Example 5.2 XYZ Securities' sovereign bond portfolio for interest rate hedging: no lending business

This illustration mirrors that of Example 5.1, except we assume that the firm (XYZ Securities) has no lending operation. That is, its Treasury desk is not a true money market desk because it is only a borrower of funds; there is no lending of funds. In this case, the firm sets up a sovereign bond portfolio to reduce its risk-hedging costs. The following are real-world examples of two such portfolios of US Treasuries and UK gilts, used to hedge their USD and GBP term-funding books.

Background

As part of its key business function, XYZ Securities' Treasury function maintains a large short cash position. It is not able to take the other side in the market, which would give it added flexibility in its dealing arrangements and ALM management, as well as more efficient mechanisms for interest rate risk hedging. This also means the Treasury desk is restricted in building counterparty relationships and funding source diversity.

In looking to diversify its business mix – to achieve cheaper interest rate risk management and a more active ALM approach – it maintains a portfolio of very short-dated US Treasury securities and Treasury strip (zero-coupon) bonds, funded in repo. This would be held to

- establish a risk-free portfolio that generates funding gain;

- allow cheaper hedging of interest rate risk (DV01) than an arrangement that uses Eurodollar futures;
- enables XYZ to use a AAA risk-free portfolio for use in setting up TRS and repo lines with market counterparties.

The benefits to XYZ of holding such a portfolio include

- earning the spread between yield and funding cost; a bonus that is not available when using Eurodollar futures for DV01 hedging, which do not earn any income;
- using the business to set up dealing relationships with bank counterparties which could then be used as sources of additional funding if required, adding to the diversity of funding (required as part of the Treasury desk's remit);
- assisting the Treasury desk to undertake ALM objectives through lower cost hedging of DV01 risk, compared with futures which impose a cost on the book.

All funding will be locked in to maturity, thus there is no gap risk.

Profitable risk-free trade example undertaken on 1 July 2004

Below are examples of funding trades that were put on in July 2004 that generated a risk-free funding gain – rates as at 1 July 2004 (data source: Lehman Brothers and Bloomberg LP). This shows where value was obtained from holding a book of Treasuries in the first instance. The following positions all yielded funding profit:

- Buy the 2% November 2004 Treasury at a yield of 1.597% and hold to maturity, and repo to maturity at a rate of 1.56%. This gives a locked-in gain of 3.97 bp for the term to maturity on a position of USD150 million at a profit of USD24,800.
- Buy the 31 July 2004 strip at a yield of 1.568% and repo to maturity at 1.28%. This gives a spread of 28.8 bp of risk-free locked-in funding. On a position of USD200 million this represents a positive P&L of USD48,000 – this is risk-free income.
- Take advantage of special rates for stocks we are long in. On 1 July, a position in $1\frac{1}{4}$% May 2005 Treasury could be funded cheaper than normal repo (general collateral or GC) by 7–8 bp as a result of its special status. So the gain on holding that stock would be around this amount for the term of the trade, as our funding cost in repo would be lower by this amount.

It would be an objective of the Treasury desk to be aware of stocks expected to go special and act accordingly.

Despite their infrequency these opportunities do occur as shown above. As the book will be primarily designed to hedge, trading is infrequent and only undertaken as opportunities arise.

Risks

There is no gap (funding) risk and no credit risk.

Just like the positions on a trading book – rather than a banking book – they will be marked-to-market. The desk expects volatility in short-dated government bonds to be lower than for the term loans they are hedging, but volatility is a risk exposure and there may be periods when the desk will experience mark-to-market losses.

Example 5.3 UK gilt portfolio

Commercial banks and building societies are natural holders of government bonds such as gilts. They do so for the following reasons:

- because gilts are the most liquid instruments in the UK market;
- as an instrument in which to invest the firm's capital reserves;
- for income generation purposes, given the favourable funding costs of gilt repo as well as zero credit and liquidity risk;
- to intermediate between gilt, stock loans and interbank markets in CDs;
- to benefit from being long in gilts that go special and can be funded at anything from 25 bp to 2% to 3% cheaper than GC repo;
- to establish an asset pool that receives favourable capital treatment (0% risk-weighted under Basel I and Basel II);

The benefits to XYZ of holding such a portfolio include some of the above, as well as the following:

- earning the spread between yield and funding cost;
- using the business to set up dealing relationships with bank counterparties that could then be used as sources of additional

funding if required, adding to the diversity of funding (required as part of the Treasury desk's remit);
- assisting the Treasury desk in undertaking ALM objectives.

Business line

A UK government bond portfolio at XYZ's Treasury desk has the objective of maintaining an income stream that is diversified from current sources and that is also relatively low risk, but stable. This is achieved by

- Establishing a portfolio of very short-dated gilts and gilt strips on the balance sheet (maximum maturity recommended 1 year, the majority in 3 to 6 months). The expected makeup of the book might be
  - 125 million 3 months
  - 200 million 6 months
  - 25 million 1 year
  - the average maturity of the portfolio in the first year would be around 6 months.
- Funding these in gilt repo – under the GMRA agreement – and funding using TRS – under ISDA – if required. The repo-funding margin for gilts in the wholesale market is often 0%. With a zero or very low margin – that is, a haircut – all positions will be virtually fully funded.
- Holding gilts and gilt strips to maturity to generate a steady income stream. With ultra-short-dated strips, we also benefit from the pull-to-par effect.

Market rates

Table 5.3 shows income yields and funding rates as at 2 June 2004. This shows where value was obtained from holding a book of gilts in the first instance. For example, all the following positions yielded funding profit:

- Hold gilts and fund in GC; depending on the specific stock and the term of funding arranged, a gain ranging from 15 bp to 50–60 bp.
- Hold strips to maturity. For example, a gain of approximately 35 bp for a Dec 04 principal strip at 1-week or 2-week funding; and a locked-in funding gain of 9 bp for a Dec 04 strip (buy a 6-month strip and fund in 6 months) – this is risk-free income.

Table 5.3 Market rates as at 2 June 2004

GC rates

1w	4.15	4.10
2w	4.25	4.15
3w	4.25	4.15
1m	4.25	4.15
2m	4.28	4.18
3m	4.32	4.22
4m	4.40	4.30
5m	4.43	4.33
6m	4.50	4.40
9m	4.67	4.57
1y	4.78	4.68

Source: HBOS screen.

Gilt yields

	GRY%	*DV01*	*Special rates*
5% Jun 04	4.05		
6T Nov 04	4.33	0.00416	100 bp
9H Apr 05	4.668	0.00817	35 bp cheaper than GC
8H Dec 05	4.818	0.014	25 bp cheaper, down from 1.5%
7T Sep 06	4.945	0.02141	
7H Dec 06	4.966	0.02364	10 bp

Source: Butler Securities/KSBB screens.

Gilt strip yields

	GRY%	*DV01*
P Jun 04	3.78	
C Sep 04	4.342	0.00195
C Dec 04	4.509	0.00432
C Mar 05	4.633	0.00664
C Jun 05	4.744	0.00888
C Sep 05	4.829	0.01107
P Dec 05	4.85	0.01321

Source: Bloomberg

- Hold strips at 3-month, 6-month and 9-month maturities as longer dated bills and hold to maturity. Funding will be locked in if available or rolled.

  - For example, as at 2 June 2004, XYZ purchased a Sep 04 coupon strip at 4.34% and funded in the 1-week term at 4.15% (and ran the resultant funding gap risk – but this gilt had a strong pull-to-par effect. If funding is no longer profitable in short dates, XYZ would have sold the gilt for a probable realized mark-to-market profit).
  - Coupon strips are bid for in repo by the main market-makers, thereby reducing liquidity risk in these products.
- Take advantage of special rates for the stocks XYZ is long in. On 2 June 2004, a position in 9.5% 2005 gilt was funded cheaper as a result of its special status, from 35 bp (down from 50 bp the week before). The 6.75% 2004 gilt was being funded at 100 bp cheaper than GC. So, the gain on holding that stock would be significant, as our funding cost in repo would be very low. It would be an objective of the Treasury desk to be aware of stocks expected to go special and act accordingly.

Risks

The principle risk is funding rollover (gap risk). Where possible we will lock in funding to match expected holding period of positions, but will also look to take advantage of market rates as appropriate and roll over funding. Gap risk will be managed in the normal way as part of overall Treasury operations. Gaps will be put on to reflect the interest rate and yield curve view of the desk.

There is no credit risk.

Interest rate risk and gap risk are managed as a standard banking ALM or cash book. The objective is to set up an income stream position at low risk, but if necessary DV01 risk would be managed where deemed necessary using 90-day sterling futures, OIS or short-dated swaps. XYZ can also sell out of positions where it expects significant market movement – for example, a central bank base rate hike. The main objective, however, is to establish an income stream, in line with a view on short-term interest rates. Hedging would only be carried out when necessary for short-term periods (say, ahead of a data release or anticipated high volatility).

As the positions would be on the trading book – not the banking book – they will be marked-to-market. The desk expects volatility in short-dated gilts to be considerably lower than for medium-dated and long-dated gilts, but volatility is a risk exposure and there may be periods when the desk will experience mark-to-market losses.

The interest rate risk for longer dated stocks is shown in Table 5.3, measured as DV01. Longer dated stocks expose the bank to a greater interest rate risk position when marking-to-market.

Chapter 6

ASSET AND LIABILITY MANAGEMENT II

In our second ALM chapter, we delve deeper – or more accurately wider – into the topic. The art of asset and liability management is essentially one of risk management and capital management, and although day-to-day activities are run at the desk level, overall direction is given at the highest level of a banking institution. Risk exposures in a banking environment are multi-dimensional; as we have seen, they encompass interest rate risk, liquidity risk, credit risk and operational risk. Interest rate risk is one type of market risk. Risks associated with moves in interest rates and levels of liquidity[1] are those that result in adverse fluctuations in earnings levels due to changes in market rates and bank funding costs. By definition, banks' earnings levels are highly sensitive to moves in interest rates and the cost of funds in the wholesale market. Asset and liability management covers the set of techniques used to manage interest rate and liquidity risks; it also deals with the structure of the bank's balance sheet, which is heavily influenced by funding and regulatory constraints and profitability targets.

In this chapter we review the concept of balance sheet management, the role of the ALM desk, liquidity risk and maturity gap risk. We also review a basic gap report. The increasing use of *securitization* and the responsibility of the ALM desk in enhancing the return on assets on the balance sheet is also introduced. For readers who are interested in developing their knowledge further, we list a selection of articles and publications in the Bibliography at the end of the chapter.

INTRODUCTION

For newcomers to the subject, an excellent introduction to the primary activity of banking is contained in an article in *The Economist* entitled 'The business of banking'.[2] Those who are complete beginners may wish to refer to this article. In this section we provide an overview of the main business of banking before considering the subject of ALM.

One of the major areas of decision-making in a bank involves the maturity of assets and liabilities. Typically, longer term interest rates are higher than shorter term rates; that is, it is common for

---

[1] In this chapter the term *liquidity* is used to refer to funding liquidity.

[2] *The Economist*, 30 October 1999.

the yield curve in the short term (say 0-to-3-year range) to be positively sloping. To take advantage of this banks usually raise a large proportion of their funds from the short-dated end of the yield curve and lend out these funds for longer maturities at higher rates. The spread between borrowing and lending rates is in principle the bank's profit. The obvious risk from such a strategy is that the level of short-term rates rises during the term of the loan, so that when the loan is refinanced the bank makes a lower profit or a net loss. Managing this risk exposure is the key function of an ALM desk. As well as managing the interest rate risk itself, banks also match assets with liabilities – thus locking in a profit – and diversify their loan book, to reduce exposure to one sector of the economy.

Another risk factor is liquidity. From a banking and Treasury point of view the term *liquidity* means funding liquidity, or the 'nearness' of money. The most liquid asset is cash money. Banks bear several interrelated liquidity risks, including the risk of being unable to pay depositors on demand, an inability to raise funds in the market at reasonable rates and an insufficient level of funds available with which to make loans. Banks keep only a small portion of their assets in the form of cash, because this earns no return for them. In fact, once they have met the minimum cash level requirement, which is something set down by international regulation (reviewed in the previous chapter), they will hold assets in the form of other instruments. Therefore, the ability to meet deposit withdrawals depends on a bank's ability to raise funds in the market. The market and the public's perception of a bank's financial position heavily influences liquidity. If this view is very negative, the bank may be unable to raise funds and consequently be unable to meet withdrawals or loan demand. Thus, liquidity management is running a bank in a way that maintains confidence in its financial position. The assets of the banks that are held in near-cash instruments, such as Treasury bills and clearing bank CDs, must be managed with liquidity considerations in mind. The asset book on which these instruments are held is sometimes called the *liquidity book.*

Basic concepts

In the era of stable interest rates that preceded the breakdown of the Bretton Woods agreement, ALM was a more straightforward process, constrained by regulatory restrictions and the saving and borrowing pattern of bank customers.[3] The introduction of the negotiable certificate of deposit by Citibank in the 1960s enabled banks to diversify both their investment and funding sources. With this there developed the concept of *interest margin*, which is the spread between the interest earned on assets and that paid on liabilities. This led to the concept of *interest gap* and management of the gap, which is the cornerstone of modern-day ALM. The increasing volatility of interest rates, and the rise in absolute levels of rates themselves, made gap management a vital part of running the banking book. This development meant that banks could no longer rely permanently on the traditional approach of borrowing short (funding short) to lend long, as a rise in the level of short-term rates would result in funding losses. The introduction of derivative instruments such as FRAs and swaps in the early 1980s removed the previous uncertainty and allowed banks to continue the traditional approach while hedging against medium-term uncertainty.

Foundations of ALM

The general term *asset and liability management* entered common usage from the mid-1970s onwards. Under a changing-interest-rate environment, it became imperative for banks to manage both assets and liabilities simultaneously, in order to minimize interest rate and liquidity risk and maximize interest income. ALM is a key component of any financial institution's overall operating strategy. As described in previous texts (Marshall and Bansal, 1992, pp. 498–501) ALM is defined in terms of four key concepts, which are described below.

The first is *liquidity*, which in an ALM context does not refer to the ease with which an asset can be bought or sold in the secondary

[3] For instance, in the US banking sector terms on deposit accounts were fixed by regulation, and there were restrictions on the geographic base of customers and the interest rates that could be offered. Interest rate volatility was also low. In this environment ALM consisted primarily of asset management, in which the bank would use depositors' funds to arrange the asset portfolio that was most appropriate for the liability portfolio. This involved little more than setting aside some of the assets in non-interest reserves at the central bank and investing the balance in short-term securities, while any surplus would be lent out at very-short-term maturities.

market, but the ease with which assets can be converted into cash.[4] A banking book is required by the regulatory authorities to hold a specified minimum share of its assets in the form of very liquid instruments. Liquidity is very important to any institution that accepts deposits because of the need to meet customer demand for instant access funds. In terms of a banking book the most liquid assets are overnight funds, while the least liquid are medium-term bonds. Short-term assets such as T-bills and CDs are also considered to be very liquid.

The second key concept is the money market *term structure* of interest rates. The shape of the yield curve at any one time, and expectations as to its shape in the short term and medium term, significantly impact the ALM strategy employed by a bank. Market risk in the form of *interest rate sensitivity*, in the form of the present value sensitivity of specific instruments to changes in the level of interest rates, and in the form of the sensitivity of floating rate assets and liabilities to changes in rates are all significant. Another key factor is the *maturity profile* of the book. The maturities of assets and liabilities can be matched or unmatched; although the latter is more common the former is not uncommon depending on the specific strategies that are being employed. Matched assets and liabilities lock in return in the form of the spread between the funding rate and the return on assets. The maturity profile, the absence of a locked-in spread and the yield curve combine to determine the total interest rate risk of the banking book.

The fourth key concept is *default risk*: the risk exposure that borrowers will default on interest or principal payments that are due to the banking institution.

These issues are placed in context in the simple hypothetical situation described in Box 6.1.

Box 6.1 ALM considerations

Assume that a bank wants to access the markets for 3-month and 6-month funds, whether for funding or investment purposes. The

[4] The marketability definition of liquidity is also important in ALM. Less liquid financial instruments must offer a yield premium that can be compared with liquid instruments.

rates for these terms are shown in Table 6.1. Assume there are no bid–offer spreads. The ALM manager also expects the 3-month Libor rate in 3 months' time to be 5.10%. The bank can usually fund its book at Libor while it is able to lend at Libor plus 1%.

Table 6.1 Hypothetical money market rates

Term	Libor	Bank rate
90-day	5.50%	6.50%
180-day	5.75%	6.75%
Expected 90-day rate in 90 days' time	5.10%	6.10%
3v6 FRA	6.60%	

The bank could adopt any of the following strategies or a combination of them:

- Borrow 3-month funds at 5.50% and lend them for a 3-month period at 6.50%. This locks in a return of 1% for a 3-month period.
- Borrow 6-month funds at 5.75% and lend them for a 6-month period at 6.75%; again this earns a locked-in spread of 1%.
- Borrow 3-month funds at 5.50% and lend them for a 6-month period at 6.75%. This approach would require the bank to refund the loan in 3 months' time, which it expects to be able to do at 5.10%. This approach locks in a return of 1.25% in the first 3-month period and an expected return of 1.65% in the second 3-month period. The risk of this tactic is that the 3-month rate in 3 months' time does not fall as expected by the ALM manager, reducing profits and possibly leading to loss.
- Borrow 6-month funds at 5.75% and lend them for a 3-month period at 6.50%. After this period, lend the funds for a 3-month or 6-month period. This strategy does not tally with the ALM manager's view, however, who expects a fall in rates and so should not wish to be long of funds in 3 months' time.
- Borrow 3-month funds at 5.50% and again lend them for a 6-month period at 6.75%. To hedge the gap risk, the ALM manager simultaneously buys a 3v6 FRA to lock in the 3-month rate in 3 months' time. The first period spread of 1.25% is guaranteed, but the FRA guarantees only a spread of 15 basis points in the second period. This is the cost of the

hedge (and also suggests that the market does not agree with the ALM manager's assessment of where rates will be 3 months from now!); the price the bank must pay for reducing uncertainty is lower spread return. Alternatively, the bank could lend for a 6-month period, funding initially for a 3-month period, and buy an interest rate cap with a ceiling rate of 6.60% that is pegged to Libor, the rate at which the bank can actually fund its book.

Although simplistic, these scenarios serve to illustrate what is possible; indeed, there are many other strategies that could be adopted. The approaches described in the last option show how derivative instruments can actively be used to manage the banking book and the cost associated with employing them.

Liquidity and gap management

We have noted that the simplest approach to ALM is to match assets with liabilities. For a number of reasons – including the need to meet client demand and to maximize return on capital – this is not practical and banks must adopt more active ALM strategies. One of the most important of these is the role of the gap and gap management. This term describes the practice of varying the asset and liability *gap* in response to expectations about the future course of interest rates and the shape of the yield curve. Simply put, this means increasing the gap when interest rates are expected to rise and decreasing it when rates are expected to decline. The gap here is the difference between floating rate assets and liabilities, but gap management must also be pursued when one of these elements is fixed rate.

Such a discipline is of course as much an art as a science. Gap management assumes that the ALM manager is proved to be correct in his prediction of the future direction of rates and the yield curve.[5] Views that turn out to be incorrect can lead to unexpected widening or narrowing of the gap spread and losses. The ALM manager must choose the level of tradeoff between risk and return.

Gap management also assumes that the profile of the banking book can be altered with relative ease. This was not always the case, and even today may still present problems, although evaluation of a

[5] Or is proved to be correct at least three times out of five . . . !

liquid market in off-balance-sheet interest rate derivatives has eased this problem somewhat. Historically, it has always been difficult to change the structure of the book, as many loans cannot be liquidated instantly and fixed rate assets and liabilities cannot be changed to floating rate ones. Client relationships must also be observed and maintained – a key banking issue. For this reason it is much more common for ALM managers to use off-balance-sheet products when dynamically managing the book. For example, FRAs can be used to hedge gap exposure, while interest rate swaps are used to alter an interest basis from fixed to floating – or vice versa. The last strategy presented in Box 6.1 presented, albeit simplistically, the use that could be made of derivatives. The widespread use of derivatives has enhanced the opportunities available to ALM managers, as well as the flexibility with which the banking book can be managed, but it has also contributed to an increase in competition and a reduction in margins and bid–offer spreads.

Interest rate risk and source

Interest rate risk

Put simply, interest rate risk is defined as the potential impact – adverse or otherwise – on the net asset value of a financial institution's balance sheet and earnings resulting from a change in interest rates. Risk exposure exists whenever there is a maturity date mismatch between assets and liabilities, or between principal and interest cashflows. Interest rate risk is not necessarily a negative thing; for instance, changes in interest rates that increase the net asset value of a banking institution would be regarded as positive. For this reason, active ALM seeks to position a banking book to gain from changes in rates. The Bank for International Settlements splits interest rate risk into two elements: *investment risk* and *income risk*. The first risk type is the term for potential risk exposure arising from changes in the market value of fixed-interest-rate cash instruments and off-balance-sheet instruments, and is also known as *price risk*. Investment risk is perhaps best exemplified by the change in value of a plain vanilla bond following a change in interest rates, and from Chapter 2 we know that there is an inverse relationship between changes in rates and the value of such bonds (see Example 2.2). Income risk is the risk of loss of income when there is a non-synchronous change in deposit and funding rates – it is this risk that is known as gap risk.

ALM covering the formulation of interest rate risk policy is usually the responsibility of what is known as the asset–liability committee (ALCO), which is made up of senior management personnel including the finance director and the heads of Treasury and risk management. The ALCO sets bank policy for balance sheet management and the likely impact on revenue of various scenarios that it considers may occur. The number of people who sit on the ALCO will depend on the complexity of the balance sheet and products traded, as well as the amount of management information available on individual products and desks.

The process employed by the ALCO for ALM will vary according to the particular internal arrangement of the institution. A common procedure involves a monthly presentation to the ALCO of the impact of different interest rate scenarios on the balance sheet. This presentation may include

- Analysis of the difference between actual net interest income (NII) for the previous month and the amount that was forecast at the previous ALCO meeting. This is usually presented as a gap report, broken by maturity buckets and individual products.
- The result of discussion with business unit heads on the basis of the assumptions used in calculating forecasts and the impact of interest rate changes; scenario analysis usually assumes an unchanging book position between now and 1 month later, which is essentially unrealistic.
- A number of interest rate scenarios, based on assumptions of (a) what is expected to happen to the shape and level of the yield curve, and (b) what could conceivably happen to it – for example, extreme scenarios. Essentially, this exercise produces a value for forecast NII due to changes in interest rates.
- Update of the latest actual revenue numbers.

Specific new or one-off topics may be introduced at the ALCO as circumstances dictate; for example, presentation of an approval process for the introduction of a new product.

Sources of interest rate risk

Assets on the balance sheet are affected by absolute changes in interest rates as well as increases in the volatility of interest rates. For instance, fixed rate assets will fall in value in the event of a rise in rates, while funding costs will rise. This decreases the margins available. We noted that the way to remove this risk was to lock in assets with matching liabilities; however, this is not only not always possible, but also sometimes undesirable, as it prevents the ALM manager from taking a view on the yield curve. In a falling interest rate environment, deposit-taking institutions may experience a decline in available funds, requiring new funding sources that may be accessed at less favourable terms. Liabilities are also impacted by a changing interest rate environment.

There are five primary sources of interest rate risk inherent in an ALM book:

- *Gap risk* is the risk that revenue and earnings decline as a result of changes in interest rates, due to differences between the maturity profiles of assets, liabilities and off-balance-sheet instruments. Another term for gap risk is *mismatch risk*. An institution with gap risk is exposed to changes in the level of the yield curve – so-called *parallel shift* – or change in the shape of the yield curve – so-called *pivotal shift*. Gap risk is measured in terms of short-term or long-term risk, which is a function of the impact of rate changes on earnings for a short or long period. Therefore, the maturity profile of the book and the time to maturity of instruments held on the book will influence whether the bank is exposed to short-term or long-term gap risk.
- *Yield curve risk* is the risk that non-parallel or pivotal shifts in the yield curve cause a reduction in NII. The ALM manager will change the structure of the book to take into account his views on the yield curve. For example, a book with a combination of short-term and long-term asset or liability maturity structures[6] is at risk from yield curve inversion, sometimes known as a twist in the curve.
- *Basis risk* arises from the fact that assets are often priced off one interest rate, while funding is priced off another interest rate. Taken one step further, hedge instruments are often linked to a different interest rate from that of the product they are hedging. In the US market the best example of basis risk is the difference between the Prime rate and Libor. Term loans in the US are often set at Prime, or a relationship to Prime, while bank funding is usually based on the Eurodollar market and linked to Libor. However, the Prime rate is what is known as an 'administered' rate and does not change on a daily basis – unlike Libor. While changes in the two rates are positively correlated, they do not

[6] This describes a *barbell* structure, but this is really a bond market term.

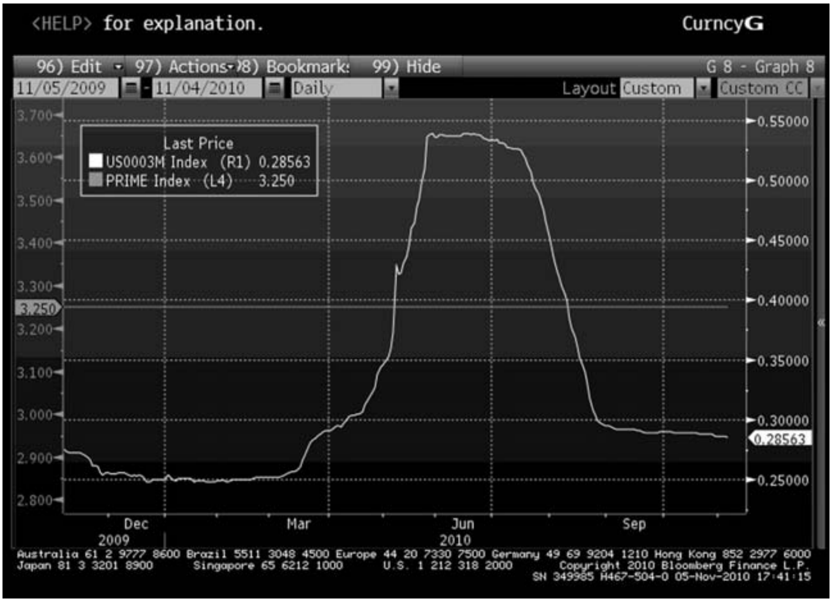


Figure 6.1 Change in spread between Prime rate and USD 3-month Libor 2009–2010.

change by the same amount, which means that the spread between them changes regularly. This results in spread earning on a loan product changing over time. Figure 6.1 illustrates the change in spread during 2009–2010.

- Another risk for deposit-taking institutions such as clearing banks is *runoff risk*, associated with the non-interest-bearing liabilities (NIBLs) of such banks. The level of interest rates at any one time represents an opportunity cost to depositors who have funds in such facilities. However, in a rising-interest-rate environment, this opportunity cost rises and depositors will withdraw these funds, available at immediate notice, resulting in an outflow of funds from the bank. The funds may be taken out of the banking system completely; for example, for investment in the stock market. This risk is significant and therefore sufficient funds must be maintained at short notice, which is an opportunity cost for the bank itself.
- Many banking products entitle the customer to terminate contractual arrangements ahead of the stated maturity term; this is sometimes referred to as *option risk*. This is another

significant risk as products – such as CDs, cheque account balances and demand deposits – can be withdrawn or liquidated at no notice, which is a risk to the level of NII should the option inherent in the products be exercised.

Gap and net interest income

We noted earlier that gap is a measure of the difference between the interest rate sensitivity of assets and liabilities that revalue at a particular date, expressed as a cash value. Put simply it is

$$\text{Gap} = A_{\text{ir}} - L_{\text{ir}} \tag{6.1}$$

where A_{ir} and L_{ir} are interest-rate-sensitive assets and interest-rate-sensitive liabilities. Where $A_{\text{ir}} > L_{\text{ir}}$ the banking book is described as being *positively gapped*, and when $A_{\text{ir}} < L_{\text{ir}}$ the book is said to be negatively gapped. The change in NII is given by

$$\Delta\text{NII} = \text{Gap} \times \Delta r \tag{6.2}$$

where r is the relevant interest rate used for valuation. The NII of a bank that is positively gapped will increase as interest rates rise and decrease as rates decline. This describes a banking book that is asset sensitive; the opposite, when a book is negatively gapped, is known as liability sensitive. The NII of a negatively gapped book will increase when interest rates decline. The value of a book with zero gap is immune to changes in the level of interest rates. The shape of the banking book at any one time is a function of customer demand, the Treasury manager's operating strategy, as well as a view of future interest rates.

Gap analysis is used to measure the difference between interest-rate-sensitive assets and liabilities over specified time periods. Another term for this analysis is *periodic gap*, and the common expression for each time period is a *maturity bucket*. For a commercial bank typical maturity buckets are:

0–3 months;
3–12 months;
1–5 years;
>5 years.

Another common approach is to group assets and liabilities by the buckets or grid points of the *Riskmetrics* value-at-risk methodology. Moreover, any combination of time periods may be used. For instance, certain US commercial banks place assets, liabilities and off-balance-sheet items in terms of *known maturities*, *judgemental maturities* and *market-driven maturities*:

- *known maturities* are fixed rate loans and CDs;
- *judgemental maturities* are passbook savings accounts, demand deposits, credit cards and non-performing loans;
- *market-driven maturities* are option-based instruments such as mortgages and other interest-rate-sensitive assets.

The other key measure is *cumulative gap*, defined as the sum of individual gaps up to 1-year maturity. Banks traditionally use cumulative gap to estimate the impact of a change in interest rates on NII.

Assumptions of gap analysis

A number of assumptions are made when using gap analysis, but they may not reflect reality in practice. These include

- The key assumption that interest rate changes manifest themselves as a parallel shift in the yield curve; in practice, changes do not occur as a parallel shift, giving rise to basis risk between short-term and long-term assets.
- The expectation that contractual repayment schedules are met; if there is a fall in interest rates, prepayments of loans by borrowers who wish to refinance their loans at lower rates will have an impact on NII. Certain assets and liabilities have option features that are exercised as interest rates change, such as letters of credit and variable rate deposits; early repayment will impact a bank's cashflow.
- The expectation that repricing of assets and liabilities takes place at the midpoint of the time bucket.
- The expectation that all loan payments will occur on schedule; in practice, certain borrowers will repay the loan earlier.

Recognized weaknesses of the gap approach include

- no incorporation of future growth, or changes in the asset/liability mix;
- no consideration of the time value of money;
- arbitrary setting of time periods.

Limitations notwithstanding, gap analysis is used extensively. Gup and Brooks (1993, p. 59) give the following reasons for the continued popularity of gap analysis:

- it was the first approach introduced to handle interest rate risk – it provides reasonable accuracy;
- the data required to perform the analysis have already been compiled for the purposes of regulatory reporting;
- gaps can be calculated using simple spreadsheet software;
- it is easier (and cheaper) to implement than more sophisticated techniques;
- it is straightforward to demonstrate and explain to senior management and shareholders.

Although there are more sophisticated methods available, gap analysis remains in widespread use.

THE BANKING BOOK

Traditionally, ALM has been concerned with the banking book. The conventional techniques of ALM were developed for application to a bank's banking book – that is, its lending and deposit-taking transactions. The core banking activity will generate either an excess of funds (when the receipt of deposits outweighs the volume of lending the bank has undertaken) or a shortage of funds (when the reverse occurs). This mismatch is balanced via financial transactions in the wholesale market. The banking book generates both interest rate and liquidity risks, which are then monitored and managed by the ALM desk. Interest rate risk is the risk that the bank suffers losses due to adverse movements in market interest rates. Liquidity risk is the risk that the bank cannot generate sufficient funds when required; the most extreme version of this is when there is a run on the bank and the bank cannot raise the funds required when depositors withdraw their cash.

Note that the asset side of the banking book – that is, the loan portfolio – also generates credit risk.

The ALM desk will be concerned with risk management that focuses on the quantitative management of liquidity and interest rate risks inherent in a banking book. The major areas of ALM include

- *Measurement and monitoring of liquidity and interest rate risk*. This includes setting up targets for earnings and the volume of transactions, as well as setting up and monitoring interest rate risk limits.

- *Funding and control of any constraints on the balance sheet.* This includes liquidity constraints and debt policy as well as the *capital adequacy* ratio and solvency.
- *Hedging of liquidity and interest-rate risk.*

THE ALM DESK

The ALM desk or unit is a specialized business unit that fulfils a range of functions. Its precise remit is a function of the type of activities of the financial institution it is a part of. Let us consider the main types of activities that are carried out.

If an ALM unit has a profit target of zero, it will act as a cost centre with a responsibility to minimize operating costs. This would be consistent with a strategy that emphasizes commercial banking as the core business of the firm, and where ALM policy is concerned purely with hedging interest rate and liquidity risk.

The next stage of development is where the ALM unit is responsible for minimizing the cost of funding. This would allow the unit to maintain an element of exposure to interest rate risk, depending on the view that was held as to the future level of interest rates. As we noted above, the core banking activity generates either an excess or shortage of funds. To hedge away all the excess or shortage, while removing interest rate exposure, has an opportunity cost associated with it since it eliminates any potential gain that might arise from movements in market rates. Of course, without a complete hedge, there is exposure to interest rate risk. The ALM desk is responsible for monitoring and managing this risk and, of course, is credited with any cost savings in the cost of funds that arise from exposure. Savings may be measured as the difference between the funding costs of a full hedging policy and the actual policy that the ALM desk adopts. Under this policy, interest rate risk limits are set which the ALM desk ensures the bank's operations do not breach.

The final stage of development is to turn the ALM unit into a profit centre, with responsibility for optimizing the funding policy within specified limits. The limits may be set as gap limits, *value-at-risk* limits or by another measure – such as the level of earnings volatility. Under this scenario the ALM desk is responsible for managing all financial risk.

The final development of the ALM function has resulted in it taking on a more active role. The previous paragraphs described the three stages of development that ALM has undergone, although all three versions are part of the 'traditional' approach. Practitioners are now beginning to think of ALM as extending beyond the risk management field and being responsible for adding value to the net worth of the bank, through proactive positioning of the book and, hence, the balance sheet. That is, in addition to the traditional function of managing liquidity risk and interest rate risk, ALM should be concerned with managing the regulatory capital of the bank and with actively positioning the balance sheet to maximize profit. The latest developments mean that there are now financial institutions that run a much more sophisticated ALM operation than that associated with a traditional banking book.

Let us review the traditional and developed elements of an ALM function.

Traditional ALM

Generally, in the past a bank's ALM function has been concerned with managing the risk associated with the banking book. This does not mean that this function is now obsolete, rather that additional functions have now been added to the ALM role. There are a large number of financial institutions that adopt the traditional approach; indeed, the nature of their operations would not lend themselves to anything more. We can summarize the role of the traditional ALM desk as follows:

- *Interest rate risk management*. This is the interest rate risk arising from operation of the banking book. It includes net interest income sensitivity analysis – typified by maturity gap and duration gap analysis – and sensitivity of the book to parallel changes in the yield curve. The ALM desk will monitor the exposure and position the book in accordance with its limits as well as its market view. Smaller banks, or subsidiaries of banks that are based overseas, often run no interest rate risk – that is, there is no short gap in their book. Apart from this, the ALM desk is responsible for hedging interest rate risk or positioning the book in accordance with its view.
- *Liquidity and funding management*. There are regulatory requirements that dictate the proportion of banking assets that must be held as short-term instruments. The liquidity book in a bank is responsible for running the portfolio of short-term instruments. The exact makeup of the book is, however, the

responsibility of the ALM desk and will be a function of the desk's view of market interest rates, as well as its opinion on the relative value of one asset over another. For example, it may decide to move some assets into short-dated government bonds, in excess of what it normally holds, at the expense of high-quality CDs, or vice versa.

- *Reporting on hedging of risks*. The ALM fulfils a senior management information function by regularly reporting on the extent of the bank's risk exposure. This may be in the form of a weekly hardcopy report or via some other medium.
- *Setting up risk limits*. The ALM unit will set limits, implement them and enforce them, although it is common for an independent 'middle office' risk function to monitor compliance with limits.
- *Capital requirement reporting*. This function involves the compilation of reports on capital usage and position limits as a percentage of capital allowed, as well as reporting to regulatory authorities.

All financial institutions carry out these activities.

Example 6.1 Gap analysis

Maturity gap analysis measures the cash difference or *gap* between the absolute values of assets and liabilities that are sensitive to movements in interest rates. Therefore, the analysis measures the relative interest rate sensitivities of assets and liabilities, and thus determines the risk profile of the bank with respect to changes in rates. The *gap ratio* is given as:

$$\text{Gap ratio} = \frac{\text{Interest} - \text{Rate-sensitive assets}}{\text{Interest} - \text{Rate-sensitive liabilities}} \tag{6.1}$$

It measures whether there are more interest-rate-sensitive assets than liabilities. A gap ratio higher than 1, for example, indicates that a rise in interest rates will increase the net present value of the book, thus raising the return on assets at a rate higher than the rise in the cost of funding. This also results in a higher income spread.

A gap ratio lower than 1 indicates a rising funding cost. *Duration gap* analysis measures impact on the net worth of the bank due to changes in interest rates by focusing on changes in the market value of either assets or liabilities. This is because the duration gap measures the percentage change in the market value of a single security for a 1% change in the underlying yield of the security (strictly speaking, this is *modified duration* but the term for the original 'duration' is now almost universally used to refer to modified duration). The duration gap is defined as:

$$\text{Duration gap} = \text{Duration of assets} - w(\text{Duration of liabilities}) \quad (6.2)$$

where w is the percentage of assets funded by liabilities. Hence, the duration gap measures the effects of change on the net worth of the bank. A higher duration gap indicates higher interest rate exposure. As the duration gap only measures the effects of a linear change in interest rate – that is, a parallel shift in yield curve change – banks with portfolios that include a significant amount of instruments with elements of optionality (such as callable bonds, asset-backed securities and convertibles) also use the *convexity* measure of risk exposure to adjust for inaccuracies that arise in the duration gap over large yield changes.

DEVELOPMENTS IN ALM

An increasing number of financial institutions have been enhancing their risk management function by adding to the responsibilities of the ALM function. These have included enhancing the role of the head of Treasury and the ALCO – by using such other risk exposure measures as option-adjusted spread and value-at-risk (VaR) – and integrating traditional interest rate risk management with credit risk and operational risk. The increasing use of credit derivatives has facilitated this integrated approach to risk management.

Additional roles played by the ALM desk may include

- using the VaR tool to assess risk exposure;
- integrating market risk and credit risk;
- using new *risk-adjusted* measures of return;
- optimizing portfolio return;
- proactively managing the balance sheet – this includes giving direction on the securitization of assets (removing them from the balance sheet), hedging credit exposure using credit derivatives and actively enhancing returns from the liquidity book, such as entering into stock lending and repo.

An enhanced ALM function will by definition expand the role of the Treasury function and the ALCO. This may see the Treasury function becoming active 'portfolio managers' of the bank's book. The ALCO – traditionally composed of risk managers from across the bank as well as the senior member of the ALM desk or liquidity desk – is responsible for assisting the head of Treasury and the finance director in the risk management process. In order to fulfil the new enhanced function the treasurer will require a more strategic approach to his function, as many of the decisions about running the bank's entire portfolio will be closely connected with the overall direction that the bank wishes to take – these are board-level decisions.

LIQUIDITY AND INTEREST RATE RISK

The liquidity gap

Liquidity risk arises because a bank's portfolio consists of assets and liabilities with different sizes and maturities. When assets exceed the resources from operations, a funding gap will exist which needs to be sourced in the wholesale market. When the opposite occurs, excess resources must be invested in the market. The difference between assets and liabilities is called the *liquidity gap*. For example, if a bank has long-term commitments that have arisen from its dealings – and its resources are exceeded by these commitments and have a shorter maturity – there is both an immediate and a future deficit. The liquidity risk for the bank is that there are not enough resources or funds available in the market to balance the assets at any time.

Liquidity management has several objectives; possibly the most important is to ensure that deficits can be funded under all foreseen circumstances and without incurring prohibitive costs. In addition, there are regulatory requirements that force a bank to operate certain limits; these requirements state that short-term assets must be in excess of short-run liabilities in order to provide a safety net of highly liquid assets. Liquidity management is also concerned with funding deficits and investing surpluses, with managing and growing the balance sheet and with ensuring that the bank operates within regulatory and in-house limits. In this section we review the main issues concerned with liquidity and interest rate risk.

The liquidity gap is the difference at all future dates between the assets and liabilities of the banking portfolio. Gaps generate liquidity risk. When liabilities exceed assets, there is an excess of funds. An excess does not of course generate liquidity risk, but it does generate interest rate risk, because the present value of the book is sensitive to changes in market rates. When assets exceed liabilities, there is a funding deficit and the bank has long-term commitments that are not currently funded by existing operations. The liquidity risk is that the bank requires funds at a future date to match the assets. The bank is able to remove any liquidity risk by locking in maturities, but there is of course a cost involved as it will be dealing at longer maturities.[7]

Gap risk and limits

Liquidity gaps are measured by taking the difference between the outstanding balances of assets and liabilities over time. At any point a positive gap between assets and liabilities is equivalent to a deficit, and this is measured as a cash amount. *Marginal gap* is the difference between changes in assets and liabilities over a given period. A positive marginal gap means that variation in the value of assets exceeds variation in the value of liabilities. As new assets and liabilities are added over time – as part of the ordinary course of business – the gap profile changes.

The gap profile is tabulated or charted (or both) during and at the end of each day as a primary measure of risk. For illustrative purposes, a tabulated gap report is shown in Table 6.2; this is an actual example from a UK banking institution. It shows assets and liabilities grouped into maturity buckets and the net position for each bucket. It is a snapshot today of the exposure – and hence funding requirement – of the bank for future maturity periods.

Table 6.2 is very much a summary figure, because the maturity gaps are very wide. For risk management purposes the buckets would be much narrower; for instance, the period between 0 and 12 months might be split into 12 different maturity buckets. An example of a more detailed gap report is shown in Figure 6.2, which is from another UK banking institution. Note that the overall net position is zero, because this is a balance sheet and therefore, not surprisingly, it balances. However, along the maturity buckets or grid points there are net positions which are the gaps that need to be managed. A full gap report is shown at Table 6.3.

[7] This assumes a conventional upward-sloping yield curve.

Table 6.2 Example gap profile

	Time periods					
	Total	**0–6 months**	**6–12 months**	**1–3 years**	**3–7 years**	**7+ years**
Assets	40,533	28,636	3,801	4,563	2,879	654
	6.17%	6.08%	6.12%	6.75%	6.58%	4.47%
Liabilities	40,533	30,733	3,234	3,005	2,048	1,513
	4.31%	4.04%	4.61%	6.29%	6.54%	2.21%
Net cumulative positions	*0*	*(2,097)*	*567*	*1,558*	*831*	*(859)*
	1.86%					
Margin on total assets		2.58%				
Average margin on total assets		2.53%				

Time periods														
Individual	0-1	1-3	3-6	6-12	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+ years
Cumulative	0-6 months				1-3 years		3-7 years				7-10 years			
Current gaps														
Individual	0	0	0	710	-520	771	417	484	104	7	4	2	2	-117
Cumulative	-1,864				251		1,011				9			
Limits														
Individual (+/-)				+/- 1250	-2000	+/-1000	+1000-200	+1000-200	+250-100	+200-75	+/-50	+/-25	+/-25	-125
Cumulative	+500 to -2500				+750 to -1000		2000				+100			
Excess	0				0		0				0			

Figure 6.2 Gap limit report.

Limits on a banking book can be set in terms of gap limits. For example, a bank may set a 6-month gap limit of £10 million. The net position of assets and maturities expiring in 6 months' time would not then exceed £10 million. An example of a gap limit report is shown at Figure 6.2, with actual net gap positions shown against the gap limits for each maturity. Again this is an actual limit report from a UK banking institution.

The maturity gap can be charted to provide an illustration of net exposure. An example is shown in Figure 6.3, which is from yet another UK banking institution. In some firms' reports both

Table 6.3 Detailed gap profile.

	Total (£m)	**Up to 1 month**	**1–3 months**	**3–6 months**	**6 months to 1 year**
Assets					
Cash and interbank loans	2,156.82	1,484.73	219.36	448.90	3.84
Certificates of deposit purchased	1,271.49	58.77	132.99	210.26	776.50
Floating rate notes purchased	936.03	245.62	586.60	12.68	26.13
Bank bills	314.35	104.09	178.36	31.90	0.00
Other loans	13.00	0.00	1.00	0.00	0.00
Debt securities/Gilts	859.45	0.00	25.98	7.58	60.05
Fixed rate mortgages	4,180.89	97.72	177.37	143.13	964.98
Variable and capped rate mortgages	14,850.49	14,850.49	0.00	0.00	0.00
Commercial loans	271.77	96.62	96.22	56.52	0.86
Unsecured lending and leasing	3,720.13	272.13	1,105.20	360.03	507.69
Other assets	665.53	357.72	0.00	18.77	5.00
Total cash assets	*29,239.95*	*17.567.91*	*2,523.06*	*1,289.77*	*2,345.05*
Swaps	9,993.28	3,707.34	1,462.32	1,735.59	1,060.61
Forward rate agreements	425.00	0.00	50.00	0.00	220.00
Futures	875.00	0.00	300.00	0.00	175.00
Total	*40,533.24*	*21,275.24*	*4,335.38*	*3,025.36*	*3,800.66*
Liabilities					
Bank deposits	3,993.45	2,553.85	850.45	233.03	329.06
Certificates of deposit issued	1,431.42	375.96	506.76	154.70	309.50
Commercial paper – CP and euro	508.46	271.82	128.42	108.21	0.00
Subordinated debt	275.00	0.00	0.00	0.00	0.00
Eurobonds + Other	2,582.24	768.75	1,231.29	121.94	53.86
Customer deposits	17,267.55	15,493.65	953.60	311.70	340.50
Other liabilities (incl. capital/reserves)	3,181.83	1,336.83	0.00	0.00	741.72
Total cash liabilities	*29,239.96*	*20,800.86*	*3,670.52*	*929.58*	*1,774.64*
Swaps	9,993.28	1,754.70	1,657.59	1,399.75	1,254.24
Forward rate agreements	425.00	0.00	150.00	70.00	55.00
Futures	875.00	0.00	0.00	300.00	150.00
Total	*40,533.24*	*22,555.56*	*5,478.11*	*2,699.33*	*3,233.89*
Net positions	**0.00**	**−1,351.09**	**−1,234.54**	**265.58**	**583.48**

1–2 years	**2–3 years**	**3–4 years**	**4–5 years**	**5–6 years**	**6–7 years**	**7–8 years**	**8–9 years**	**9–10 years**	**10+ years**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.48	0.00	0.00	19.52	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
439.06	199.48	26.81	100.50	0.00	0.00	0.00	0.00	0.00	0.00
1,452.91	181.86	661.36	450.42	22.78	4.30	3.65	3.10	2.63	14.67
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.16	1.12	3.64	8.85	1.06	0.16	0.17	0.16	4.23	0.00
694.86	400.84	195.19	79.98	25.45	14.06	10.03	10.44	10.82	33.42
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,734.43	*783.31*	*888.00*	*659.26*	*49.28*	*20.53*	*15.85*	*13.71*	*17.68*	*332.12*
344.00	146.50	537.60	649.00	70.00	5.32	200.00	75.00	0.00	0.00
5.00	150.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
400.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3,483.43	*1,079.81*	*1,425.60*	*1,308.26*	*119.28*	*25.84*	*215.85*	*88.71*	*17.68*	*332.12*
21.07	1.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
60.00	20.0	3.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	200.00	75.00	0.00	0.00
9.77	13.16	150.43	150.43	0.00	7.51	0.00	0.00	0.00	75.00
129.10	6.60	24.90	0.00	7.50	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,103.28
219.93	*40.76*	*178.83*	*156.53*	*7.50*	*7.51*	*200.00*	*75.00*	*0.00*	*1,178.28*
1,887.97	281.44	905.06	770.52	15.76	6.48	7.27	8.13	13.06	31.30
150.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
425.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,682.90	*322.20*	*1,083.90*	*927.05*	*23.26*	*13.99*	*207.27*	*83.13*	*13.06*	*1,209.58*
929.10	**803.46**	**341.70**	**404.88**	**104.28**	**11.85**	**8.58**	**5.57**	**4.62**	**−877.45**

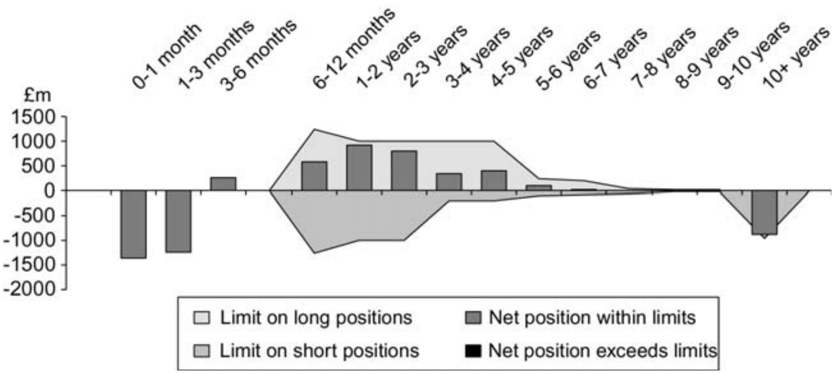


Figure 6.3 Gap maturity profile in graphical form.

assets and liabilities are shown for each maturity point, but in our example only the net position is shown. This net position is the gap exposure for that maturity point. A second example, used by the overseas subsidiary of a middle eastern commercial bank, which has no funding lines in the interbank market and so does not run short positions, is shown at Figure 6.4, while the gap report for a UK high-street bank is shown in Figure 6.5. Note the large short gap under the maturity labelled 'non-int'; this stands for *non-interest-bearing liabilities* and represents the balance of current accounts (cheque or 'checking' accounts) which are funds that attract no interest and are in theory very short-dated (because they are demand deposits and may be called at instant notice).

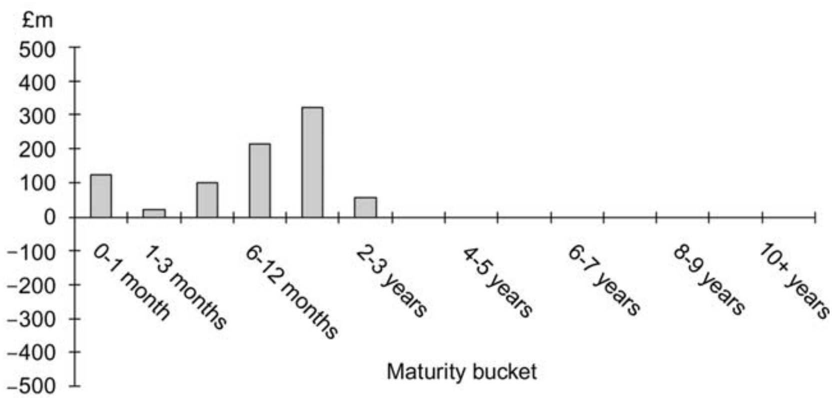


Figure 6.4 Gap maturity profile of a bank where short funding is not allowed.

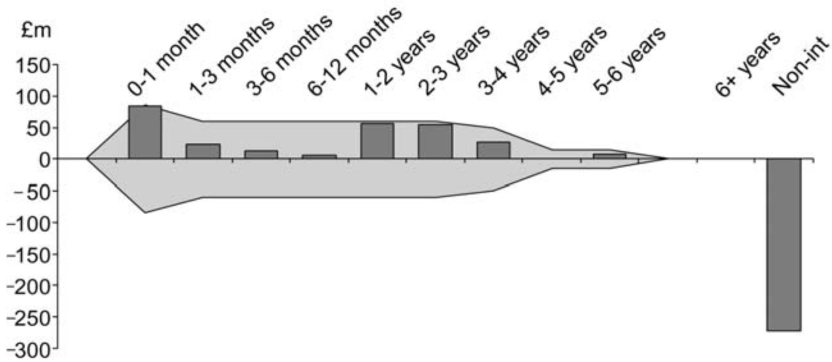


Figure 6.5 Gap maturity profile of a UK high-street bank.

Gaps represent the cumulative funding required at all dates. Cumulative funding is not necessarily identical to the new funding required at each period, because the debt issued in previous periods is not necessarily amortized at subsequent periods. The new funding between, for example, Months 3 and 4 is not the accumulated deficit between Months 2 and 4 because the debt contracted at Month 3 is not necessarily amortized at Month 4. Marginal gaps may be identified as the new funding required or the new excess funds of the period that should be invested in the market. Note that all the reports are snapshots at a fixed point in time and the picture is, of course, continuously moving. In practice, the liquidity position of a bank cannot be characterized by one gap at any given date; the entire gap profile must be used to gauge the extent of the book's profile.

The liquidity book may decide to match its assets with its liabilities. This is known as *cash matching* and occurs when the time profiles of assets and liabilities are identical. By following such a course the bank can lock in the spread between its funding rate and the rate at which it lends cash, and run a guaranteed profit. Under cash matching the liquidity gaps will be zero. Matching the profile of both legs of the book is done at the overall level; that is, cash matching does not mean that deposits should always match loans. This would be difficult as both result from customer demand, although an individual purchase of, say, a CD can be matched with an identical loan. Nevertheless, the bank can elect to match assets and liabilities once the net position is known, and keep the book matched at all times. However, it is highly unusual for a bank to adopt a cash-matching strategy.

Liquidity management

The continuous process of raising new funds or investing surplus funds is known as liquidity management. If we consider that the gap today is funded – thus balancing assets and liabilities and squaring off the book – the next day a new deficit or surplus is generated which also has to be funded. The liquidity management decision must cover the amount required to bridge the gap that exists the following day and to position the book across future dates in line with the bank's view on interest rates. Usually, in order to ascertain the maturity structure of debt a target profile of resources is defined. This may be done in several ways. If the objective of ALM is to replicate the asset profile with resources, the new funding should contribute to bringing the resources profile closer to that of the assets; that is, more of a matched book looking forward. This is the lowest risk option. Another target profile may be imposed on the bank by liquidity constraints. This may arise if, for example, the bank has a limit on borrowing lines in the market such that it could not raise a certain amount each week or month. For instance, if the maximum that could be raised in one week by a bank is £10 million, the maximum period liquidity gap is constrained by that limit. The ALM desk will manage the book in line with the target profile that has been adopted, which requires it to try to reach the required profile over a given time horizon.

Managing the liquidity of the banking book is a dynamic process, as loans and deposits are known at any given point, but new business will be taking place continuously and the profile of the book looking forward must be constantly rebalanced to keep it within the target profile. There are several factors that influence this dynamic process, the most important of which are reviewed below.

Demand deposits

Deposits placed on demand at the bank – such as current accounts (known in the US as 'checking accounts') – have no stated maturity and are available on demand at the bank. Technically, they are referred to as 'non-interest-bearing liabilities' because the bank pays no or very low rates of interest on them, so they are effectively free funds. The balance of these funds can increase or decrease throughout the day without any warning, although in practice the balance is quite stable. There are a number of ways that a bank can choose to deal with these balances:

- By grouping all outstanding balances into one maturity bucket at a future date chosen to be the preferred time horizon of the bank, or a date beyond this. This would then exclude them from the gap profile. Although this is considered unrealistic because it excludes current account balances from the gap profile, it is nevertheless a fairly common approach.
- By relying on an assumed rate of amortization for the balances – say, 5% or 10% each year.
- By dividing deposits into stable and unstable balances, the core deposits of which are set as a permanent balance. The amount of the core balance is set by the bank based on a study of the total balance volatility pattern over time. The excess over the core balance is then viewed as very short-term debt. This method is reasonably close to reality as it is based on historical observations.
- By making projections based on observable variables that are correlated with the outstanding balances of deposits. For instance, such variables could be based on the level of economic growth plus an error factor based on short-term fluctuations in the growth pattern.

Preset contingencies

A bank will have committed lines of credit, the utilization of which will depend on customer demand. Contingencies generate outflows of funds that are by definition uncertain, as they are contingent upon some event – for example, the willingness of the borrower to use a committed line of credit. The usual way for a bank to deal with these unforeseen fluctuations is to use statistical data based on past observations to project a future level of activity.

Prepayment options of existing assets

Where the maturity schedule is stated in terms of a loan, it may still be subject to uncertainty because of prepayment options. This is similar to the prepayment risk associated with a mortgage-backed bond. An element of prepayment risk renders the actual maturity profile of a loan book as uncertain; banks often calculate an 'effective maturity schedule' based on prepayment statistics instead of the theoretical schedule. There are also a range of prepayment models that may be used, the simplest of which use constant prepayment ratios to assess the average life of the portfolio. More sophisticated models incorporate more parameters, like basing the prepayment

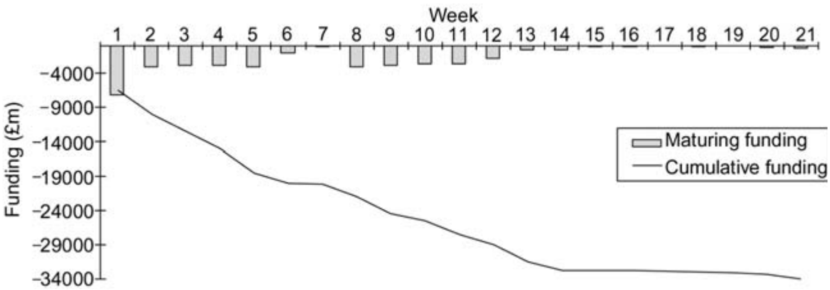


Figure 6.6 Liquidity analysis for a UK retail bank.

rate on the interest rate differential between the loan rate and the current market rate or on the time elapsed since the loan was taken out.

Interest cashflows

Assets and liabilities generate interest cash inflows and outflows, in addition to amortization of principal. Interest payments must be included in the gap profile as well.

Interest rate gap

The interest rate gap is the standard measure of the exposure of the banking book to interest rate risk. The interest rate gap for a given period is defined as the difference between fixed rate assets and fixed rate liabilities. It can also be calculated as the difference between interest-rate-sensitive assets and interest rate liabilities. Both differences are identical in value when total assets equal total liabilities, but will differ when the balance sheet is not balanced. This only occurs intra-day when, for example, a short position has yet to be funded. The general market practice is to calculate the interest rate gap as the difference between assets and liabilities. The gap is defined in terms of the maturity period that has been specified for it.

The convention used to calculate gaps is important for their interpretation. A 'fixed rate' gap is the opposite of a 'variable rate' gap when assets and liabilities are equal. They differ when assets and liabilities do not match and there are many reference rates. When there is a deficit, a 'fixed rate gap' is consistent with the assumption that it will be funded through liabilities whose rate is unknown. This funding is then a variable rate liability and is the bank's risk, unless the rate has been locked in beforehand. The same assumption applies when the bank runs a cash surplus position and the interest rate for any period in the future is unknown. The gap position at a given time bucket is sensitive to the interest rate that applies to that period.

The gap is calculated for each discrete time bucket, so there is a net exposure for, say, 0–1 month, 1–3 months and so on. Loans and deposits do not – except at the time they are undertaken – have such precise maturities, so they are 'mapped' to a time bucket in terms of their relative weighting. For example, a £100 million deposit that matures in 20 days' time will have most of its balance mapped to the 3-week time bucket, but a smaller amount will also be allocated to the 2-week bucket. Interest rate risk is measured as the change in present value of the deposit at each grid point given a 1 bp change in the interest rate. So, a £10 million 1-month CD that was bought at 6.50% will have its present value move upwards if on the next day the 1-month rate moves down by 1 bp.

The net change in present value for a 1 bp move is the key measure of interest rate risk for a banking book; this is what is usually referred to as a 'gap report', although strictly speaking it is not. Such a report is called a PVBP (present value of a basis point) report or a DV01 (dollar value of a 01, or 1 bp) report. The calculation of interest rate sensitivity assumes a *parallel shift* in the yield curve – that is, that every maturity point along the term structure moves by the same amount (here 1 bp) and in the same direction. An example of a PVBP report is given in Table 6.4, split by different currency books, but with all values converted to sterling.

The basic concept of a gap report is the net present value (NPV) of the banking book (introduced in Chapter 2). A PVBP report measures the difference between the market values of assets and liabilities in the banking book. To calculate NPV we require a discount rate which represents the *mark to market* of the book. The rates used are always zero-coupon rates derived from the government bond yield curve, although some adjustment should be made to allow for individual instruments.

Gaps may be calculated as differences between outstanding balances at a given date, or as differences in the variation of those balances over a time period. The gap number calculated from such variation is known as a *margin gap*. Cumulative margin gaps over a period of time – plus the initial difference in assets and liabilities at the

Table 6.4 Banking book PVBP grid report

	1 day	1 week	1 month	2 months	3 months	6 months	12 months	2 years
GBP	8,395	6,431	9,927	8,856	(20,897)	(115,303)	(11,500)	(237,658)
USD	1,796	(903)	10,502	12,941	16,784	17,308	(13,998)	(18,768)
Euro	1,026	1,450	5,105	2,877	(24,433)	(24,864)	(17,980)	(9,675)
Total	*11,217*	*6,978*	*25,534*	*24,674*	*(28,546)*	*(122,859)*	*(43,478)*	*(266,101)*

	3 years	4 years	5 years	7 years	10 years	15 years	20 years	30 years
GBP	(349,876)	(349,654)	5,398	(5,015)	(25,334)	(1,765)	(31,243)	(50,980)
USD	(66,543)	(9,876)	(1,966)	237	2,320	(5,676)	(1,121)	0
Euro	(11,208)	(3,076)	1,365	1,122	3,354	(545)	(440)	(52)
Total	*(427,627)*	*(362,606)*	*4,797*	*(3,656)*	*(19,660)*	*(7,986)*	*(32,804)*	*(51,032)*
GBP total		(1,160,218)						
USD total		(56,963)						
Euro total		(75,974)						
Grand total		**(1,293,155)**						

All figures are in pounds sterling.

beginning of the period – are identical to gaps between assets and liabilities at the end of the period.

The interest rate gap differs from the liquidity gap in a number of ways:

- only those assets and liabilities that have a fixed rate are used for the interest rate gap, whereas the liquidity gap accounts for all assets and liabilities;
- an interest rate gap cannot be calculated unless a period has been defined, because of the fixed-rate/variable-rate distinction – the interest rate gap is dependent on a maturity period and an original date.

The primary purpose in compiling the gap report is to determine the sensitivity of the interest margin to changes in interest rates.

Measurement of the gap is always 'behind the curve' as it is an historical snapshot; the actual gap is a dynamic value as the banking book continuously undertakes day-to-day business.

Portfolio-modified duration gap

Modified duration measures the change in market price of a financial instrument that results from a given change in market interest rates. The duration gap of a net portfolio value is a measure of the interest rate sensitivity of a portfolio of financial instruments and is the difference between the weighted average duration of assets and liabilities, adjusted for the net duration of any off-balance-sheet instruments. Hence, it measures the percentage change in net portfolio value that is expected to occur if interest rates change by 1%.

Net portfolio value, given by the NPV of the book, is the market value of assets A minus the market value of liabilities L, plus or minus the market value OBS of off-balance-sheet instruments, shown as:

$$\text{NPV} = A - L \pm \text{OBS} \tag{6.3}$$

To calculate the duration gap of NPV, we obtain the modified duration of each instrument in the portfolio and weight this by the ratio of its market value to the net value of the portfolio. This is done for assets, liabilities and off-balance-sheet instruments. The modified duration of the portfolio is:

$$\text{MD}_{\text{NPV}} = \text{MD}_A - \text{MD}_L \pm \text{MD}_{\text{OBS}} \tag{6.4}$$

The modified duration of NPV may be used to estimate expected change in the market value of the portfolio for a given change in interest rates:

$$\Delta\text{NPV} = \text{NPV}' - \text{MD}'_{\text{NPV}}\Delta r \tag{6.5}$$

It is often problematic to obtain an accurate value for the market value of every instrument in a banking book. In practice, book values are often used to calculate the duration gap when market values are not available. This may result in inaccurate results when actual market values differ from book values by a material amount.

Other points to note about duration gap analysis are

- The analysis uses modified duration to calculate the change in NPV and therefore provides an accurate estimate of the price sensitivity of instruments for only small changes in interest rates. For a change in rates of more than, say, 50 basis points the sensitivity measure given by modified duration will be significantly incorrect.

- Duration gap analysis, like the maturity gap model, assumes that interest rates change by means of parallel shift, which is clearly unrealistic.

As with maturity gap analysis, the duration gap is favoured in ALM application because it is easily understood and summarizes a banking book's interest rate exposure in one convenient number.

CRITIQUE OF THE TRADITIONAL APPROACH

Traditionally, the main approach of ALM concentrates on the interest sensitivity and net present value sensitivity of a bank's loan/deposit book. The usual interest sensitivity report is the maturity gap report, which we reviewed briefly earlier. However, the maturity gap report is not perfect and can be said to have the following drawbacks:

- The repricing intervals chosen for gap analysis are ultimately arbitrary, and there may be significant mismatches within a repricing interval. For instance, a common repricing interval is the 1-year gap and the 1-to-3-year gap; there are (albeit extreme) circumstances when mismatches would go undetected by the model. Consider a banking book that is composed solely of liabilities that reprice in 1 month's time, and an equal cash value of assets that reprice in 11 months' time. The 1-year gap of the book (assuming no other positions) would be zero, implying no risk to net interest income. In fact, under our scenario net interest income is significantly at risk from a rise in interest rates.
- Maturity gap models assume that interest rates change by a uniform magnitude and direction. However, for any given change in the general level of interest rates it is more realistic for different maturity interest rates to change by different amounts – this is known as non-parallel shift.
- Maturity gap models assume that principal cashflows do not change when interest rates change. Therefore, it is not possible to incorporate the impact of options embedded in certain financial instruments effectively. Instruments such as mortgage-

backed bonds and convertibles do not fall accurately into gap analysis, as only their first-order risk exposure is captured.

Notwithstanding these drawbacks, the gap model is widely used, as it is easily understood in the commercial banking and mortgage industry; moreover, its application does not require a knowledge of sophisticated financial modelling techniques.

The cost of funding

Banks can choose to set up their Treasury function as either a cost centre or a profit centre. Most of the discussion up to now has assumed a profit centre arrangement, with the Treasury desk responsible for the market-making of money market instruments and for positioning the bank's ALM requirement and trade money markets to profit. Some institutions set the Treasury function up simply to arrange the firm's funding requirement such that it is not expected to generate profit.

In such an arrangement, the question arises as to what the Treasury desk should charge the firm's lines of business for their funds. Consider a broker-dealer firm that operated the following lines of business:

- a corporate bond market-making desk;
- an equity derivatives trading desk;
- an investment portfolio that holds ABS, MBS and CDO securities for the medium term;
- a business that offers structured derivatives products, on a leveraged basis, to clients that wish to invest in a hedge fund of funds.

Each of these lines of business will have a different funding requirement; for example, the market-making desk would expect to have a frequent turnover of its portfolio and so its liquidity profile would be fairly short dated. It could be funded using short-term borrowing – no more than 1 week to 1 month – with much funding on an overnight to 1-week basis. The client business would have a longer dated asset profile, and so should really be funded using a mixture of short-dated, medium-dated and long-dated funds. Assuming a positive-sloping yield curve, the term structure effect means that the client business would have a higher cost of funds. However, the Treasury desk would not fund each desk separately – it could, but that would be inefficient and wasteful of resources. So, what charge should be made to the desks for their funds?

In practice, banks use either a weighted average cost of funds – sometimes called a 'blended' or 'pooled' rate – which is passed on to the whole firm, or they apply a form of internal funds pricing – sometimes called 'transfer pricing' or 'transfer liquidity pricing' (TLP) – in which a spread is added to the Libor-based funding cost, determined by the extent of liquidity stress put onto the bank's balance sheet by the individual business line. This is discussed further in Chapter 8.

The cost of borrowing

There are two approaches to ascertaining the transfer price for loans. The first approach refers to existing assets and liabilities, and charges a cost for each loan as a proportion of the total. The second, and more common approach, is to define an optimum funding solution and use this as the cost of funds. In practice, this will be the blended rate.

Using existing resources has the appeal of simplicity. However, it raises the problems we encountered at the start of this section; each type of resource has a different cost. We could define a maturity term for all assets and match each term loan to assets of identical maturity. But this is not effective in practice. For instance, if an asset can be identified that has a precise maturity profile, then one can fund it to matching dates either with one loan or a set of loans that all roll off in sequence until the final maturity date. To do this for every asset would be impractical, however.

Hence, a 'weighted average cost of capital' (WACC) is used.

The blended cost of funds

For fixed rate loans the cost of funds is explicit, but when more than one loan is taken out the funding cost will depend on the combination of amounts borrowed and their respective maturity dates. For instance, consider a funding arrangement for USD100 that is comprised of:

- USD40 borrowed for 2 years;
- USD60 borrowed for 1 year.

The relevant interest rates are the zero-coupon interest rates for 1-year and 2-year loans. The transfer price to use for overall funding of 100 in the first 12 months is the average cost of the funds of these two loans. It is in fact given by the discount rate that would equate the present value of the future values of each loan to the original amount borrowed. The future value is of course the maturity amount, which is the original principal plus interest. To be strictly accurate, we assume that the loans are zero-coupon loans and the interest rates charged are zero-coupon interest rates.

Future cashflows on the above arrangement are:

- $60(1 + r_1)$ in Year 1, and
- $40(1 + r_2)^2$ in Year 1 and Year 2.

So, WACC is given by the rate rw such that

$$100 = 60(1 + r_1)/(1 + rw) + 40(1 + r_2)^2/(1 + rw)^2$$

This discount rate will obviously lie somewhere between r_1 and r_2. A 'back of the envelope' solution could be done by calculating the linear approximation of the above formula, namely

$$100 = 60(1 + r_1 - rw) + 40(1 + 2r_2 - 2rw)$$
$$rw = (60 \times r_1 + 40 \times 2 \times r_2)/(60 + 2 \times 40)$$

The rate rw is the weighted average of the two rates r_1 and r_2, which we took to be the 1-year and 2-year zero-coupon rates, respectively. The weighting used refers to the size of the loan in proportion to the total and its maturity. As a rough rule of thumb, a 1-year rate rolled over in a 2-year period would be weighed at twice the 2-year rate. If we imagine that r_1 is 4.00% and r_2 is 5.00%, then rw in this case will be nearer to r_2, because it is the longest dated loan, but the fact that the 1-year loan in our example was for a larger sum compensates for this.

In practice, even very large commercial banks and investment banks calculate their WACC as the sum of daily interest payments on every loan outstanding divided by the total nominal amount of all loans.

We illustrate the concept of WACC in a practical fashion in Figure 6.7. This shows a USD500 million funding requirement that has been arranged as three loans, namely,

- overnight loan of USD200 million at 1.05%;
- 1-week loan of USD200 million at 1.07%;
- 3-month loan of USD100 million at 1.15%.

The spreadsheet shows the calculation of WACC on a more scientific basis than the 'back of the envelope' approach, as it takes into account the term structure effect of the loans (as we go

WACC calculation

					0.002777778	0.01944444
					Amount of Interest (accrued)	
					1	7
					o/n	1wk
Term (days)			Interest rate % pa (Libor fix)		Amount of Interest	
1	o/n	200,000,000		1.05%	5,833.33	-
7	1wk	200,000,000		1.07%	5,944.44	41,611.11
90	3mth	100,000,000		1.15%	3,194.44	22,361.11
		500,000,000			1.078%	1.097%
					14,972.22	63,972.22
			Period		1	6
					0.0030%	0.0183%
			Overall cost of funds - WAC measure		1.146%	
			Total interest		1,432,055.56	

SAME CALCULATION - as above - but using the effective cost of funds

					0.002777778	0.01944444
					Amount of Interest (accrued)	
					1	7
					o/n	1wk
Term (days)			WAC rate		Amount of Interest	
1	o/n	200,000,000		1.1456%	6,364.69	-
7	1wk	200,000,000		1.1456%	6,364.69	44,552.84
90	3mth	100,000,000		1.1456%	3,182.35	22,276.42
		500,000,000			1.146%	1.146%
					15,911.73	66,829.26
			Period		1	6
					0.0032%	0.0191%
			Overall cost of funds		1.146%	
					1,432,055.56	

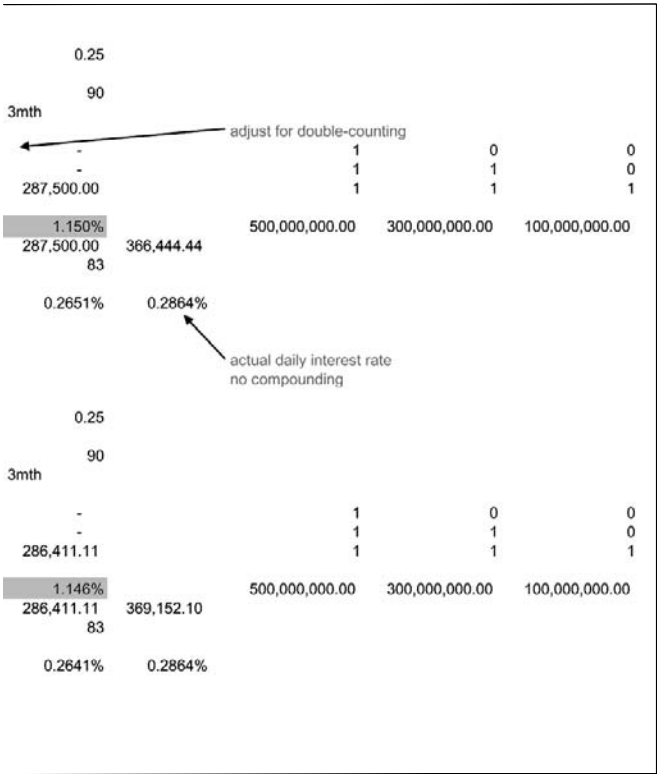
Figure 6.7 USD500 million funding requirement that has been arranged as three loans.

further out along the term structure, we pay a higher rate of interest). However, the result is very close to the simple approach. The WACC for these three loans is shown to be 1.146%.

We repeat the spreadsheet at Figure 6.8 with the formulae used in each cell shown instead of the value.

SECURITIZATION

It is common for the ALM units in banks to take responsibility for a more proactive balance sheet management role; *securitization* is a good example of this. Securitization is a process undertaken by banks to both realize additional value from assets held on the balance sheet and to remove them from the balance sheet entirely, thus freeing up



lending lines. Essentially, it involves selling assets on the balance sheet to third-party investors. In principle, the process is straightforward, as assets that are sold generate cashflows in the future, which provides return to investors who have purchased the securitized assets. To control risk exposure for investors, the uncertainty associated with certain asset cashflows is controlled or re-engineered – there are a range of ways in which this may be done.

For balance sheet management one of the principal benefits of securitisation is to save or reduce capital charges by the sale of assets. The other added benefit, of course, is that the process generates additional return for the issuing bank; therefore, securitization is not only a method by which capital charges may be saved, but an instrument in its own right that enables a bank to increase its return on capital.

WACC calculation - Excel formula

Cell ref	B	C	D	E	F	G
3					=F4/360	=G5/360
4					Amount of Interest (accrued)	
5					1	7
6					o/n	1wk
7	Term (days)			Interest rate % pa (Libor fix)	Amount of Interest	
8	1	o/n	200,000,000	1.05%	=$E8*(F$5/360)*$D8 *IF(F$5>$B8,0,1)	=$E8*(G$5/360)*$D8 *IF(G$5>$B8,0,1)
9	7	1wk	200,000,000	1.07%	=$E9*(F$5/360)*$D9 *IF(F$5>$B9,0,1)	=$E9*(G$5/360)*$D9 *IF(G$5>$B9,0,1)
10	90	3mth	100,000,000	1.15%	=$E10*(F$5/360)*$D10 *IF(F$5>$B10.0.1)	=$E10*(G$5/360)*$D10 *IF(G$5>$B10.0.1
11						
12			=SUM(D8:D10)		=(SUM(F$8:F$10)/K12)*360/F$5	=(SUM(G$8:G$10)/L12)*360/G$5
13					=SUM(F8:F10)	=SUM(G8:G10)
14				Period	=F5-E5	=G5-F5
15						
16					=F12*F14/360	=G12*G14/360
17						
18				Overall cost of funds - WAC measure	=I16*360/90	
19						
20				Total interest	=F18*90/360*D12	
21						
22					=F24/360	=G24/360
23					Amount of Interest (accrued)	
24	SAME CALCULATION - as above - but using the effective cost of funds				1	7
25					o/n	1wk
26	Term (days)			WAC rate	Amount of Interest	
27	1	o/n	200,000,000	=$F$18	=$E27*(F$5/360)*$D27 *IF(F$5>$B27.0.1)	=$E27*(G$5/360)*$D27 *IF(G$5>$B27.0.1
28	7	1wk	200,000,000	=$F$18	=$E28*(F$5/360)*$D28 *IF(F$5>$B28.0.1)	=$E28*(G$5/360)*$D28 *IF(G$5>$B28.0.1
29	90	3mth	100,000,000	=$F$18	=$E29*(F$5/360)*$D29 *IF(F$5>$B29.0.1)	=$E29*(G$5/360)*$D29 *IF(G$5>$B29.0.1
30						
31			500,000,000		=(SUM(F27:F29)/K31)*360/F$5	=(SUM(G27:G29)/L31)*360/G$5
32					=SUM(F27:F29)	=SUM(G27:G29)
33				Period	=F24-E24	=G24-F24
34						
35					=F31*F33/360	=G31*G33/360
36						
37				Overall cost of funds	=I35*360/90	
38						
39					=F37*90/360*D31	

Figure 6.8 Formulae used to calculate the USD500 million funding requirement that has been arranged as three loans.

The securitization process

For an introduction to asset-backed instruments see Fabozzi and Choudhry (2004). In this section we consider the implications of securitization from the point of view of asset and liability management. The subject is considered in greater detail in Choudhry (2007).

The basic principle of securitization is to sell assets to investors – usually through a medium known as a *special purpose vehicle* or some other intermediate structure – and to provide investors with a fixed or floating rate return on the assets they have purchased; the cashflows from the original assets are used to provide this return. It is rare, though not totally unknown, for investors to buy the assets directly; to avoid this, a class of securities is created to represent the

H	I	J	K	L	M
=H5/360					
90					
3mth					
			adjust for double-counting		
=$E8*(H$5/360)*$D8 *IF(H$5>$B8,0,1)			=IF(F8<>0,1,0)	=IF(G8<>0,1,0)	1
=$E9*(H$5/360)*$D9 *IF(H$5>$B9,0,1)			=IF(F9<>0,1,0)	=IF(G9<>0,1,0)	1
=$E10*(H$5/360)*$D10 *IF(H$5>$B10,0,1)			=IF(F10<>0,1,0)	=IF(G10<>0,1,0)	1
=(SUM(H$8:H$10)/M12)*360/H$5			=SUMPRODUCT(K8:K10,$D$8:$D$10)	=SUMPRODUCT(L8:L10,$D$8:$D$10)	=SUMPRODUCT(M8:M10,$D$8:$D$10)
=SUM(H8:H10)	=SUM(F13:H13)				
=H5-G5					
=H12*H14/360	=SUM(F16:H16)				
			actual daily interest rate no compounding		
=H24/360					
90					
3mth					
=$E27*(H$5/360)*$D27 *IF(H$5>$B27,0,1)			1	1	1
=$E28*(H$5/360)*$D28 *IF(H$5>$B28,0,1)			1	1	1
=$E29*(H$5/360)*$D29 *IF(H$5>$B29,0,1)			1	1	1
=(SUM(H27:H29)/M31)*360/H$5			=SUMPRODUCT(K27:K29,$D$8:$D$10)	=SUMPRODUCT(L27:L29.$D$8:$D$10'	=SUMPRODUCT(M27:M29,$D$8:$D$10)
=SUM(H27:H29)	=SUM(F32:H32)				
=H24-G24					
=H31*H33/360	=SUM(F35:H35)				

assets and investors then purchase these securities. The most common types of assets securitized include mortgages, car loans and credit card loans. However, in theory, virtually any asset that generates a cashflow that can be predicted or modelled may be securitized. The vehicle used is constructed such that securities issued against the asset base have a risk return profile that is attractive to the investors being targeted.

To benefit from diversification, asset types are usually pooled and this pool then generates a range of interest payments, principal repayments and principal prepayments. The precise nature of cash-flows is unclear not only because of the uncertainty of payment and prepayment patterns, but also because of the occurrence of loan defaults and delays in payment. However, pooling of a large number of loans means that cashflow fluctuation can be ironed out to a large extent, sufficient to issue notes against. The cashflows generated by the pool of assets are re-routed to investors by means of a dedicated structure, and a credit rating for the issue is usually requested from one or more private credit agencies. Most asset-backed securities carry investment-grade credit ratings – often triple A or double A – mainly because of various credit insurance facilities that are set up to guarantee the bonds. The securitization structure disassociates the quality of original cashflows from that of flows accruing to investors. In many cases, original borrowers are not aware that the process has occurred and notice no difference in the way their loan is handled. The credit rating on the securitization issue has no bearing on the rating of the selling bank and often will be different.

Benefits of securitization

Securitizing assets produces a double benefit for the issuing bank. Assets that are sold to investors generate a saving in the cost of required capital for the bank, as they are no longer on the balance sheet, so the bank's capital requirement is reduced. Second, if the credit rating of the issued securities is higher than that of the originating bank, there is a potential gain in the funding costs of the bank. For example, if the securities issued are triple A rated, a double-A-rated bank will have lower funding costs for those securities. The bank benefits from paying a lower rate on the borrowed funds than if it had borrowed those funds directly in the market. This has led to strong growth in, for example, the specialized 'credit card' banks in the US, where banks such as Capital One, First USA and MBNA Bank have benefited from triple-A-rated funding levels and low capital charges. It is doubtful whether such banks could have grown as rapidly as they did without securitization. Although there is a cost associated with securitizing assets – which include direct issue transaction costs and the cost of running the payment structure – these are outweighed by the benefits obtained from the process.

The major benefit of securitization is reduced funding costs. Several factors influence such costs. These include

- Lower cost of funds due to the enhanced credit rating of the bonds issued. The extent of this gain is a function of current spreads in the market and the current rating of the originating bank. It will fluctuate in line with market conditions.

- Saving the capital charges that result from reducing the size of assets on the balance sheet. This decreases the minimum earnings required to ensure adequate return for shareholders, in effect improving return on capital at a stroke.

The costs of the process include

- Costs associated with setting up the issuing structure and, subsequently, the payment mechanism that channels cashflows to investors. These costs are a function of the structure and risk of the original assets; the higher the risk of the original assets, the higher the cost of ensuring cashflows for investors.
- The legal costs of origination, plus operating costs and servicing costs.

However, the reduction in funding cost obtained as a result of securitization should significantly outweigh the cost of the process itself. In order to determine whether securitization is feasible, as well as how it impacts return on capital, the originating bank will conduct a cost-and-benefit analysis prior to embarking on the process. This is frequently the responsibility of the ALM unit.

Example 6.1 Securitization transaction

We illustrate the impact of securitizing the balance sheet by an example from our hypothetical bank – ABC Bank plc.

The bank has a mortgage book of £100 million; the regulatory weight for this asset is 50%. The capital requirement is therefore £4 million – that is, $8\% \times 0.5\% \times$ £100 million. The capital is comprised of equity (estimated to cost 25%) and subordinated debt (which has a cost of 10.2%). The cost of straight debt is 10%. The ALM desk reviews a securitization of 10% of the asset book, or £10 million. The loan book has a fixed duration of 20 years, but its effective duration is estimated at 7 years, due to refinancings and early repayments. Net return from the loan book is 10.2%.

The ALM desk decides on a securitized structure that is made up of two classes of security: subordinated notes and senior notes. Subordinated notes will be granted a single A rating due to their higher risk, while senior notes are rated triple A. Given such ratings the required rate of return for subordinated notes is 10.61% and that of senior notes is 9.80%. Senior notes have a lower costthan current balance sheet debt, which has a cost of 10%. To

Table 6.5 ABC Bank plc mortgage loan book and securitization proposal

Current funding	
Cost of equity	25%
Cost of subordinated debt	10.20%
Cost of debt	10%
Mortgage book	
Net yield	10.20%
Duration	7 years
Balance outstanding	100 million
Proposed structure	
Securitized amount	10 million
Senior securities:	
Cost	9.80%
Weighting	90%
Maturity	10 years
Subordinated notes:	
Cost	10.61%
Weighting	10%
Maturity	10 years
Servicing costs	0.20%

obtain a single A rating, subordinated notes need to represent at least 10% of the securitized amount. The costs associated with the transaction are the initial cost of issue and the yearly servicing cost, estimated at 0.20% of the securitized amount. Summary information is given in Table 6.5.

A bank's cost of funding is the average cost of all funds employed. The funding structure in our example is capital 4% – which is further split up as 2% equity at 25%, 2% subordinated debt at 10.20% and 96% debt at 10%. The weighted funding cost F therefore is:

$$\begin{aligned} F_{\text{balance sheet}} &= 96\% \times 10\% \\ &\quad + ((8\% \times 50\%)(25\% \times 50\%) + (10.20\% \times 50\%)) \\ &= 10.30\% \end{aligned}$$

This average rate is consistent with the 25% before-tax return on equity given at the start. If the assets do not generate this return, the return received will change accordingly, since it is the end result of the bank's profitability. As the assets only generate 10.20%, they are currently performing below shareholder expectations. The return actually obtained by shareholders is such that the average cost of funds is identical to the 10.20% return on assets. We may calculate this return to be:

$$\begin{aligned}\text{Asset return} &= 10.20\% \\ &= (96\% \times 10\%) \\ &\quad + 8\% \times 50\%(\text{ROE} \times 50\% + 10.20\% \times 50\%)\end{aligned}$$

Solving this relationship we obtain a return on equity (ROE) of 19.80%, which is lower than shareholder expectations. In theory, the bank would find it impossible to raise new equity in the market because its performance would not compensate shareholders for the risk they are incurring by holding the bank's paper. Therefore, any asset that is originated by the bank would not only have to be securitized, but also be expected to raise shareholder return.

The ALM desk proceeds with securitization, issuing £9 million in senior securities and £1 million in subordinated notes. The bonds are placed by an investment bank with institutional investors. The outstanding balance of the loan book decreases from £100 million to £90 million. Weighted assets are therefore £45 million. Therefore, the capital requirement for the loan book is now £3.6 million, a reduction from the original capital requirement of £400,000, which can be used for expansion in another area (see Table 6.6).

Table 6.6 Impact of securitization on balance sheet

Outstanding balances	**Value (£m)**	**Capital required (£m)**
Initial loan book	100	4
Securitized amount	10	0.4
Senior securities	9	Sold
Subordinated notes	1	Sold
New loan book	90	3.6
Total asset	*90*	
Total weighted assets	*45*	*3.6*

The benefit of securitization is reduction in the cost of funding. Funding cost as a result of securitization is the weighted cost of senior notes and subordinated notes, together with the annual servicing cost. The cost of senior securities is 9.80%, while subordinated notes have a cost of 10.61% (for simplicity we ignore any differences in the duration and amortization profiles of the two bonds). This is calculated as:

$$(90\% \times 9.80\%) + (10\% \times 10.61\%) + 0.20\% = 10.08\%$$

This overall cost is lower than the target funding cost obtained directly from the balance sheet, which was 10.30%. This is the quantified benefit of the securitization process. Note that the funding cost obtained through securitization is lower than the yield on the loan book. Therefore, the original loan can be sold to the structure issuing the securities for a gain.

Example 6.2 Position management

Starting the day with a flat position, a money market interbank desk transacts the following deals:

1. £100 million borrowing from 16/9/09 to 7/10/09 (3 weeks) at 6.375%.
2. £60 million borrowing from 16/9/09 to 16/10/09 (1 month) at 6.25%.
3. £110 million loan from 16/9/09 to 18/10/09 (32 days) at 6.45%.

The desk reviews its cash position and the implications for refunding and interest rate risk, bearing in mind the following:

- There is an internal overnight rollover limit of £40 million (net).
- The bank's economist feels more pessimistic about a rise in interest rates than most others in the market, and has recently given an internal seminar on the dangers of inflation in the UK as a result of recent increases in the level of average earnings.
- Today, some important figures are being released including inflation (RPI) data. If today's RPI figures exceed market expectations, the dealer expects a tightening of monetary policy by *at least* 0.50% almost immediately.
- Brokers estimate daily market liquidity for the next few weeks to be one of low shortage, with little central bank intervention

required, and hence low volatilities and low rates in the overnight rate.

- Brokers' screens indicate the following term repo rates:

O/N	6.350%–6.300%
1 week	6.390%–6.340%
2 week	6.400%–6.350%
1 month	6.410%–6.375%
2 month	6.500%–6.450%
3 month	6.670%–6.620%.

- The indication for a 1v2 FRA is:

1v2 FRA	6.680%–6.630%.

- The quote for an 11-day forward borrowing in 3 weeks' time (the '21v32 rate') is 6.50% bid.

The book's exposure looks like this:

16 September	7 October	16 October	18 October
Long £50m	Short £50m	Short £110m	Flat

What courses of action are open to the desk, bearing in mind that the book needs to be squared off such that the position is flat each night?

Possible solutions

Investing early surplus

From a cash management point of view, the desk has a £50 million surplus from 16/9 up to 7/10. This needs to be invested. It may be able to negotiate a 6.31% loan with the market for overnight, or a 6.35% term deposit for 1 week or 6.38% for 1 month.

An overnight roll is the most flexible but offers the worst rate. If the desk expects the overnight rate to remain both low and stable (due to forecasts of low market shortages), it may not opt for this course of action.

However, it may make sense from an interest rate risk point of view. If the desk agrees with the bank's economist, it should be able to benefit from rolling at higher rates soon – possibly in the next 3 weeks. Therefore, it may not want to lock in a term rate now, and the overnight roll would match this view. However, it exposes them to lower rates, if their view is wrong, which will limit the extent of the positive funding spread. The market itself appears neutral about rate changes in the next month, but appears to factor in a rise thereafter.

The forward 'gap'

Looking forward, the book is currently on course to exceed the £40 million overnight position limit on 7/10, when the refunding requirement is £50 million. The situation gets worse on 16/10 (for 2 days) when the refunding requirement is £110 million. The desk needs to fix a term deal before those dates to carry it over until 18/10 when the funding position reverts to zero. A borrowing from 7/10 to 18/10 of £50 million will bring the rollover requirement back to within limits.

However, given that interest rates will rise, should the desk wait until the 7th to deal in the cash? Not if it has a firm view. It may end up paying as much as 6.91% or higher for the funding (after the 0.50% rate rise). So, it would be better to transact a forward-starting repo now to cover the period, thus locking in the benefits obtainable from today's yield curve. The market rate for a 21 × 32-day repo is quoted at 6.50%. This reflects the market's consensus that rates may rise in about a month's time. However, the desk's own expectation is of a larger rise – hence, its own logic suggests trading in the forward loan. This strategy will pay dividends if its view is right, as it limits the extent of funding loss.

An alternative means of protecting interest rate risk is to buy a 1v2-month FRA for 6.68%. This does not exactly match the gap, but should act as an effective hedge. If there is a rate rise, the book gains from the FRA profit. Note that the cash position still needs to be squared off. Should the desk deal before or after the inflation announcement? That is, of course, down to its own intuition, but most dealers like to sit tight ahead of releases of key economic data, if at all possible.

Generic ALM policy for different-sized banks

The management of interest rate risk is a fundamental ingredient of commercial banking. Bank shareholders take comfort from interest rate risk being measured and managed satisfactorily. A common approach to risk management involves the following:

- Preparation and adoption of a high-level interest rate risk policy at board level. This sets general guidelines on the type and extent of risk exposure that can be taken on by the bank.
- Setting limits on the risk exposure levels of the banking book. This can be by product type, desk, geographic area and so on, and will be along the maturity spectrum.
- Actively measuring the level of interest rate risk exposure at regular, specified intervals.
- Reporting to senior management on general aspects of risk management, risk exposure levels, limit breaches and so on.
- Monitoring risk management policies and procedures by an independent 'middle office' risk function.

The risk management approach adopted by banks will vary according to their specific markets and appetite for risk. Certain institutions have their activities set out or prescribed for them under regulatory rules. For instance, building societies in the UK are prohibited from trading in certain instruments by the regulator. In this section we present for illustrative purposes the ALM policies of three hypothetical banks: Bank S, Bank M and Bank L. These banks are, respectively, a small banking entity with assets of £500 million, a medium-sized bank with assets of £2.5 billion and a large bank with assets of £10 billion. In the following we demonstrate the differing approaches that can be taken according to the environment that a financial institution operates in.

ALM policy for Bank S (assets = £500 million)

The aim of the ALM policy for Bank S is to provide guidelines on risk appetite, revenue targets and rates of return, in addition to providing a risk management policy. Areas that may be covered include capital ratios, liquidity, asset mix, rate-setting policy for loans and deposits, as well as investment guidelines for the banking portfolio. The key objectives should include

- maintaining capital ratios at the planned minimum and ensuring the safety of the deposit base;
- generating a satisfactory revenue stream, both for income purposes and to further protect the deposit base.

The responsibility for overseeing the operations of the bank to ensure that these objectives are achieved is lodged with the ALCO. This body monitors the volume and mix of the bank's assets and funding (liabilities), and ensures that this asset mix follows internal guidelines with regard to banking liquidity, capital adequacy, asset base growth targets, risk exposure and return on capital. The norm is for the committee to meet on a monthly basis; membership of the committee will include the finance director, the head of Treasury and the risk manager at the very least. For a bank the size of Bank S the ALCO membership will possibly be extended to the chief executive, the head of the loans business and the chief operating officer.

As a matter of course the committee will wish to discuss and review the following on a regular basis:

- Overall macroeconomic conditions.
- Financial results and key management ratios – such as share price analysis and rates of return on capital and equity.
- House view on the likely direction of short-term interest rates.
- Current lending strategy – and any suggestions for changes – and current funding strategy.
- Anticipated changes to the volume and mix of the loan book, and to that of the main sources of funding.
- Appropriateness or otherwise of alternative sources of funding.
- Suggestions for any alterations to the bank's ALM policy.
- Maturity gap profile as well as anticipated and suggested changes to it.

The committee will also wish to consider interest rates currently offered on loans and deposits, and whether they are still appropriate.

Interest rate sensitivity is monitored and confirmed as lying within specified parameters; these parameters are regularly reviewed and adjusted if deemed necessary according to changes in the business cycle and economic conditions. Interest rate sensitivity is measured using the following ratio:

$$A_{\mathrm{ir}}/L_{\mathrm{ir}}$$

Typical risk levels would be expected to lie between 90% and 120% for the maturity period 0–90 days, and between 80% and 110% for the maturity period over 90 days but less than 365 days.

Put simply, the objective of Bank S is to remain within specified risk parameters at all times, and to maintain as consistent a level of earnings as possible (and one that is immune to changes in the business cycle).

ALM policy for Bank M (assets = £2.5 billion)

Bank M is our hypothetical 'medium-sized' banking institution. Its ALM policy would be overseen by the ALCO. Typically, the committee would consist of the following members of senior management:

- deputy chief executive
- finance director
- head of retail banking
- head of corporate banking
- head of Treasury
- head of risk management
- head of internal audit.

Others – such as product specialists – would be called to attend as and when required. The finance director often chairs the meeting.

The primary responsibilities of the ALCO are detailed below.

Objectives

The ALCO is tasked with reviewing the bank's overall funding strategy. Decisions taken are recorded in the minutes and circulated to attendees and designated key staff. ALCO members are responsible for undertaking regular reviews of the following:

- minutes of the previous meeting;
- the ratio of interest-rate-sensitive assets to liabilities, gap reports, risk reports and the funding position;
- the bank's view on the expected level of interest rates and how the book should be positioned in light of this;
- the ALCO view on anticipated funding costs in the short term and medium term – this is closely related to the previous item;
- stress-testing in the form of 'what if?' scenarios, to check the effect on the banking book of specified changes in market conditions;
- change in parameters that may be required if there is a change in market conditions or risk tolerance;
- current interest rates for loans and deposits, to ensure that they are in accordance with the overall lending and funding strategy;
- maturity distribution of the liquidity book (expected to be comprised of T-bills, CDs and very short-dated government bonds);
- current liquidity position and expected position in the short term and medium term.

As the ALCO meets on a regular monthly basis, it is usual for only a few of these aspects to be discussed at every meeting; the agenda is set by the chair of the meeting in consultation with committee members. The policies adopted by the ALCO should be dynamic and flexible, and capable of adaptation to changes in operating conditions. Any changes to policy can only be made by the committee itself and any exceptions to agreed policy can only be made with the approval of the CEO or the ALCO itself.

Interest rate risk policy

The objective will be to keep earnings volatility resulting from an upward or downward move in interest rates to a minimum. To this end, at each ALCO meeting members will review risk and position reports and discuss them in light of the risk policy. Generally, the 6-month and 12-month $A_{\mathrm{ir}}/L_{\mathrm{ir}}$ cumulative ratio will lie in the range 90% to 110%. A significant move outside this range will most likely be subject to corrective action. The committee will also consider the results of various scenario analyses on the book, and if these tests indicate a potential earnings impact of greater than, say, 10%, instructions may be given to alter the shape and maturity profile of the book.

Liquidity policy

A primary responsibility of the ALCO is to ensure that an adequate level of liquidity is maintained at all times. Gup and Brooks (1993, p. 238) define liquidity as

> '. . . the ability to meet anticipated and unanticipated operating cash needs, loan demand, and deposit withdrawals, without incurring a sustained negative impact on profitability.'

Generally, a Bank-M-type operation would expect to have a target level for loans to deposits of around 75% to 85%, and a loans-to-core-deposits ratio of 85% to 95%. The loan/deposit ratio is reported to the ALCO and reviewed on a monthly basis, and any reported figure significantly outside these ranges (say, by 5% or more) will be reviewed and asked to be adjusted to bring it back into line with ALCO policy.

ALM policy for Bank L (assets = £10 billion)

The policy for ALM at a larger entity will build on that described for a medium-sized financial institution. If Bank L is a group company, the policy will cover the consolidated balance sheet as well as individual subsidiary balance sheets; the committee will provide direction on the management of assets and liabilities as well as on the off-balance-sheet instruments used to manage interest rate and credit risk. A well-functioning management process will be proactive and concentrate on direction in response to anticipated changes in operating conditions, rather than reactive responses to changes that have already taken place. Primary objectives will be to maximize shareholder value, with target returns on capital of 15% to 22%.

The responsibility for implementing and overseeing ALM policy will reside with the ALCO. The committee will establish operating guidelines for ALM and review them periodically. It will meet on a more frequent basis than is the case for Bank M – usually fortnightly. In addition to this, it will set policies governing liquidity and funding objectives, investment activities and interest rate risk. It will also oversee the activities of the investment-banking division. The head of the ALM desk will prepare the interest rate risk sensitivity report and present it to the ALCO.

Interest rate risk management

The ALCO will establish an interest rate risk policy that sets the direction for acceptable levels of interest rate risk. This risk policy is designed to help management evaluate the impact of interest rate risk on the bank's earnings. The extent of risk exposure is a function of the maturity profile of the balance sheet, as well as the frequency of repricing, the level of loan prepayments and funding costs. Managing interest rate risk is, in effect, the adjustment of risk exposure upwards or downwards in response to the ALCO's views on the future direction of interest rates. As part of the risk management process the committee will monitor current risk exposure and the duration gap, using rate sensitivity analysis and simulation modelling to assess whether the current level of risk is satisfactory.

Measuring interest rate risk

Notwithstanding the widespread adoption of value-at-risk as the key market risk measurement tool, funding books such as repo books continue to use the gap report as a key measure of interest rate risk exposure. This enables the ALCO to view risk sensitivity along the maturity structure. Cumulative gap positions and the ratio of asset revaluation to liability revaluation are calculated and compared with earnings levels on the current asset/liability position. Generally, the 90-day, 6-month and 1-year gap positions are the most significant points along the term structure at which interest rate risk exposure is calculated. The ratio of gap to earnings assets is set at the ±15% to ±20% level.

As it is a traditional duration-based approach, gap reporting is a static measure for risk sensitivity at one specific point in time. It is for this reason that banks combine a value-at-risk measure as well, or use it exclusively. It is outside the scope of this book to consider VaR – we cite a useful introductory reference at the end of this chapter (Butler, 1998).

Simulation modelling

Simulation modelling is a procedure that measures potential impact on the banking book – and hence earnings levels – of a user-specified change in interest rates and/or a change in the shape of the book itself. This process enables senior management to gauge the risk associated with particular strategies. Put simply the process involves

- Constructing a 'base' balance sheet and income statement as the starting point (this is derived from the current shape of the banking book and any changes expected from current growth trends that have been projected forward).
- Assessing the impact on the balance sheet of changes under selected scenarios: say, no change in rates; a 100 bp and 250 bp upward parallel shift in the yield curve; a 100 bp and 250 bp downward parallel shift; a 25 bp steepening and flattening of the yield curve between the 5-month and the 3-year maturity points; a combination of parallel shift with pivotal shift at a selected point; an increase or decrease in 3-month T-bill yield volatility levels; and a 20 bp change in swap spreads.
- Comparing the difference in earnings resulting from any of the scenarios to the anticipated earnings stream under the current environment.

Generally, the committee sets guidelines about the significance of simulation results; for example, there may be a rule that for a 100 bp change in interest rates the impact on NII should be no more than 10%. If results indicate such an impact, the ALCO will determine whether the current risk strategy is satisfactory or whether adjustments are necessary.

NPV AND VALUE-AT-RISK

The NPV of a banking book is an appropriate target of interest rate policy because it captures all future cashflows and is equal to the discounted value of future margins when the discount rate is the cost of all debt. The sensitivity of NPV is derived from the duration of assets and liabilities. Therefore, we may write the change in NPV as:

$$\frac{\Delta \text{NPV}}{\Delta r} = \left(\frac{1}{(1+r)}\right)(-D_A MV_A + D_L MV_L) \tag{6.6}$$

where D_A is the duration of assets and MV_A is the market value of assets. Equation (6.6) is applicable when only one interest rate is used for reference. Sensitivity with respect to interest rate r is known. It is then possible to derive value-at-risk (VaR) from these simple relationships. With one interest rate we are interested in the maximum variation of NPV that results from a change in the reference interest rate. NPV volatility can be derived from its sensitivity and from interest rate volatility. If we set S_r as the sensitivity of NPV to interest rate r, NPV volatility is given by:

$$\sum(\text{NPV}) = S_r \times \sum(r) \tag{6.7}$$

Once volatility is known, maximum change at a given confidence level is obtained as a multiple of volatility. The multiple is based on assumptions with respect to the shape of the distribution of interest rates. Under a curve with normal distribution, a multiple of 1.96 provides maximum expected change at a 2.5% two-tailed confidence level, so that we are able to say that the VaR of the book is as given by:

$$\text{VaR} = 1.96 \times S_r \times \sum(r) \tag{6.8}$$

Where there is more than one interest rate, variation in NPV can be approximated as a linear combination of variations due to the change in each interest rate. This is written as:

$$\text{NPV} = S_r \times \Delta r + S_s \times \Delta s + S_t \times \Delta t + L \tag{6.9}$$

where r, s and t are the different interest rates. Since all interest rate changes are uncertain, NPV volatility is the volatility of a sum of random variables. Deriving the volatility of this sum requires assumptions on correlations between interest rates.

This problem is identical to the general problem of measuring the market risk of a portfolio when mindful that its change in market value arises as a result of changes generated by random variations of market parameters. The main concern is to calculate the volatility of the mark-to-market value of the portfolio, expressed as the sum of random changes of mark-to-market values of the various individual transactions. These random changes can be interdependent, in the same way that underlying market parameters are. Volatility in the value of the portfolio depends upon the sensitivities of individual transactions, upon the volatilities of individual market parameters and upon their interdependency, if any exists. The methodology that calculates this volatility is known as *delta-VaR*. This is based on the delta sensitivity of the portfolio to changes in market interest rates.

BIBLIOGRAPHY

Anon. (1998) *Asset and Liability Management*, RISK Publications.

Bitner, J. (1992) *Successful Bank Asset–Liability Management*, John Wiley & Sons.

Butler, C. (1998) *Mastering Value-at-Risk*, FT/Prentice Hall.

Choudhry, M. (2007) *Bank Asset and Liability Management*, Singapore: John Wiley & Sons.

Cornyn, A. and Mays, E. (Eds.) (1997) *Interest Rate Risk Models: Theory and Practice*, Glenlake Publishing/Fitzroy Dearborn Publishers, Chapters 6 and 15

Fabozzi, F. and Choudhry, M. (2004) *Handbook of European Structured Financial Products*, John Wiley & Sons.

Fabozzi, F. and Konishi, A. (1996) *The Handbook of Asset/Liability Management*, Revised Edition, Irwin McGraw-Hill, Chapters 3, 6–8, 12.

Greenbaum, S. and Thakor, A. (1995) *Contemporary Financial Intermediation*, Dryden Press.

Gup, B. and Brooks, R. (1993) *Interest Rate Risk Management*, Irwin Professional Publishing.

Howe, D. (1992) *A Guide to Managing Interest-Rate Risk*, New York Institute of Finance.

Johnson, H. (1994) *Bank Asset/Liability Management*, Probus Publishing.

Kamakura Corporation (1998) *Asset & Liability Management: A Synthesis of New Methodologies*, Risk Publications.

Koch, T. (1988) *Bank Management*, Dryden Press.

Marshall, J. and Bansal, V.K. (1992) *Financial Engineering*, New York Institute of Finance, Chapter 20

Schaffer, S. (1991) 'Interest rate risk,' *Business Review, Federal Reserve Bank of Philadelphia*, May/June, 17–27

Sinkey, J. (1992) *Commercial Bank Financial Management*, Fourth Edition, Macmillan.

Stevenson, B. and Fadil, M. (1995) 'Modern portfolio theory: Can it work for commercial loans?' *Commercial Lending Review*, **10**(2), Spring, 4–12.

Toevs, A. and Haney, W. (1984) *Measuring and Managing Interest Rate Risk*, Morgan Stanley.

Toevs, A. and Haney, W. (1986) 'Measuring and managing interest rate risk: A guide to asset/liability models used in banks and thrifts,' in R. Platt (Ed.), *Controlling Interest Rate Risk: New Techniques and Applications for Money Management*, John Wiley & Sons.

Wilson, J.S.G. (Ed.) (1988) *Managing Banks' Assets and Liabilities*, Euromoney Publications.

Chapter 7

ASSET AND LIABILITY MANAGEMENT III: THE ALCO

The third and final strand of our look at bank ALM considers the reporting process, often overseen by the asset–liability management committee (ALCO). The ALCO has a specific remit to oversee all aspects of asset–liability management, from the front-office money market function to back-office operations and middle-office reporting and risk management. In this chapter we consider the salient features of ALCO procedures.

ALCO policy

The ALM reporting process is often overseen by the bank's ALCO. It is responsible for setting and implementing ALM policy. Its composition varies in different banks but usually includes heads of business lines as well as director-level staff such as the finance director. It also sets hedging policy.

Typical membership of the ALCO is as follows:

Members	CFO (Chairman); Deputy (Head of Financial Accounting) CEO (Deputy Chairman) Head of Treasury; Deputy (Head of Money Markets) MD Commercial Banking MD Retail Banking Chief Risk Officer
Guests	Head of Market & Liquidity Risk Head of Product Control Head of ALM/Money Markets Head of Financial Institutions
Secretary	PA to the Head of Treasury

The ALM process may be undertaken by the Treasury desk, the ALM desk or other dedicated function within the bank. In traditional commercial banks it will be responsible for management reporting to the ALCO. The ALCO will consider the report in detail at regular meetings, usually monthly. The main points of interest in the ALCO report include variations in interest income, the areas that are experiencing fluctuations in income and the latest short-term income projections. The ALM report will link these three strands across the group as a whole and to each individual business line as well. That is, it will consider macro-level factors driving variations in interest income as well as specific desk-level factors. The former include changes in the shape and level of the yield curve, while the latter

Table 7.1 ALCO main mission – bank ALM strategic overview

Mission	Components
ALCO management and reporting	Formulating ALM strategy Management reporting ALCO agenda and minutes Assessing liquidity, gap and interest rate risk reports Scenario planning and analysis Interest income projection
Asset management	Managing bank liquidity book (CDs, bills) Managing FRN book Investing bank capital
ALM strategy	Yield curve analysis Money market trading
Funding and liquidity management	Liquidity policy Managing funding and liquidity risk Ensuring funding diversification Managing lending of funds
Risk management	Formulating hedging policy Interest rate risk exposure management Implementing hedging policy using cash and derivative instruments
Internal Treasury function	Formulating transfer-pricing system and level Funding group entities Calculating the cost of capital

include new business, customer behaviour and so on. Of necessity the ALM report is a detailed, large document.

Table 7.1 is a summary overview of the responsibilities of ALCO.

The ALCO will meet on a regular basis; the frequency depends on the type of institution but is usually once a month. The composition of the ALCO varies by institution but may comprise the heads of Treasury, trading and risk management, as well as the finance director. Representatives from the credit committee and loan syndication may also be present. A typical agenda would consider all the elements listed in Table 7.1. Thus, the meeting will discuss and generate action points on the following:

- Management reporting – this will entail analysing various management reports and either signing them off or agreeing items to be actioned. The issues to consider include lending margin, interest income, variance from last projection, customer business and future business. Current business policy with regard to lending and portfolio management will be reviewed and either continued or adjusted.
- Business planning – existing asset (and liability) books will be reviewed, and future business directions drawn up. This will consider the performance of existing business, most importantly with regard to return on capital. The existing asset portfolio will be analysed from a risk–reward perspective, and a decision taken to continue or modify all lines of business. Any proposed new business will be discussed and – if accepted – in principle will be moved on to the next stage.[1] At this stage any new business will be assessed for projected returns, revenue and risk exposure.
- Hedging policy – overall hedging policy will consider acceptable levels of risk exposure, existing risk limits and use of hedging instruments. Hedging instruments also include derivative instruments. Many bank ALM desks find that their hedging requirements can be met using plain vanilla products such as interest rate swaps and exchange-traded short-money futures contracts. The use of options and especially vanilla instruments such as FRAs[2] is much lower than one might think. Hedging policy takes into account the cash book revenue level, current market volatility levels and the overall cost of hedging. On occasion, certain exposures may be left unhedged because the costs associated with hedging them are deemed prohibitive (this includes the actual cost of putting on the hedge as well as the opportunity cost associated with expected reduced income from the cash book). Of course, hedging policy is formulated in co-ordination with overall funding and liquidity policy. Its final form must consider the bank's views of the following:

---

[1] New business will follow a long process of approval, typically involving all the relevant front-office, middle-office and back-office departments of the bank and culminating in a 'new products committee' meeting at which the proposed new line of business will be either approved, sent back to the sponsoring department for modification or rejected.

[2] See Chapter 4.

- expectations on the future level and direction of interest rates;
- balancing the need to manage and control risk exposure with the need to maximize revenue and income;
- level of risk aversion, and the level of risk exposure the bank is willing to accept.

The ALCO is dependent on management reporting from the ALM or Treasury desk – reports may be compiled by the Treasury middle office. The main report is the overall ALM report, showing the composition of the bank's ALM book. Other reports will look at specific business lines and consider the return on capital generated by these businesses. These reports will need to break down aggregate levels of revenue and risk by business line. Reports will also drill down by product type across business lines. Other reports will consider the gap, gap risk, the VaR or DV01 report and credit risk exposures. Overall, the reporting system must be able to isolate revenues, return and risk by country sector, business line and product type. There is usually an element of scenario planning as well, which is expected performance under various specified macro-level and micro-level market conditions.

Figure 7.1 illustrates the general reporting concept.

ALCO reporting

We now provide a flavour of the reporting that is provided to and analysed by the ALCO. This is of course a generalization – reports will vary by type of institution and the nature of its business.

In Chapter 5 we showed an example of a macro-level ALM report. The ALCO will also consider macro-level gap and liquidity reports compiled for product and market. The interest rate gap – simply the difference between assets and liabilities – is easily set into these parameters. For management reporting purposes the report will attempt to show a dynamic profile, but its chief limitation is that it is always a snapshot of a fixed point in time, and therefore – strictly speaking – will always be out of date.

Figure 7.2 shows a typical dynamic gap, positioned in a desired ALM 'smile', with projected interest rate gaps based on the current snapshot profile. This report shows future funding requirements, on

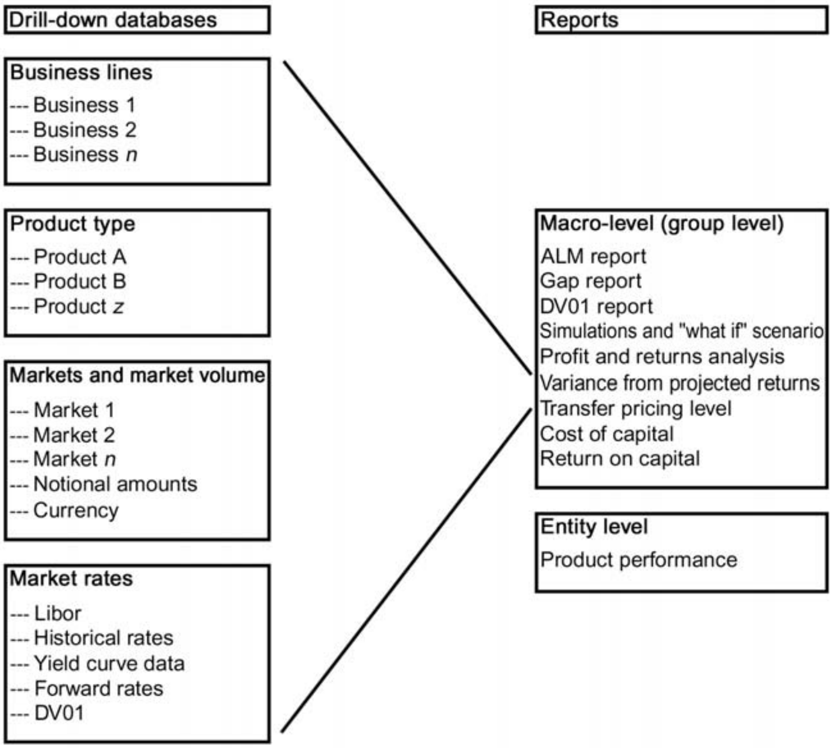


Figure 7.1 ALCO reporting input and output.

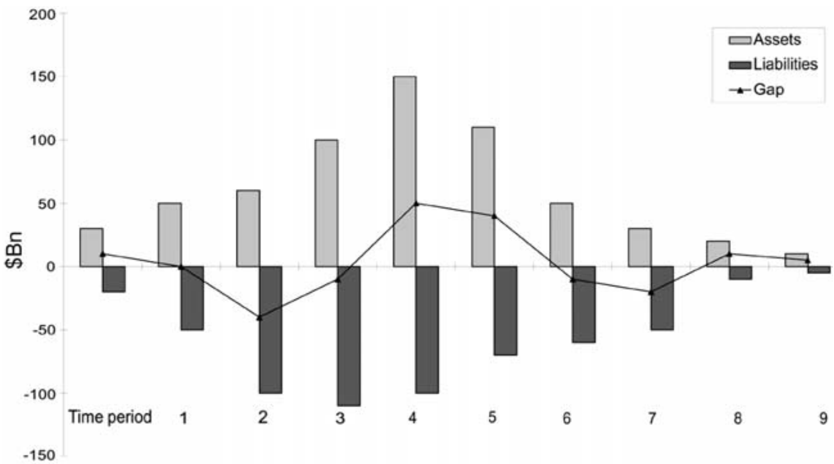


Figure 7.2 ALM, expected liquidity and interest rate gap – snapshot profile.

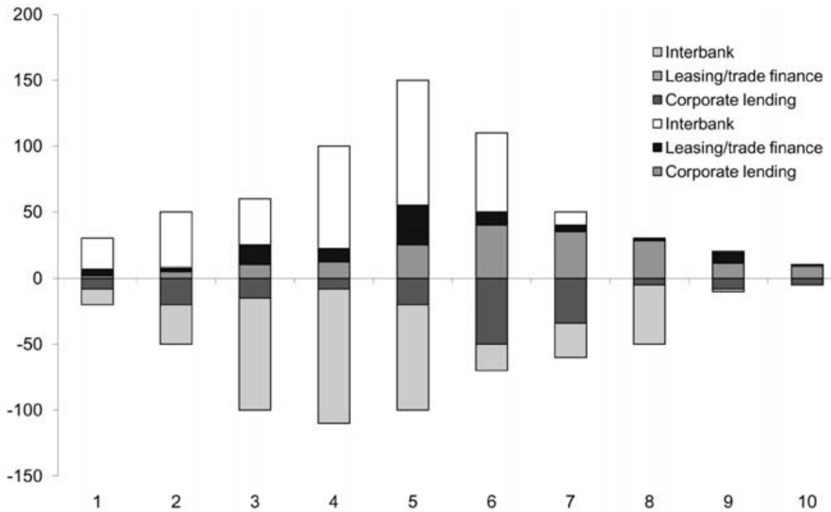


Figure 7.3 ALM breakdown by product (or market) segment.

which the ALCO can give guidance reflecting its view on future interest rate levels. It also shows where sensitivity to falling interest rates, in terms of revenue, lies because it shows the volume of assets. Again, the ALCO can give instructions on hedging if it expects interest income to be affected adversely. The *x*-axis indicates time buckets from overnight out to 2 years or more. Banks use different time buckets to suit their own requirements.[3]

Figure 7.3 shows the same report broken down by product (or market – the report would have a similar layout). We use a hypothetical sample of different business lines. Using this format the ALCO can observe which assets and liabilities are producing the gaps; this is important because it shows if products (or markets) are fitting into overall bank policy. Equally, policy can be adjusted if required in response to what the report shows. So, the ALCO can see what proportion of total assets is represented by each business line, and which line has the greatest forward funding requirement. The

[3] For example, a bank may have just the 'overnight' time bucket or may incorporate it into an 'overnight to 1-week' period. Similarly, banks may have each period from 1 month to 12 months in their own separate buckets or may place some periods into combined time periods. There is no single 'correct' way.

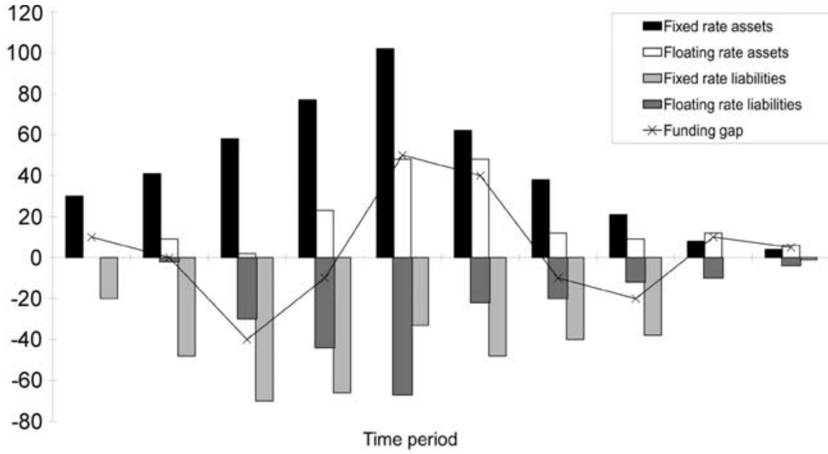


Figure 7.4 ALM breakdown by type of interest rate.

same report is shown again in Figure 7.4, but this time the breakdown is by type of interest rate: fixed or variable.

Another variation of this report under the scrutiny of the ALCO is a breakdown by income and margin, again separated into business lines or markets as required. In a purely commercial banking operation the revenue type mix will comprise the following (among others):

- the bid–offer spread between borrowing and lending in the interbank market;
- corporate lending margin – that is, the loan rate over and above the bank's cost of funds;
- trading income;
- fixed fees charged for services rendered.

The ALCO will receive an income breakdown report, split by business line. The *x*-axis in such a report would show the margin level for each time period; that is, the margin of the lending rate over the cost of funds by each time bucket. Figure 7.5 is another type of income report, which shows volumes and income spread by business line. The spread is shown in basis points and is an average for that time bucket (across all loans and deposits for that bucket). Volumes will be those reported in the main ALM report (Figure 7.2) but this time with margin contribution per time period. As we might expect, the spread levels per product across time are roughly similar. They will differ more markedly by product time. The latter report is shown

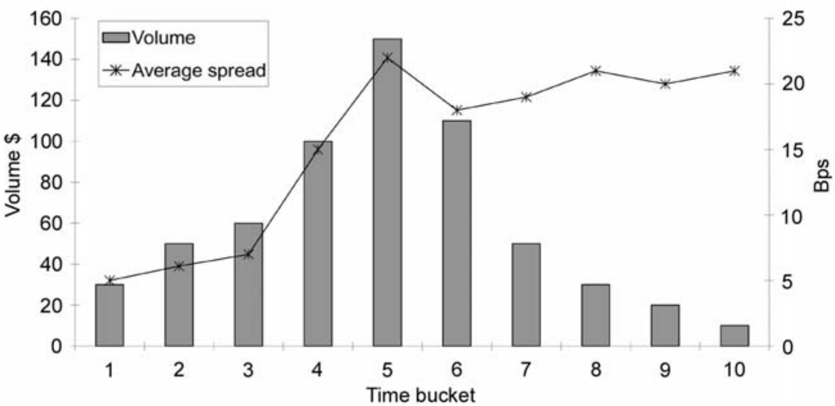


Figure 7.5 Asset profile volume and average income spread.

at Figure 7.6 (see next page), which is more useful because it shows the performance of each business line. In general, the ALCO will prefer low volumes and high margin as a combination, because lower volumes consume less capital. However, some significant high-volume business (such as interbank money market operations) operates at a relatively low margin.

The income and return reports viewed by ALCO are necessary for it to check whether bank policy with regard to lending and money market trading is being adhered to. Essentially, these reports provide information on the risk–return profile of the bank. The ideal combination is the lowest possible risk for the highest possible return, although of course low-risk business carries the lowest return. The level of tradeoff at which the bank is comfortable is what the ALCO will set as its direction and strategy. With regard to volumes and bank business, it might be thought that the optimum mix is high volume mixed with high income margin. However, high-volume business consumes the most capital, so there will be another tradeoff with regard to the use of capital.

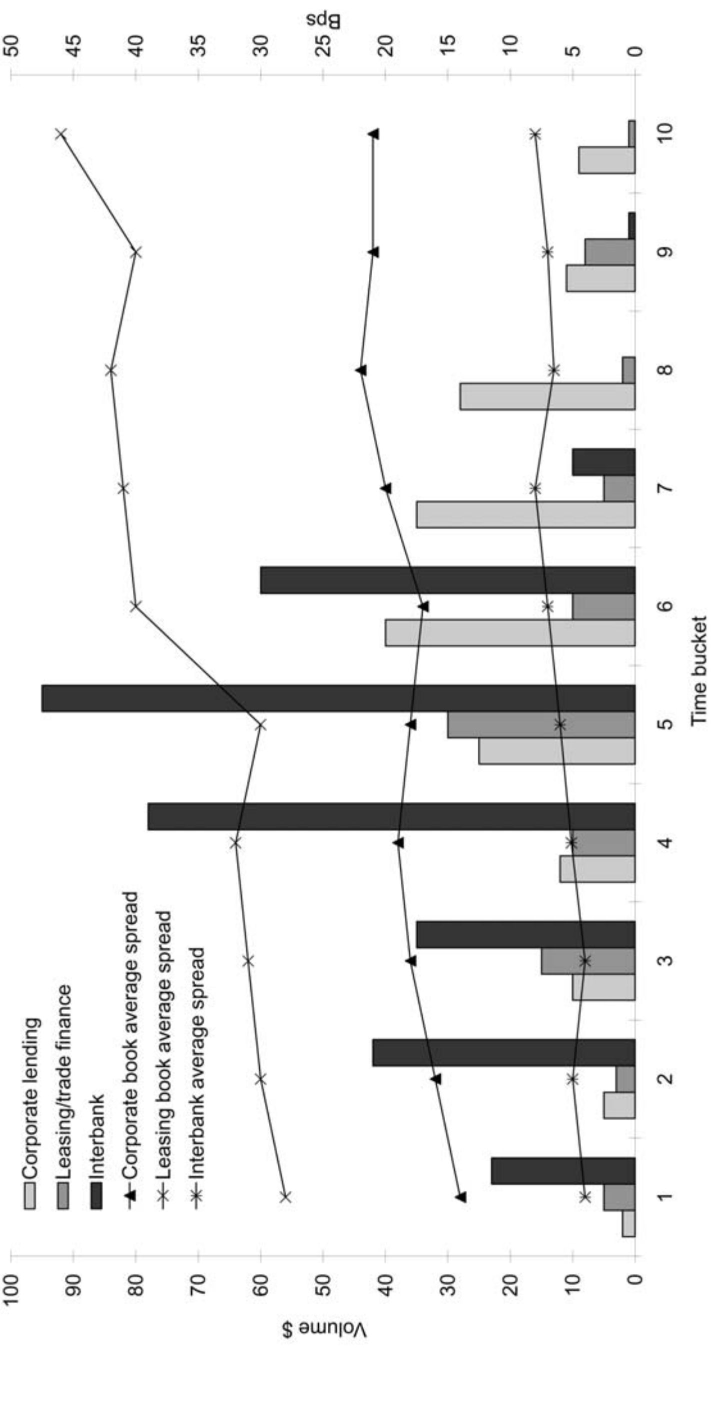


Figure 7.6 Business lines and average income spread.

Chapter 8

BANK LIQUIDITY RISK MANAGEMENT

The Western World's banking system was – in some jurisdictions at least – on the brink of collapse in September and October 2008, in the wake of the Lehman bankruptcy. Intervention by governments, which in some cases extended to a blanket guarantee of banks' complete liabilities, prevented this collapse from taking place. In the aftermath of the crisis, national regulators and the Bank for International Settlements (BIS) circulated consultative papers and recommendations that addressed new requirements on bank capital, liquidity and risk management. The UK's Financial Services Authority (FSA) was perhaps the most demanding; in its *Policy Statement 09/16*, which was issued in October 2009, it outlined measures on capital treatment, liquidity requirements and stress-testing that implied a fundamental change in the bank's business model going forward.

In this and the next chapter, we discuss the implications for banks of the new emphasis on risk management by the regulators and the BIS committee – this was the committee that issued the 'Basel III' rules in September 2010 for implementation from 2015 onwards. We also provide our own recommendations on how banks can go about meeting these requirements in a way that generates sustained return on capital. This chapter looks at the fundamentals of liquidity risk management, and what its basic principles need to be in the light of current central bank and regulatory requirements. In the following chapter, we consider the implications of these changes for the basic banking model.

The liquidity policy statement

Business best practice dictates that a bank formally documents its liquidity policy. This will articulate the bank's approach to and appetite for liquidity risk, the actions it should follow to maintain liquidity safety and the contingent actions to follow in the event of stressed conditions in the financial markets. We provide a template for bank liquidity policy here with a series of illustrations. They are self-explanatory and applicable to a conventional medium-sized commercial bank.

The basic principles of the policy statement are shown in Figures 8.1 to 8.6. Figure 8.4 shows the alternative actions that can be taken in the event of liquidity stress. Figure 8.6 is the summary liquidity-risk-reporting template.

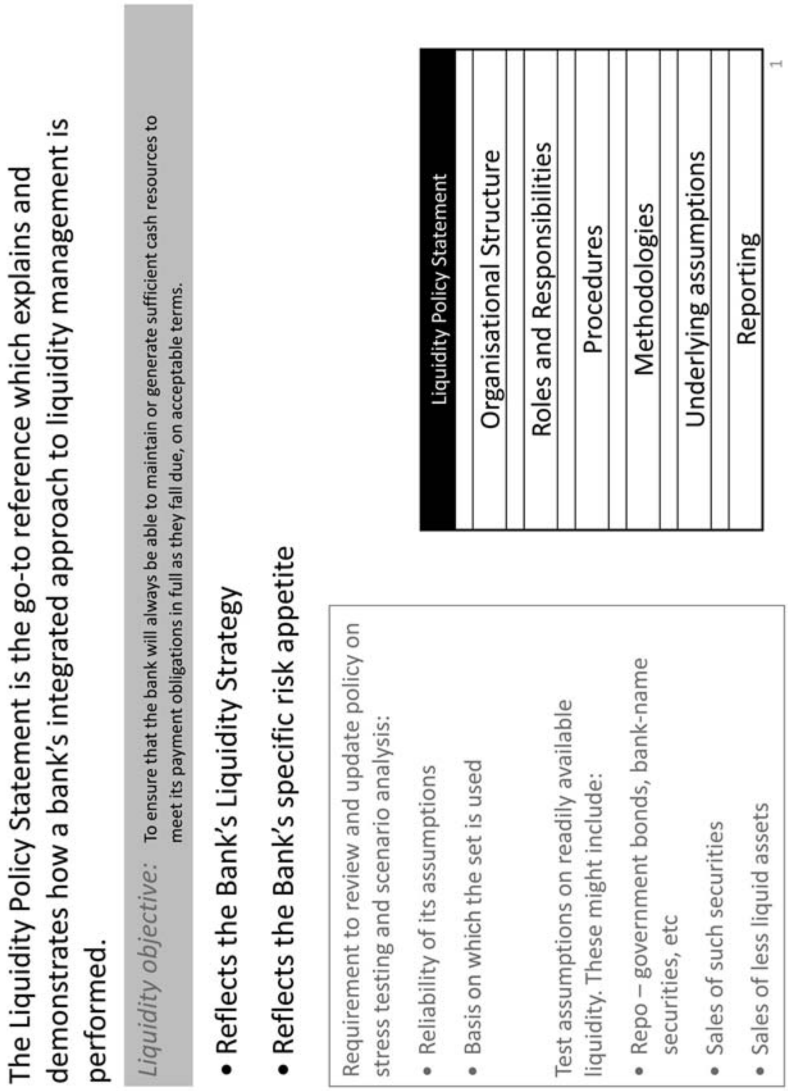


Figure 8.1 Liquidity policy statement: basic framework.

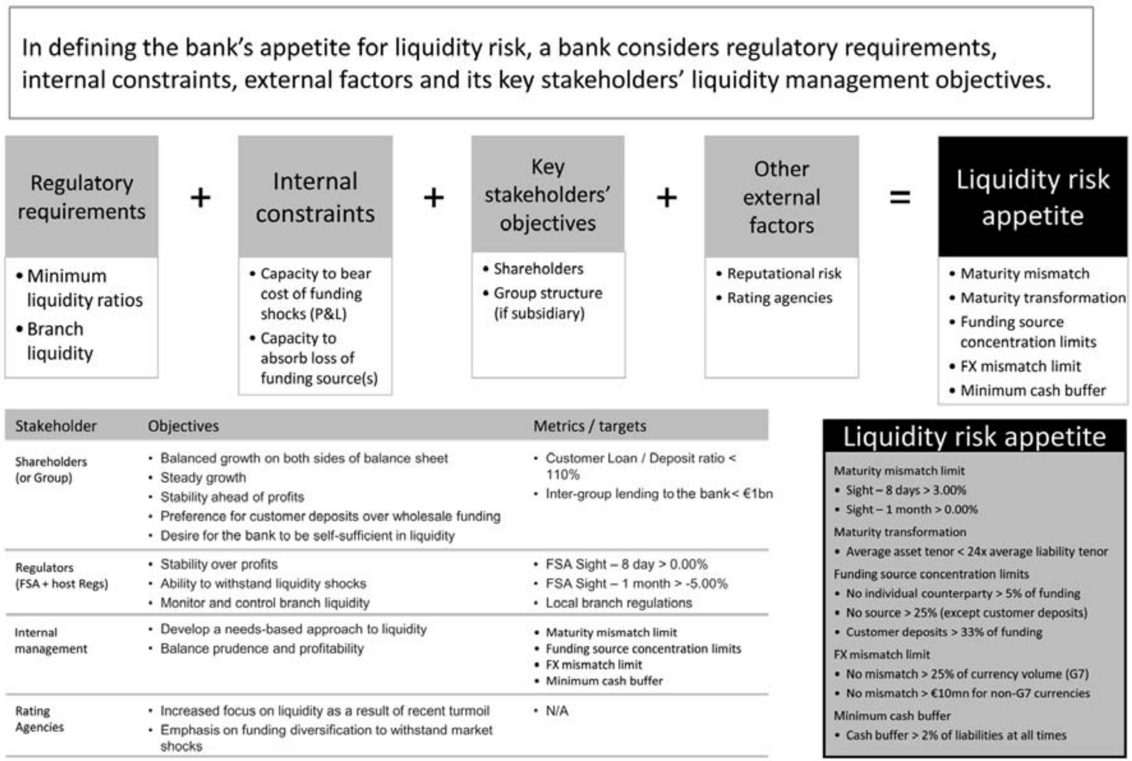


Figure 8.2 Liquidity policy statement: appetite for liquidity risk.

Treasury assesses the bank's exposure to liquidity risk in three main categories and seeks to ensure that appropriate mitigation is effected where possible, and that adequate insurance and contingency plans exist to handle the unexpected.

Type of liquidity risk	BAU actions	Mitigation / insurance
Short-term tactical liquidity risk *The risk that the Bank's liquid assets are insufficient to meet its short-term commitments.*	• Monitoring and controlling operational liquidity • Understanding the business pipeline and predicted funding requirements	• Developing a broad range of effective FI / Money Market counterparty relationships to diversify sources of funding • Increasing customer deposits to reduce reliance on wholesale funding • Maintaining a pool of highly rated, liquid assets for repo / sale purposes
Structural liquidity risk *The risk that the Bank's business model (and consequently, its balance sheet) develops in a way that causes difficulty attracting adequate funding on reasonable terms* *and/or* *The risk that the structure of the balance sheet is unduly exposed to disruption in its funding markets*	• Monitoring and influencing strategy development to take account of liquidity • Maintaining an appropriate balance between risk and profit in respect of maturity transformation	• Reducing FX structural mismatch to reduce reliance on FX-swap markets • Active portfolio management (securitisation / syndication / sale) to match asset growth to funding capacity • Diversification of funding channels, maturities and investor classes (e.g. MTN programme, CD issuance, different geographies, range of currencies)
Contingency liquidity risk *The risk that the Bank experiences unexpected and/or acute liquidity shocks*	• N/A	• Implementing an effective contingency plan with clearly defined roles and responsibilities, which is tested frequently

Figure 8.3 Liquidity policy statement: basic framework.

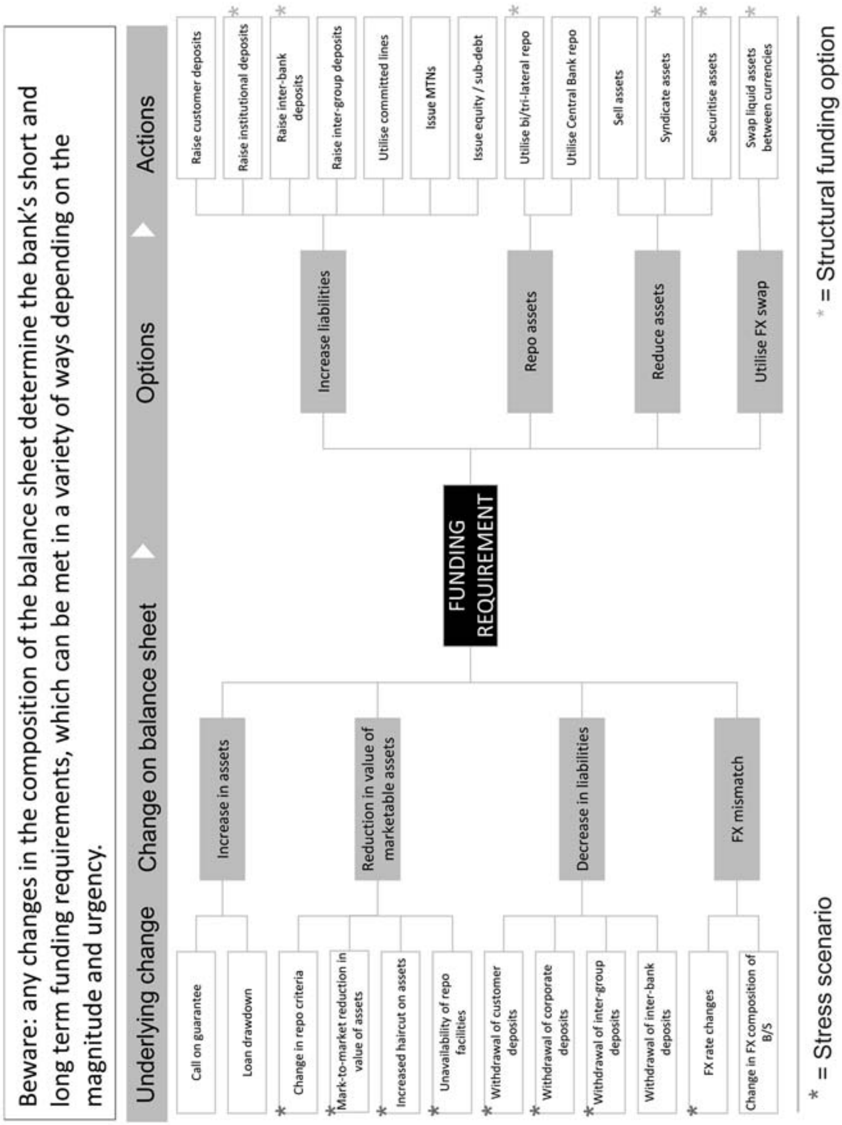


Figure 8.4 Liquidity policy statement: funding options.

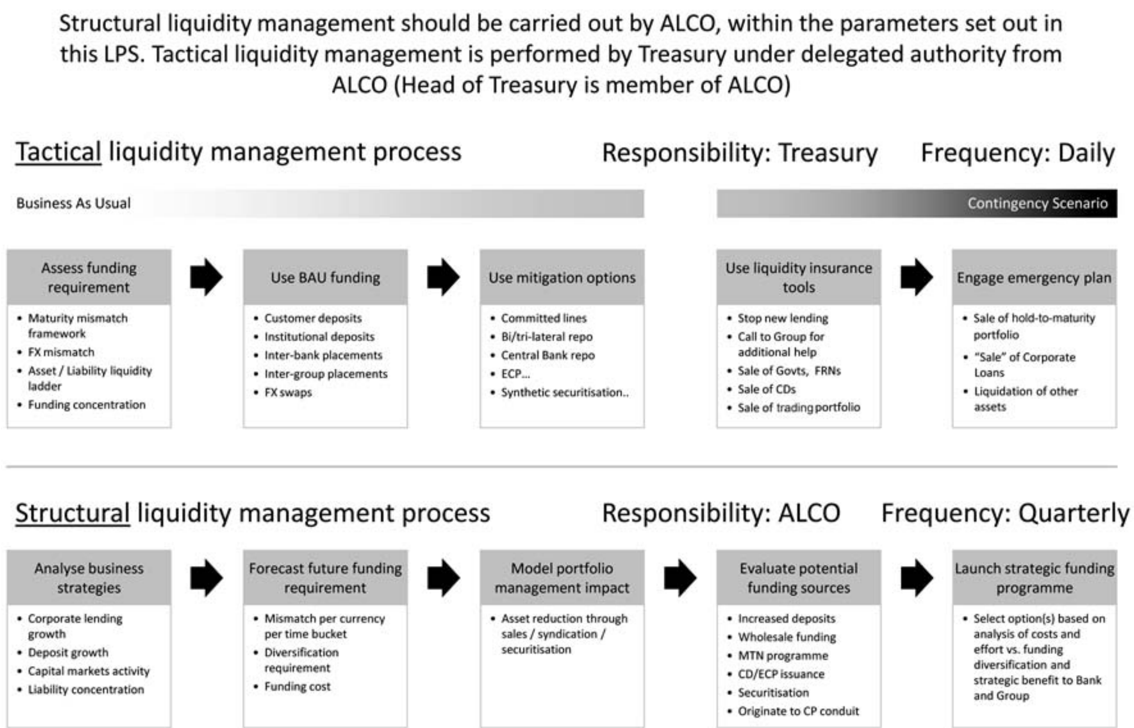


Figure 8.5 Liquidity policy statement: management process.

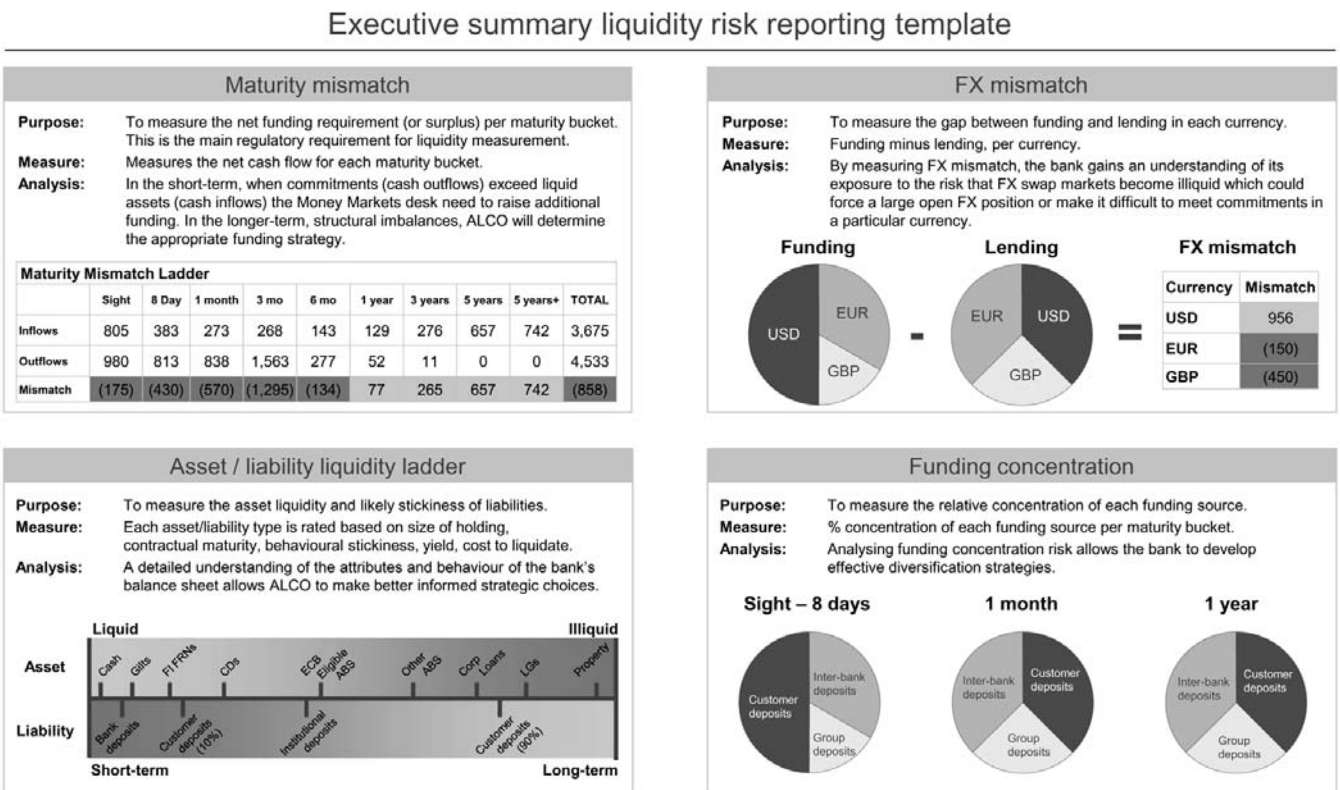


Figure 8.6 Liquidity policy statement: summary M1.

Principles of bank liquidity risk management

At a conference hosted by the UK Financial Services Authority (FSA) on 9 October 2009, there was significant focus given to the model of liquidity management of the HSBC (a UK bank). Given its rarity amongst large Western banks in not suffering a liquidity crisis in 2007–2008, observers commented on the efficacy of the HSBC model, and on what lessons could be learned by banks in general.

In truth, a close look at the HSBC's approach to liquidity and asset generation shows that it is neither unique nor proprietary to the bank; indeed, a number of other banks such as Standard Chartered Bank follow a similar approach. The 'HSBC model' would have been the norm, rather than the exception, amongst banks as recently as 10 or 15 years ago. In an era of excess the basic tenets of the approach were applied by fewer and fewer banks, to the extent that they were no longer seen as an essential ingredient of prudent bank risk management at the time of the 2007–2008 financial crash.

As such these principles represent the basic principles of banking – not a specific response to the events of 2007–2008. They should be taken to be general principles of banking liquidity management, and ones that more banks will re-adopt as they return to a more conservative business model, either through choice or because the requirements of the national banking regulator insist upon a more robust approach to risk management.

This section considers the most important principles of what should be taken as the cornerstone of banking and liquidity management.

(1) Fund illiquid assets with core customer deposits

In hindsight, this looks an eminently sensible guideline but during the bull market buildup of 2001–2007 it was not applied universally. The best example of this was Northern Rock, which built an asset book that far exceeded its retail deposit base in size, but this pattern was observed with many banks in Western Europe. It is not difficult to ascertain the logic behind this principle: core customer deposits are generally more stable than wholesale funds and are also at lower risk of withdrawal in the event of a downturn in economic conditions (an apparent paradox is that they may actually increase as customers seek to deleverage and also hold off committing to cash-rich expenditure). Therefore, funding illiquid assets with core customer deposits is prudent banking practice.

(2) Where core customer deposits are not available, use long-term wholesale funding sources

This follows on naturally from the first principle. Where there is insufficient core deposits available, and banks resort to the wholesale-funding market, banks should ensure that only long-dated wholesale funds are used to fund illiquid assets. Generally, 'long-dated' means over 1 year in maturity, although of course the appropriate tenor to source is a function of the maturity of the asset. This approach reduces rollover liquidity risk in the event of a crisis.

(3) No overreliance on wholesale funding. Run a sensible term structure wherever this is used: more funding should be long term (>5 years) than short term

This follows on from the primary dictum of not building up the asset base using wholesale funds unless absolutely necessary. Where recourse is made to wholesale funds, as much of this as possible should be long term, so as to minimize exposure to frequent short-term rollover risk to wholesale funds.

(4) Maintain 'liquidity buffers' to cater for stresses – both firm-specific stresses and market-wide stresses

The UK FSA published this requirement in its *Policy Statement 09/16* in October 2009. However, only 10 or 15 years ago it was quite common for banks to hold some of their assets in the form of liquid risk-free government bonds. Traditionally, a bank's capital was always invested in such securities or in shorter dated government bills, but beyond this it was accepted good practice for banks to have a proportion of their balance sheet assets in sovereign securities. For the FSA to make it a requirement under law demonstrates the extent to which this practice has fallen into disuse.

It is evident that banks reduced their holdings of government bonds so they could deploy more of their funds in higher paying risky assets. But, the logic of holding a liquidity buffer is irrefutable: in periods of stress or illiquidity, government bonds are the only assets that remain liquid. As such, they can be sold to release liquidity if need be. Even hitherto highly liquid assets such as high-rated bank CDs or short-dated MTNs became illiquid virtually overnight in the immediate aftermath of the Lehman collapse in 2008. This demonstrates that the liquidity buffer should only be comprised of sovereign risk-free securities.

(5) Establish a liquidity contingency plan

A well-managed liquidity operation recognizes that bank funding should be sourced from multiple origins, and that 'concentration risk' should be avoided both in any specific sector and any single lender. However, even without excess concentration, at any time particular sectors or lenders may become unavailable for either exogenous or endogenous reasons.

Given this risk, banks needs to have contingencies to fall back on whenever particular sources of funding dry up. This may include applying for and setting up facilities at the central bank, or establishing relationships with particular sectors that, for reasons of cost or convenience, the bank does not customarily access. The contingency plan needs to be tested regularly and kept updated.

(6) Know what central bank facilities the bank can access and test that it really can gain access to them

This follows logically from the requirement to have a contingency funding plan in place. Once a bank has established borrowing facilities at its central bank, it needs to be aware exactly how they function and what the requirements to access them are, so that if necessary it can benefit from them without delay.

(7) Be aware of all the bank's exposures (on the liability side – not the credit side). For example, sponsoring an asset-backed commercial paper (ABCP) conduit creates a reputational, rather than contractual, obligation to provide funding. Therefore, be wary of reputational obligations, especially if it means the bank has to lend its name to another entity

This is fairly straightforward to understand, but in a bull market when credit spreads are tight it is frequently forgotten. Banks may desire the fee-based income, at favourable capital levels, that comes with sponsoring a third-party entity or providing a line of liquidity, but in a stress situation that line will be drawn on. Is the bank prepared to take on this additional liquidity risk exposure to an entity that it might not normally, in a bear market, wish to lend funds to?

(8) Liquidity risk is not a single metric. It is an array of metrics, and a bank must calculate them all in order to obtain the most accurate picture of liquidity. This is especially true for multinational banks and/or banks with multiple business lines

Smaller banks often rely on just one or two liquidity indicators such as loan-to-deposit ratio. Given that bank asset–liability management is more an art than a science, it is vital that banks use a range of liquidity measures for risk estimation and forecasting. We will address the different metrics required in the next section.

(9) The internal transfer-pricing framework must be set up correctly and adequately

An artificial internal lending rate to business lines can drive inappropriate business decision-making and was a factor behind the growth in risky assets during the buildup to the US subprime crisis. We address this subject on pp. 252–259.

The business of banking is – if nothing else – the business of managing the gap between assets and liabilities. In the history of banking, banks have never matched their asset maturity with their funding liability maturity. But, it is the management of this gap risk that should be the primary concern of all banks. The basic principles we have discussed above represent business best practice – evolved over centuries of modern banking – in mitigating gap risk.

Measuring bank liquidity risk: key metrics

As we note above, given that bank asset–liability management is as much an art as a science, it is vital that banks use a range of liquidity measures for risk estimation and forecasting. In this section we list seven baseline liquidity metrics which all banks – irrespective of their size or line of business – should adopt and monitor as a matter of course:

- liquidity ratio
- loan-to-deposit ratio
- 1-week and 1-month liquidity ratios
- cumulative liquidity model
- liquidity risk factor
- concentration report
- inter-entity lending report.

These reports measure and illustrate different elements of liquidity risk. For consolidated or group banking entities, reports must be at the country level, legal entity level and group level. Taken together, on aggregate the reports provide detail on

- the exposure of the bank to funding rollover or 'gap' risk;
- the daily funding requirement, and what it is likely to be at a forward date;
- the extent of 'self-sufficiency' of a branch or subsidiary.

Liquidity reports also help in providing early warning of any likely funding stress points. Let us examine them individually.

Liquidity ratio

A bank's liquidity ratio is the basic asset–liability gap ratio. A liquidity report for a commercial bank is shown in Figure 8.7.

The liquidity gap value shown in the report is made up of the assets minus the liabilities of each tenor bucket. The 'total available funds' number is the liquidity gap, plus 'marketable securities' such as government bonds, bank bonds, CDs, minus any committed facilities that are as yet undrawn. The liquidity ratio calculation itself is the 'total available funds' value, which is +781,065 for the 8-day bucket and −61,438 for the 30-day bucket, divided by the 'total liabilities' value which is 4,511,294. This gives ratios of 17.31% and −13.6% for the two buckets, respectively, which are above the bank regulators' limits of 0.00% and −5.00%. In the case of this bank, the liquidity ratios must not fall below these limits.

Note that it is the 'liquidity gap' element that drives the 30-day ratio to a lower level than the 8-day ratio. In other words, the bigger the gap the lower the ratio; this is why regulators place limits on liquidity ratios such that banks are required to maintain asset–liability gaps at manageable levels.

Loan-to-deposit ratio (LTD)

This is a standard and commonly used metric, typically reported monthly. It measures the relationship between lending and customer deposits, and is a measure of the self-sustainability of the bank (or the branch or subsidiary). A level above 100% is an early warning sign of excessive asset growth; of course, a level below 70% implies excessive liquidity and implies a potentially inadequate return on funds.

EUR '000
Bank Liquidity Report
28-Nov-10

	Sight	2 - 8 Days	9 Days - 1 Month	1 - 3 Months	3 - 6 Months	6 Mths to 1 Yr	1 - 3 Years	3 - 5 Years	+5 Years	Total
Corporate Current / Call	24,289	0	0	0	0	0	0	0	0	**24,289**
Corporate Time Loan	28,433	14,203	151,471	106,637	98,959	47,608	357,872	573,993	642,563	**2,021,738**
Government Current/Call	342	0	0	0	0	0	0	0	0	**342**
Government Time Loan	250	3	805	63	3,383	2,942	12,656	7,016	76,853	**103,971**
Interbank Current / Call	41,752	0	0	0	0	0	0	0	0	**41,752**
Interbank Time Loan	339,276	201,745	6,251	31,906	18,704	28,428	11,971	0	0	**638,281**
Repos	0	0	0	47,500	0	0	0	0	0	**47,500**
Intergroup Current / Call	4,445	0	0	0	0	0	0	0	0	**4,445**
Intergroup Time Loan	210,177	348,414	277,964	76,268	13,981	30,047	156	101	0	**957,108**
Marketable Secs & CDs - <1Mth to maturity	5,009	0	55,358	0	0	0	0	0	0	**60,367**
Retail Current / Call	8,215	0	0	0	0	0	0	0	0	**8,215**
Retail Time Loan	238	41	221	2,643	2,427	310	6,294	38,755	10,204	**61,133**
Additional Corporate Time Lending	0	8	1,313	43	624	0	21,608	7,857	75,724	**107,177**
Receivables	0	0	0	0	0	0	0	0	0	**0**
Total Assets	**662,426**	**564,414**	**493,383**	**265,060**	**138,078**	**109,335**	**410,557**	**627,722**	**805,344**	**4,076,318**
Corporate Current / Call	51,033	0	0	12,758	0	0	0	0	0	**63,791**
Corporate Time Deposit	32,303	122,955	114,627	299,551	28,387	928	0	0	0	**598,751**
Government Current / Call	1,946	0	0	0	0	0	0	0	0	**1,946**
Government Time Deposit	2,056	8,112	24,391	23,503	22,687	1,200	0	0	0	**81,949**
Interbank Current / Call	82,087	0	0	0	0	0	0	0	0	**82,087**
Interbank Time Deposit	83,898	83,684	349,461	86,979	23,967	1,205	0	0	0	**629,194**
Repos	0	0	0	50,000	0	0	0	0	0	**50,000**
Intergroup Current / Call	47,095	0	0	0	0	0	0	0	0	**47,095**
Intergroup Time Deposit	302,879	418,383	629,809	225,314	88,464	78,769	375	0	0	**1,743,993**
Retail Current / Call	65,273	0	0	16,318	0	0	0	0	0	**81,591**
Retail Time Deposit	203	54,128	167,090	683,288	27,925	13,273	9,224	0	0	**955,131**
Additional Govt / Local AuthorityTime Deposits	8,656	9,319	50,508	82,531	15,252	8,500	1,000	0	0	**175,766**
Share Capital	0	0	0	0	0	0	0	0	0	**0**
Payables	0	0	0	0	0	0	0	0	0	**0**
Total Liabilities	**677,429**	**696,581**	**1,335,886**	**1,480,242**	**206,682**	**103,875**	**10,599**	**0**	**0**	**4,511,294**

Ratio Calculation		**O/N**	**8 Day**	**1 Month**
Marketable Securities		0	630,536	630,536
Repos		0	0	0
CD'S	39,000	0	353,219	353,219
Unutilised Commitments		(55,520)	(55,520)	(55,520)
Liquidity Gap		(15,003)	(147,170)	(989,673)
Total Available Funds		(70,523)	$\boxed{781,065}$	(61,438)
Total Liabilities		4,511,294	4,511,294	4,511,294
Liquidity Ratio		**-1.56%**	**17.31%**	**-1.36%**
Internal Limit			3.00%	-3.00%
Regulatory Authority Limit			0.00%	-5.00%

Figure 8.7 Bank liquidity report showing 8-day and 1-month liquidity ratios.

Table 8.1 Sample liquidity ratio report

Country	1-week gap	1-week liquidity		1-month liquidity	
	USD (million)	This week (%)	Limit/ Excess (%)	This week (%)	Limit/ Excess (%)
F	−1,586	−22.83	−30.00	−39.11	−50.00
D	188	15.26	0.00	1.62	−5.00
H	786	22.57	0.00	19.12	−5.00
G	550	53.27	25.00	69.83	25.00
Regional total	−62	−0.48		−10.64	

The LTD ratio is a good measure of the contribution of customer funding to the bank's overall funding; however, it is not predictive and does not account for the tenor, concentration and volatility of funds. As such it is insufficient as a liquidity risk measure on its own and must be used in conjunction with other measures.

1-week and 1-month liquidity ratios

Both the 1-week and 1-month liquidity ratios are standard liquidity ratios that are commonly measured against a regulatory limit. An example of a report for a group-type entity comprised of four subsidiaries is shown in Table 8.1.

Liquidity ratios are an essential measure of 'gap' risk. They show net cash flows – including the cash effect of liquidating 'liquid' securities – as a percentage of liabilities for a specific maturity bucket. They are an effective measure of structural liquidity, with early warning of likely stress points.

A more detailed liquidity ratio report is shown in Figure 8.8. This shows the breakdown of cash inflows and outflows per time bucket, as well as the liquidity ratio. The ratio itself is calculated by dividing the selected time bucket liability by cumulative liability. So, in this example the 30-day ratio of 17.3% is given by the fraction $\frac{781,065}{4,511,294}$.

Cumulative liquidity model

The cumulative liquidity model is an extension of the liquidity ratio report and is a forward-looking model of inflows, outflows and available liquidity, accumulated for a 12-month period. It recognizes

EURO's
XYZ Bank, London - Liquidity Report
28-Nov-09

	Sight	2 - 8 Days	9 Days - 1 Month	1 - 3 Months	3 - 6 Months	6 Mths to 1 Yr	1 - 3 Years	3 - 5 Years	+5 Years	Total
Corporate Current / Call	24,289	0	0	0	0	0	0	0	0	24,289
Corporate Time Loan	28,433	14,203	151,471	106,637	98,959	47,608	357,872	573,993	642,563	2,021,738
Government Current/Call	342	0	0	0	0	0	0	0	0	342
Government Time Loan	250	3	805	63	3,383	2,942	12,656	7,016	76,853	103,971
Interbank Current / Call	41,752	0	0	0	0	0	0	0	0	41,752
Interbank Time Loan	339,276	201,745	6,251	31,906	18,704	28,428	11,971	0	0	638,281
Repos	0	0	0	47,500	0	0	0	0	0	47,500
Intergroup Current / Call	4,445	0	0	0	0	0	0	0	0	4,445
Intergroup Time Loan	210,177	348,414	277,964	76,268	13,981	30,047	156	101	0	957,108
Marketable Secs & CDs - <1Mth to maturity	5,009	0	55,358	0	0	0	0	0	0	60,367
Retail Current / Call	8,215	0	0	0	0	0	0	0	0	8,215
Retail Time Loan	238	41	221	2,643	2,427	310	6,294	38,755	10,204	61,133
Additional Corporate Time Lending	0	8	1,313	43	624	0	21,608	7,857	75,724	107,177
Receivables	0	0	0	0	0	0	0	0	0	0
Total Assets	662,426	564,414	493,383	265,060	138,078	109,335	410,557	627,722	805,344	4,076,318
Corporate Current / Call	51,033	0	0	12,758	0	0	0	0	0	63,791
Corporate Time Deposit	32,303	122,955	114,627	299,551	28,387	928	0	0	0	598,751
Government Current / Call	1,946	0	0	0	0	0	0	0	0	1,946
Government Time Deposit	2,056	8,112	24,391	23,503	22,687	1,200	0	0	0	81,949
Interbank Current / Call	82,087	0	0	0	0	0	0	0	0	82,087
Interbank Time Deposit	83,898	83,684	349,461	86,979	23,967	1,205	0	0	0	629,194
Repos	0	0	0	50,000	0	0	0	0	0	50,000
Intergroup Current / Call	47,095	0	0	0	0	0	0	0	0	47,095
Intergroup Time Deposit	302,879	418,383	629,809	225,314	88,464	78,769	375	0	0	1,743,993
Retail Current / Call	65,273	0	0	16,318	0	0	0	0	0	81,591
Retail Time Deposit	203	54,128	167,090	683,288	27,925	13,273	9,224	0	0	955,131
Additional Govt / Local AuthorityTime Deposits	8,656	9,319	50,508	82,531	15,252	8,500	1,000	0	0	175,766
Share Capital	0	0	0	0	0	0	0	0	0	0
Payables	0	0	0	0	0	0	0	0	0	0
Total Liabilities	677,429	696,581	1,335,886	1,480,242	206,682	103,875	10,599	0	0	4,511,294

Ratio Calculation		Sight	Sight - 8 Days	Sight - 1 M	
Marketable Securities		0	630,536	630,536	
Repos Adj*		0	0	0	
CD'S	GBP Denominated 39,000	0	353,219	353,219	
Unutilised Commitments		(55,520)	(55,520)	(55,520)	
Liquidity Gap		(15,003)	(147,170)	(989,673)	LIQUIDITY GAP IS ASSETS MINUS LIABILITY
Total Available Funds		(70,523)	$\boxed{781,065}$	(61,438)	TOTAL AVAILABLE FUNDS IS LIQUIDITY
					Total ALM Gap all tenors: 434,976
Total Liabilities		4,511,294	4,511,294	4,511,294	
Liquidity Ratio		-1.56%	17.31%	-1.36%	
		45	45	45	
Internal Limit			3.00%	-3.00%	
FSA Limit			0.00%	-5.00%	
Stress testing	10% Fall in Marketable Securities		15.13%	-3.54%	
Stress testing	10% Fall in Stickiness		17.32%	-2.79%	
Stress testing	Combined Effect of above		15.14%	-4.97%	

Figure 8.8 Liquidity report and liquidity ratio calculation.

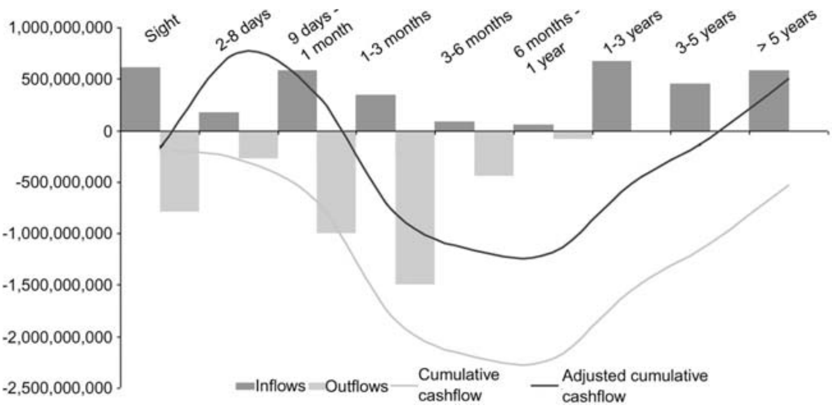


Figure 8.9 Cumulative liquidity model.

and predicts liquidity stress points on a cash basis. A report such as this – just like liquidity ratios – will be prepared daily at the legal entity level and group level.

Figure 8.9 is an example of a cumulative outflow output graph rising from the cumulative liquidity model. It gives a snapshot view of forward-funding stress points.

Liquidity risk factor (LRF)

This measure shows the aggregate size of the liquidity gap: it compares the average tenor of assets with that of liabilities. It is also known as a 'maturity transformation report'. The ratio can be calculated using years or days, as desired. For example, Table 8.2 is an example of the risk factor for a hypothetical bank, where the unit of measurement is days. In this example, 262/19 is slightly below 14.

The higher the LRF, the larger the liquidity gap and the greater the liquidity risk It is important to observe the trend over time and any

Table 8.2 Liquidity risk factor

Report date	**Average liability tenor** (days)	**Average asset tenor** (days)	**Maturity transformation effect**	**Limit**
30/09/2009	19	262	14	24

change to long-run averages, so as to get early warning of the buildup of a potentially unsustainable funding structure.

Concentration report and funding source report

The concentration report and funding source report show the extent of reliance on single sources of funds. An excess concentration to any one lender, sector or country is an early warning sign of potential stress points in the event of a crash.

An example of a concentration report is shown in Table 8.3. In this table, Customer 1 is clearly the focus of a potential stress point, and a bank would need to build in some contingency in the event that this source of funds dries up.

A related report is the funding source report, an example of which is shown in Table 8.4.

This is a summary of the share of funding obtained from all the various sources, and should be used to flag potential concentration risk by sector.

Table 8.3 Large depositors as percentage of total funding report

Customer	**Deposit amount** 000s	**Percentage of bank funding** (%)	**Percentage of group external funding** (%)
Customer 1	836,395	17.1	2.6
Customer 2	595,784	7.9	1.8
Customer 3	425,709	5.8	1.3
Customer 4	241,012	0.6	0.7
Customer 6	214,500	1.2	0.7
Customer 21	190,711	4.5	0.6
Customer 17	123,654	2.9	0.4
Customer 18	97,877	2.3	0.3
Customer 14	89,344	2.1	0.3
Customer 15	88,842	2.1	0.3
Customer 31	83,272	2.0	0.3
Customer 19	74,815	0.5	0.2
Customer 10	64,639	1.5	0.2
Customer 29	59,575	1.4	0.2
Customer 16	58,613	1.4	0.2
Total	*6,562,116*	*53.3*	*20.1*

Table 8.4 Funding source report

Source	Balance (EUR000,000s)	Funding (%)	Limit	Limit breach (Y/N)
Corporate and retail customers	1,891	46	>40%	Y
Institutional – financial institutions	675	17	<25% or 1bn	Y
Inter-bank	301	7	<25% or 1bn	Y
Inter-group (net balance)	400	10	<25% or 1bn	Y
Other	20	0	<25% or 1bn	Y
Total liabilities	*4,087*			

Inter-entity lending report

The inter-entity lending report is relevant for group and consolidated banking entities. As intra-group lending is common in banking entities, this report is a valuable tool used to determine how reliant a specific banking subsidiary is on group funds. An example of such a report is shown in Table 8.5.

We have described the range of reports that represent essential metrics in the measurement of liquidity risk. They are the minimum management information (MI) that banks and group treasuries will wish to prepare, both as business best practice and as part of adherence to new regulatory standards.

Table 8.5 Sample inter-company lending report

	Group Treasury		
As at (date)	Total borrowing	Total lending	Net intergroup lending
London	1,713,280	883,133	−830,157
Paris	3,345,986	978,195	−2,367,617
Frankfurt	17,026	195,096	178,089
Dublin	453,490	83,420	−370,070
Hong Kong	0	162,000	162,000
New York	690,949	1,516,251	825,302

Summary liquidity report

For executive summary reporting to senior management, a bank may provide a one-sided report of the main liquidity metrics. An example of this is shown in Figure 8.10.

Internal funding rate policy

We define liquidity risk as the risk of being unable to (i) raise funds to meet payment obligations as they fall due and (ii) fund an increase in assets. Funding risk is the risk of being unable to borrow funds in the market. The UK regulatory authority, the Financial Services Authority, has prescribed a mechanism to mitigate liquidity and funding risk that is notable for its focus on the type, tenor, source and availability of funding, exercised under normal and stressed market conditions.[1]

This emphasis on liquidity is correct and an example of a return to the roots of banking, when liquidity management was paramount. While capital ratios are a necessary part of bank risk management, they are not sufficient. Northern Rock and Bradford & Bingley were more a failure of liquidity management than capital erosion. Hence, it is not surprising that there is now a strong focus on extraneous considerations to funding.

However, the use of such funding within banks, including the price at which cash is internally lent or transferred to business lines, has not been as closely scrutinized by the FSA. This issue needs to be addressed by regulators because it is a driver of bank business models, which were shown to be flawed and based on inaccurate assumptions during 2007–2008.

An effective internal funding framework

While the FSA does touch on bank internal liquidity pricing,[2] the coverage is peripheral. This is unfortunate because it is a key element driving a bank's business model. Essentially, the price at which an individual bank business line raises funding from its Treasury desk is a major parameter in business decision-making,

---

[1] FSA, *Policy Statement 09/16*, October 2009.

[2] See p. 23, FSA CP 08/22, *Strengthening Liquidity Standards*, December 2008.

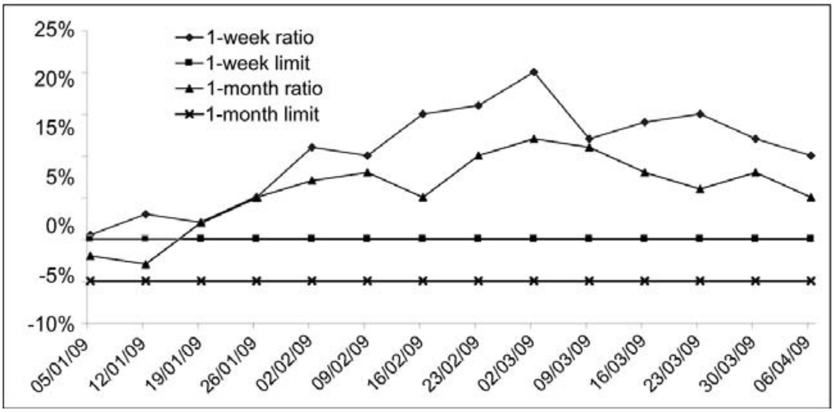
MONTHLY LIQUIDITY SNAPSHOT – Bank "D"

CUMULATIVE LIQUIDITY REPORT ($ '000)

Cumulative Liquidity Report									
	1 Day	2 Day	1 Week	2 Week	1 Month	2 Months	3 Months	6 Months	1 Year
Cumulative Net Cash Balance	80	80	-1,260	-1,260	-1,180	-1,408	-1,150	-850	-850
Other Forecast Inflows									
Other Forecast Outflows									
Cumulative Cash Gap	80	80	-1,260	-1,260	-1,180	-1,408	-1,150	-850	-850
Counterbalancing Capacity	180	180	635	640	748	748	1,238	1,238	1,238
Liquidity Gap	260	260	-625	-620	-432	-660	88	388	388
Limit									
Variance	**260**	**260**	**-625**	**-620**	**-432**	**-660**	**88**	**388**	**388**

The cash gap and the liquidity gap turn negative between 2 days and 1 week

LIQUIDITY RATIOS – THREE MONTH VIEW



Ratios are above the limit

	Current month	Previous month	Change
LIQUIDITY RISK FACTOR	22.2	25.1	
LOAN-to-DEPOSIT RATIO	96%	93%	
NET INTERGROUP LENDING	(1,228)	(1,552)	

Figure 8.10 Summary liquidity snapshot.

driving sales, asset allocation, and product pricing. It is also a key hurdle rate behind the product approval process and an individual business line's performance measurement. Just as capital allocation decisions affecting front-office business units need to account for the cost of that capital (in terms of return on regulatory and economic capital), so funding decisions exercised by corporate treasurers carry significant implications for sales and trading teams at the trade level.

In an ideal world, the price at which cash is internally transferred within a bank should reflect the true economic cost of that cash (at each maturity band) and its impact on overall bank liquidity. This would ensure that each business aligns the commercial propensity to maximize profit with the correct maturity profile of associated funding. From a liquidity point of view, any mismatch between the asset tenor and funding tenor, after taking into account the 'repoability' of each asset class in question, should be highlighted and acted upon as a matter of priority, with the objective to reduce recourse to short-term, passive funding as much as possible. Equally, it is important that the internal funding framework is transparent to all trading groups.

A measure of discipline in business decision-making is enforced via the imposition of minimum return-on-capital (ROC) targets. Independent of the internal cost of funds, a business line would ordinarily seek to ensure that any transaction it entered into achieved its targeted ROC. However, relying solely on this measure is not always sufficient. For this to work, each business line should be set ROC levels that are commensurate with its (risk-adjusted) risk–reward profile. However, banks do not always set different target ROCs for each business line, which means that the required discipline breaks down. Second, a uniform cost of funds, even allowing for different ROCs, will mean that the different liquidity stresses created by different types of asset are not addressed adequately at the aggregate funding level.

For example, consider the following asset types:

- a 3-month inter-bank loan
- a 3-year floating rate corporate loan, fixing quarterly
- a 3-year floating rate corporate loan, fixing weekly
- a 3-year fixed rate loan
- a 10-year floating rate corporate loan, fixing monthly
- a 15-year floating rate project finance loan, fixing quarterly.

These asset types have been deliberately chosen to demonstrate the different liquidity pressures that each places on the Treasury funding desk (listed in increasing amount of funding rollover risk). Even allowing for different credit risk exposures and capital risk weights, the impact on the liability funding desk is different for each asset; hence, the importance of applying a structurally sound transfer-pricing policy, dependent on the type of business line being funded.

Cost of funds

As a key driver of the economic decision-making process, the cost at which funds are lent from the central Treasury to a bank's business lines needs to be set at a rate that reflects the true liquidity risk position of each business line. If it is unrealistic, there is a risk that transactions are entered into that produce an unrealistic profit. This profit will reflect an artificial funding gain, rather than the true economic value-added of the business.

There is empirical evidence of the damage that can be caused by artificially low transfer pricing. In a working paper from 2008, Adrian Blundell-Wignall and Paul Atkinson[3] discuss the losses at UBS in its structured credit business, which originated collateralized debt obligations (CDOs) and invested in them. On p. 97 of their paper they quote a UBS shareholder report,

> '... internal bid prices were always higher than the relevant London inter-bank bid rate (LIBID) and internal offer prices were always lower than relevant London inter-bank offered rate (LIBOR).'

In other words, UBS' structured credit business was able to fund itself at prices better than in the market (which is implicitly inter-bank risk), despite the fact that it was investing in assets of considerably lower liquidity (and credit quality) than inter-bank risk. There was no adjustment for tenor mismatch – to better align term funding to liquidity. A more realistic funding model was viewed as a 'constraint on the growth strategy'.

This lack of funding discipline undoubtedly played an important role in the decision-making process because it allowed the desk to report inflated profits based on low funding costs. As a stand-alone busi-

---

[3] Blundell-Wignall, A., and Atkinson, P. (2008) 'The sub-prime crisis: Causal distortions and regulatory reform,' working paper, OECD, July.

ness, a CDO investor would not expect to raise funds at sub-Libor, but rather at significantly over Libor. By receiving artificially low pricing, the desk could report super profits and very high ROC, which encouraged increasingly risky investment decisions.

Another example involved banks that entered into the 'fund derivatives' business. This was lending to investors in hedge funds via a leveraged structured product. These instruments were illiquid, with maturities of 2 years or longer. Once dealt, they could not be unwound, thus creating significant liquidity stress for the lender. However, banks funded these business lines from the central Treasury at Libor flat, rolling over the short term. The liquidity problems that resulted became apparent during the 2007–2008 financial crisis, when inter-bank liquidity dried up.

Many banks operate on a similar model, with a fixed internal funding rate of Libor plus, say, 15 bp for all business lines and for any tenor. But, such an approach does not take into account the differing risk–reward and liquidity profiles of the businesses. The corporate lending desk creates different liquidity risk exposures for the bank compared with the CDO desk or the project finance desk. For the most efficient capital allocation, banks should adjust the basic internal transfer price for the resulting liquidity risk exposure of the business. Otherwise, they run the risk of excessive risk-taking heavily influenced by artificial funding gains.

Business best practice

It is important that the regulatory authorities review the internal funding structure in place at the banks they supervise. An artificially low funding rate can create as much potentially unmanageable risk exposure as a risk-seeking loan origination culture. A regulatory requirement to impose a realistic internal funding arrangement will mitigate this risk. We recommend the following approach:

- a fixed add-on spread over Libor for term loans or assets over a certain maturity – say, one year, where coupon refix is frequent (such as weekly or monthly) – to compensate for liquidity mismatch. The spread would be on a sliding scale for longer term assets.

Internal funding discipline is as pertinent to bank risk management as capital buffers and effective liquidity management discipline. As banks adjust to the new liquidity requirements soon to be imposed by the FSA, it is worthwhile for them to look beyond the literal scope of the new supervisory fiat and consider the internal determinants of an efficient, cost-effective funding regime. In this way they can move towards the heart of this proposition, which is to embed true funding cost into business line decision-making.

Funds transfer-pricing policy: liquidity premium framework

This policy framework has been introduced to better reflect the usage and provision of funds that flow through the Treasury as a result of the business undertaken by individual bank business lines (SBUs). It is meant to be reflective of market conditions and is separate from any Treasury margin that may be applied.

It is also a requirement of the UK FSA under its *Policy Statement 09/16* that the cost of liquidity should be included as part of the internal pricing of funds within an entity. We refer to this internal funding rate as the 'transfer price' (TP).

TP does not in any way reflect credit spread or credit premium. It is purely a liquidity premium.

Scope

This policy applies to all interest-bearing assets and liabilities on the bank's balance sheet, effective from 1 January 2010 onwards. It includes

- all interest-bearing assets and liabilities that are 'live' – that is, legacy transactions – as at 1 January 2010;
- separate trading desks within the Treasury;
- gross cashflows of each SBU/trading desk – as per existing transfer-pricing rules for interest rate risk, there is no netting allowed by SBUs.

Non-interest-bearing assets and liabilities are covered under a separate policy.

Framework

The TP policy applies equally to both sides of the balance sheet.

Assets

The framework for the pricing of assets is as follows:

- Libor will be used as the basis for funding as per existing transfer pricing rules.
- The final maturity date for assets is to be determined by reference to economic life or legal maturity date whichever is the shorter; economic life, in the case of corporate lending/securities, is to be determined on a case-by-case basis although the legal maturity date is to be used as the default endpoint.
- The framework applies to legacy trades.
- The pricing framework has been set by the Treasury and agreed by the bank's ALCO as:

Period to maturity	**<6 mo**	**6 mo–12 mo**	**1 yr–5 yr**	**>5 yr**
Assets	Libor	Libor + 15 bp	Libor + 20 bp	Libor + 50 bp

Liabilities

The proposed framework for the pricing of liabilities is as follows:

- Libor will be used as the basis for funding as per existing transfer-pricing rules.
- The final maturity date for liabilities is to be determined by reference to economic life or final maturity date whichever is the longer; economic life will be determined with reference to the stickiness rate allowed by the FSA under current reporting rules:

Corporate deposits	50%
Retail deposits	60%

- For the purposes of this framework, deposits that have had stickiness applied will be treated as having an economic life of 1-to-5 years. Stickiness is applied on a portfolio basis.
- The framework applies to legacy trades.
- The pricing framework has been set by the Treasury and agreed by the ALCO as:

Period to maturity	<6 mo	6 mo–12 mo	1 yr–5 yr	>5 yr
Liabilities	Libor	Libor + 15 bp	Libor + 20 bp	Libor + 50 bp

Ongoing

On an ongoing basis

- the ALCO is responsible for ensuring that this policy is maintained;
- a review of the pricing framework is to be undertaken by the ALCO every 6 months;
- pricing can be updated more frequently should market conditions require it.

Calculation methodology: the liquidity premium

The TP rate will be reviewed every 6 months to ensure that it is realistic to the market.

There is no universal method to calculate the liquidity premium that should be added to the Libor funding cost.

Methods that have been used include

- the difference between the ASW and CDS of the banks (where this is negative) for each tenor maturity;
- the difference between the funding spread over a bank of the same credit rating;
- a subjective add-on based on what the ALCO believes the bank will pay to raise longer dated funds, separate from the credit risk perception of the bank.

Conclusion

In this chapter we have considered the essential principles of bank liquidity risk management. The events of 2007–2008 serve to re-iterate the importance of sound ALM practice in banks. For this reason it is important that a bank's ALCO be set up as an effective management entity and be empowered to ensure correct business practice for asset–liability management. The framework set out in this chapter can be viewed as a best endeavours approach to operation of the ALCO function at a bank.

This page intentionally left blank

Chapter 9

A SUSTAINABLE BANK BUSINESS MODEL: CAPITAL, LIQUIDITY AND LEVERAGE

The global financial crisis has had the effect of making all participants in the banking industry – from regulators, central banks and governments to bank boards, directors and trade associations – undertake a fundamental review of the principles of banking. Issues such as capital and liquidity management as well as systemic risk became the subject of renewed focus. In practical terms, legislators realized that they needed to address the issue of the 'too-big-to-fail' bank, and this issue remains unresolved.

From the point of view of bank practitioners, the most important task is to address the issues of capital, liquidity and risk management and work them into a coherent strategy that is designed to produce sustainable returns over the business cycle. In this chapter we discuss these topics and consider how bank strategy can be formulated to handle the changed requirements of the post-crisis age. The contents are laid out as follows:

- bank business models
- strategy
- corporate governance
- liquidity risk and the liquid asset buffer.

We conclude with a view on sustainable banking.

The new bank business model

The basic bank business model has remained unchanged ever since banks became an integral part of modern society. Of course, as it more of an art than science, the model parameters themselves can be set to suit the specific strategy of the individual bank, depending on whether the strategy operates at a higher or lower risk–reward profile. However, the basic model is identical across all banks. In essence, banking involves taking risks followed by effective management of that risk. This risk can be categorized as follows:

- managing the bank's capital;
- managing the liquidity mismatch – a fundamental ingredient of banking is 'maturity transformation', the recognition that loans (assets) generally have a longer tenor than deposits (liabilities).

If we wished to summarize the basic ingredients of the historical bank model, we might describe it in the following terms:

- Leverage – a small capital base is levered up into an asset pool that can be 10 to 30 times greater (sometimes even higher).
- The 'gap' – essentially, funding short to lend long – is a function of the conventional positive-sloping yield curve and dictated by recognition of the asset–liability mismatch noted above.
- Liquidity – an assumption that a bank will always be able to roll over funding as it falls due.
- Risk management – an understanding of credit or default risk.

These fundamentals remain unchanged. The critical issue for bank management, however, is that some of the assumptions behind the application of these fundamentals *have* changed, as demonstrated by the crash of 2007–2008. The changed landscape in the wake of the crisis has resulted in some hitherto 'safe' or profitable business lines being viewed as risky. Although favourable conditions for banking may well return in due course, for the foreseeable future the challenge for banks will be to set their strategy only after first arriving at a true and full understanding of economic conditions as they exist today. The first subject for discussion is to consider what a realistic, sustainable return on the capital target level should be and to ensure that it is commensurate with the level of risk aversion desired by the board. The board should also consider the bank's capital availability and what amount of business this could realistically support. These two issues need to be addressed before the remainder of the bank's strategy can be considered.

Bank strategy

The most important function that a bank's board can undertake is to set the bank's strategy. This is not as obvious as it sounds. It is vital that banks have a coherent, articulated strategy in place that sets the tone for the entire business, from the top down.

In the first instance the board must take into account the current regulatory environment. This includes the requirements of the forthcoming Basel III rules. A bank cannot formulate strategy without a clear understanding of the environment in which it operates. Once this is achieved – before proceeding with a formal strategy – the bank needs to determine what markets it wishes to operate in, what products and what class of customer. All its individual business lines should be set up to operate within the main strategy, once markets and customers have been identified.

In other words, a bank cannot afford to operate by simply meandering along, noting its peer group market share and RoE and making up strategy as it goes along. This approach, which again is evidently what many banks do indeed follow – however inadvertently – results in a senior management and board that is not fully aware of what the bank's liabilities and risk exposures are.

The first task is to understand one's operating environment. Then, it is to incorporate a specific target market and product suite as the basis of its strategy. Concurrent with this, the bank must set its RoE target, which drives much of the bank's culture and ethos. It is important to get this part of the process right at the start. Prior to the crash, it was common for banks to seek to increase revenue by adding to their risk exposure. Assets were added to the balance sheet, or higher risk assets were taken on. In the bull market environment of 2001–2007 – allied to low funding costs as a result of low base interest rates – this resulted in ever higher RoE figures, to the point where it was common for even Tier 2 banks to target levels of 22% to 25% RoE in their business appraisal. This process was of course not tenable in the long run.

The second task – following on immediately from the first – is to set a realistic RoE target and one that is sustainable over the entire business cycle. This cannot be done without educating board directors as well as shareholders, who must appreciate the new, lower RoE targets. Managing expectations will contribute to a more dispassionate review of strategy. Just as importantly, risk-adjusted RoE should also be set at a realistic level and not be allowed to increase. Hence, the board and shareholders must accept that lower RoE levels will become the standard. This should also be allied to lower leverage levels and higher capital ratios.

Concurrently with the above process, a bank must also ask itself where its strengths lie and formulate its strategy around that. In other words, it is important to focus on core competencies. Again, the experience of the crash has served to demonstrate that many banks found themselves with risk exposures that they did not understand. This may have been simply the holding of assets (such as structured finance securities) whose credit exposures, valuation and secondary market liquidity they did not understand, or embarking on investment strategies such as negative basis trading without being aware of all the measurement parameters of such strategies.[1] To implement a coherent, articulate strategy properly, a bank needs to be aware of exactly what it does have (or does not have) expertise for undertaking, and not operate in products or markets in which it has no genuine knowledge base.

Allied to an understanding of core competence is a review of core and non-core assets. Bank strategy is not a static process or document, but rather a dynamic one. Regular reviews of the balance sheet need to be undertaken to identify any non-core assets, which can then be assessed to determine whether they remain compatible with the strategy. If they are not, then a realistic disposal process would need to be drawn up. In the long run, this is connected with an understanding of where the bank's real strengths lie. Long-term core assets may well differ from core assets, but this needs to be articulated explicitly. The decision on whether an asset is core or non-core, or short-term core or long-term core, is a function of the bank's overall strategy – based on its expertise – and what markets and customers it wishes to service. This will be embedded in the strategy and the bank's business model. This drives the choice of products and business lines to which the bank feels it can add value.

Leverage ratios

We discuss banks' capital structures on p. 268. There is no doubt that the new model for banking assumes higher capital ratios and buffers for all banks during the next 10 years. The higher level of capital will be substantial in some cases because under the proposed 'Basel III' rules trading business will be required to hold up to three times as much capital as vanilla banking business. It is also evident that

[1] Without naming the banks, the author is aware of institutions that purchased ABS and CDO securities under the belief that the senior tranche, rated AAA, would not be downgraded even if there was a default in the underlying asset pool, presumably because the junior note(s) would absorb the losses. Of course, this loss of subordination does erode the initial rating of the senior note – with a consequent markdown in market value. Another institution, according to anecdotal evidence received by email, entered into negative basis trades without any consideration for the funding cost of the trade package. This resulted in losses irrespective of how the basis performed. In this case, it is clear that the trading desk in question entered into a relatively sophisticated trading strategy without being sufficiently aware of the technical implications.

many bank jurisdictions will, in addition, implement leverage ratio limits.

A leverage ratio is the total value of a bank's assets relative to its equity capital. The financial crash highlighted the extent of risk-taking by certain banks when measured using leverage ratios. As a measure of the ratio of assets to owners' equity, they are an explicit indication of risk exposure. Lehman Brothers' leverage ratio increased from approximately 24× in 2003 to over 31× by 2007. Such aggressive asset growth generated tremendous profits during the boom years, but exposed the bank to such an extent that even a 3% or 4% decline in the value of its assets was capable of completely eliminating its equity. As we are all aware, this duly happened.

The Basel Committee on Banking Supervision (BCBS) and some national regulatory authorities are going to introduce a limit on leverage ratios as an added safety measure alongside capital requirements. In the aftermath of the crash it is accepted that bank leverage ratios have to adjust downwards, and the prevailing sentiment today dictates that boards should be wary of a business model that ramps up the ratio to an excessive level. Figure 9.1 shows levels during 2007–2009; prudent management suggests average levels will be much lower than these figures during the next 10–15 years. This is business best practice, because lower average leverage ratio levels also contribute to greater systemic stability.

Bank management will have to adjust to the concept of an explicit ratio limit, the rationale for which is clear. The experience of the last and previous crises has shown that during a period of upside growth

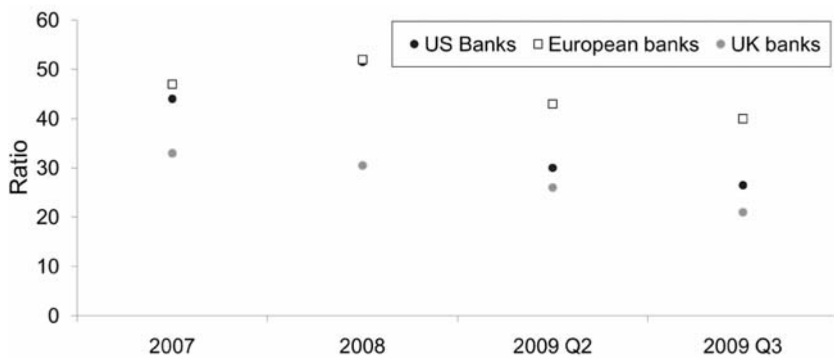


Figure 9.1 Bank median leverage ratios, 2007–2009.

Source: Bank of England (2009).

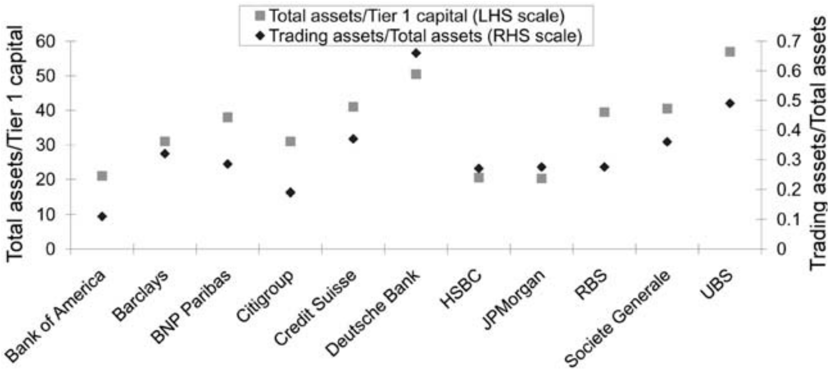


Figure 9.2 Selected bank ratio of total assets to Tier 1 capital and trading assets to total assets.
Source: Bank of England (2009).

banks' risk models tend to underestimate their exposure; this has two consequences: first, the bank takes on ever-greater risk as it targets greater revenue and profit during a bull market and, second, the amount of capital set aside is below what is adequate at the time the crash occurs. Figure 9.2, which shows a sample of 'bulge-bracket' banks, suggests that banks focused on trading assets as they expanded their balance sheets.

In such an environment, capital ratio requirements are insufficient to safeguard against instability, and it becomes necessary to monitor leverage ratios. Hence, in the post-crash environment banks need to adjust their business strategy to allow for this constraint.

As we noted above in the case of Lehman's, excessively high leverage results in a higher sensitivity of the balance sheet to trading and/or default losses. Limiting the amount of leverage acts as an additional risk control measure, backing up the safety net provided by a regulatory capital buffer. In advance of the introduction of a standardized ratio – as part of a future Basel III – banks can address this issue themselves as part of their prudential capital and risk management.

Note that a number of jurisdictions already employ a leverage ratio limit, although there is no uniform definition (see Table 9.1). It is likely that the new Basel III rules will incorporate a limit, along with a common definition of capital and an agreed measure of all assets, both on balance sheet and off balance sheet.

Table 9.1 Summary of selected regulatory leverage ratio limits

Canada	Tier 1 and Tier 2 capital must be at least 5% of on-balance-sheet assets plus qualifying off-balance-sheet assets
Switzerland	Tier 1 capital must be at least 3% of on-balance-sheet assets less Swiss domestic lending for bank holding companies, and at least 4% for individual institutions
United States	Tier 1 capital must be at least 3% of on-balance-sheet assets for 'strong' bank holding companies and at least 4% for all other bank holding companies

Source: Bank of England (2009).

Capital structure

The efficient management of capital is a vital function of bank senior management. In the aftermath of any recession, capital is of course a scarce commodity. However, this fact itself leads to one of the lessons learned from the crisis: the need for 'countercyclical' capital management. In other words, boards should treat capital as scarce at all times, and build up capital bases even as a bull market is helping to generate higher profits. The level of capital needs to be sufficient to cushion the fallout from 'stress events', which are the outlier events that normal distribution models of finance do not capture.

Contingent capital instruments can convert to equity whenever the issuing bank's capital ratio falls below a pre-specified level. Going forward, this should be the only 'sophisticated' financial instrument in the bank's capital structure. It will assist efficient capital management, as well as investor transparency, if a bank's capital is just held in the form of simple instruments: essentially, common equity and retained profits (reserves). Of course, long-dated debt instruments can also form part of capital, but again it is more transparent if these are vanilla instruments.

Capital on its own is an insufficient protection against firm failure. This is why bank management must take additional measures, over and above capital buffers, to safeguard the institution in the event of systemic stress or other market crash events, because the capital base in isolation will be insufficient to preserve the firm as a going concern. Hence, leverage ratio limits and robust liquidity management is as important as capital buffers. A report from the Bank of England (2009) has suggested that, on average, a Tier 1 capital ratio of 8.5% would have been needed by banks to avoid falling below the Basel minimum of 4% during the last crisis. This suggests that the current requirement is far too low to act as a genuine risk-based capital reserve. Of course, a financial crisis will affect different banks in different ways; the Bank of England report goes on to state that even if all the banks in its study sample had indeed possessed a Tier 1 ratio of 8.5%, as many as 40% of these banks would still have breached their 4% limit during the crash. For some firms the 'hindsight' sufficient level of capital was as high as 18%.

The implications of the Bank of England report are clear: minimum capital requirements must be higher and banks need to build an element of flexibility into their capital structure, perhaps by means of the contingent capital instruments discussed in Chapter 5. Contingent capital is any instrument that would convert into common equity on occurrence of a pre-specified trigger. This is illustrated in Figure 9.3. An issue of bonds by Lloyds Banking Group in 2009, called 'enhanced capital notes', was of this type. Such instruments enable a bank to purchase catastrophe insurance from the private sector rather than the public sector via the lender of last resort. They also allow a bank to hold a Tier 1 equity reserve at a lower cost than equity itself, in theory at least.

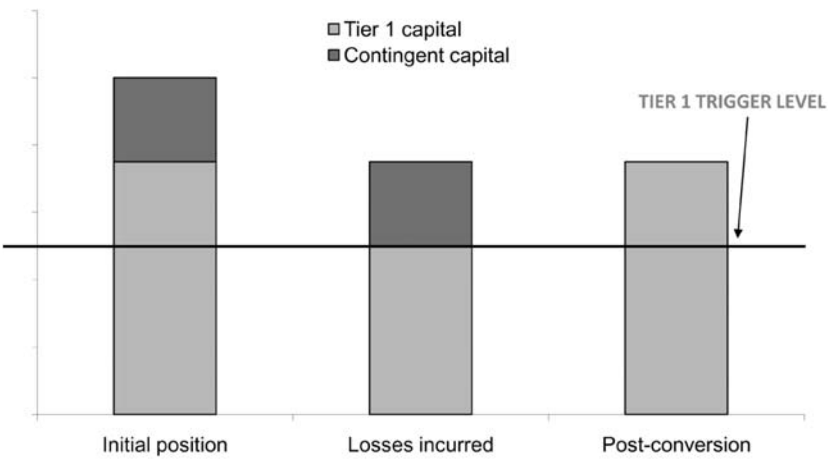


Figure 9.3 Illustration of contingent capital note triggering.

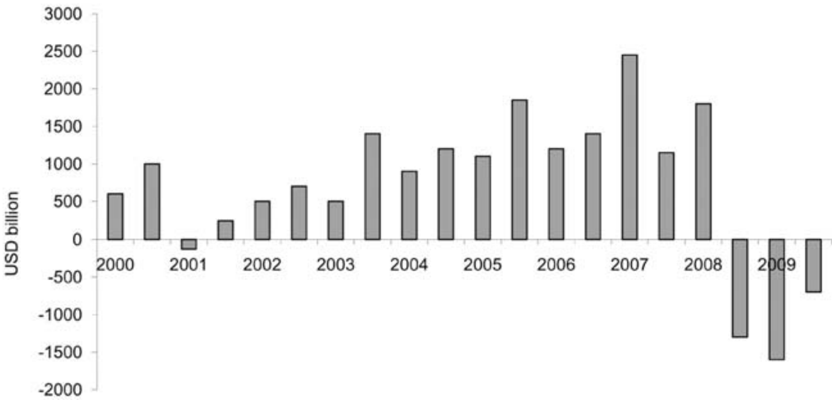


Figure 9.4 Cross-border bank lending volumes, 2000–2009.
Source: Bank of England (2009).

Core competence: 'know your risk'

Regulatory authorities noticed a considerable decline in cross-border lending flows in the aftermath of the Lehman bankruptcy (see Bank of England, 2009). This is significant. During the bull market of 2001–2007, international lending volumes had expanded steadily (see Figure 9.4), as banks grew their balance sheets and sought higher yield opportunities elsewhere.

It is evident that during and after the bank crisis, when interbank market liquidity had dried up, banks pulled back from overseas markets, irrespective of whether these were deemed peripheral or not, and concentrated on core markets. This reflects informational advantages in core markets compared with overseas and non-core markets. The UK corporate lending sector is a case in point: between 2002 and 2009, the lending volume from UK banks fell by approximately 16% (the figure between 2006 and 2009 was a decline of 14%). However, the equivalent figures for foreign subsidiaries was a fall of 10.5% and 20% while for foreign branches the decline was even more dramatic, at 17% and 46%.[2] Foreign banks would, on average, have less depth and breadth in their corporate relationships, while branches would be expected to have even less developed relationships in the domestic market.

[2] *Source*: Bank of England (2009).

The lessons for the bank business model are clear: during an expansionary phase, it is important to remain focused on areas of core competence and sectors in which the bank possesses actual knowledge and strength. Concentrating on areas in which the bank carries competitive advantage makes it less likely that loan origination standards will decline, resulting in lower losses during an economic downturn. There is also a technical reason for ensuring that overseas lending standards are maintained strictly and limits set carefully because it is often undertaken in foreign currency. A bank's ability to fund such lending is more dependent on external markets and wholesale counterparties relative to domestic lending, thus making the bank more vulnerable to a market downturn. For example, the cross-currency swap market in US dollars came under pressure resulting in higher swap prices, following the Lehman default, and many banks struggled to obtain dollar funding.

Liquidity risk management

In the aftermath of the crisis the UK's Financial Services Authority published *Consultative Paper 08/22* and *Consultative Paper 08/24* in 2008, the recommended requirements of which were formalized in its *Policy Statement 09/16* in October 2009. These documents have set a standard for bank liquidity management that is expected to be mirrored, in part if not wholly, in other jurisdictions around the world. As such they hint at a new facet of the basic bank business model that concentrates on the liabilities' side of the balance sheet. In essence the FSA has recognized that the crisis of 2007/2008 was as much a liquidity crisis as a capital loss crisis and has acted to mitigate this risk going forward.

Liquidity management: the new model

The basic tenets of the FSA's proposals are grounded in market logic. Their content is expected to become business best practice in due course, and bank boards and senior management need to incorporate these tenets in their operating models. The salient points include

- the number of mismatch (gap) limits are increased, as is supervisory oversight;
- increased international co-operation between regulators;

- bank-liquidity-reporting obligations and their frequency are increased;
- certain behavioural adjustments that were previously allowed are now revoked or reduced; for example, intra-group committed liquidity facilities no longer count as automatic funding self-sufficiency;
- other behavioural adjustments are to be reviewed on a case-by-case basis – for example, the treatment of deposit 'stickiness';
- new requirements to hold buffers of truly liquid assets – this is discussed on p. 276;
- new requirements to increase the average tenor of funding and diversify the sources of funds.

The main implication of these requirements is increased cost and, all else being equal, lower RoE. Other implications for this new business model include

- greater level of governance responsibility by senior management and the board;
- improved liquidity risk management capability (including better use of stress-testing and improved contingency-funding plans);
- decreased reliance on short-term wholesale funding;
- greater incentive for a bank to attract retail time deposits and longer term wholesale deposits;
- higher amount and quality of liquid asset stocks (including a higher proportion held in government bonds) – the liquid asset buffer;
- in theory, slower expansion of bank lending during favourable economic times.

The main implication for banks is increased likelihood of their surviving a liquidity stress event.

Another aspect of the new bank model required by regulators is more in-depth and realistic stress-testing. Jurisdictions will differ in detail. Taking the FSA papers as an example, however, banks should implement the following stress tests:

(1) Under the banner of name-specific shocks
   - Is there a risk of an unforeseen name-specific shock?
   - Is there a chance the market perceives the firm to be potentially insolvent in the short term?
   - What would be the long-term impact of a multi-notch downgrade in credit rating?

(2) Under the banner of market-wide dislocation
  - Is there a risk of unforeseen short-term market-wide dislocation that gradually evolves into long-term market-wide liquidity stress?
  - Are there widespread concerns about the solvency of the financial sector?
  - Is there uncertainty about the value of financial assets?
  - Is there a risk of certain asset classes remaining illiquid for a long period?

(3) A combination of (1) and (2).

Using the FSA template as a guide, a bank should stress-test the following main risk drivers:

- wholesale funding risk
- intra-group funding risk
- intra-day liquidity risk
- cross-currency liquidity risk
- retail funding risk
- size and quality of liquidity buffer
- wholesale (unsecured) lending and retail loans
- off-balance-sheet liquidity risk
- continuation of business
- diversification of funding sources.

Responsibility for formulating the stress tests, ensuring that they are carried out robustly and at the required frequency, and reporting the results to the board, lies with the chief risk officer. Under business best practice culture, this person will report direct to a NED on the board.

Basel Committee proposals and the net stable funding ratio

The Basel Committee for Banking Supervision (BCBS) published extensive proposals for a revamp of certain aspects of the Basel rules – termed 'Basel III' – for implementation from the end of 2012. In this section we consider the implications of its contents for bank liquidity-funding arrangements and liquidity reporting.

A significant aspect of Basel III is a new liquidity measurement metric known as the net stable funding ratio (NSFR).

The stated objective of the NSFR is to encourage more medium-term funding; the metric itself highlights the level of long-term funding compared with short-term liabilities. At this stage, no limit for the

NSFR has been set, and such a limit is unlikely; however, regulators are expected to compare each bank's figure against its peer group average and range. At the time of writing, the exact calculation of the metric has not been specified; the author agrees with either of two suggestions put forward by the British Bankers Association (BBA) as part of its response to the BCBS proposals.

Certainly, the NSFR is not a metric on which one could set a 'one-size-fits-all' limit. As such, it is expected that supervisors will view it as part of a set of other metrics before determining regulatory compliance. However, bank senior management need to be aware of it, and structure their liabilities within an acceptable bound for regulatory compliance.

The BBA has suggested either of the following definitions for calculation of the NSFR:

- Capital *plus* term funding with residual maturity over 1 year *plus* non-wholesale funding *divided by* assets not marketable within 1 year:

$$\frac{\text{Capital} + \text{Term funding } (> 1 \text{ year}) + \text{Retail funding}}{\text{Assets} > 1 \text{ year}}$$

- Given that the problem during the crisis was one of overreliance on short-term (<1 year) wholesale funding, an alternative calculation of the metric could be by using a formula of the form:

$$\frac{\text{Unsecured wholesale funding} < 1 \text{ year}}{\text{Total deposits} + \text{Debt securities in issue} + \text{Capital}}$$

In essence. the purpose of the NFSR is to control the level of maturity transformation that an institution undertakes.

With regard to liquidity measurement reporting, the BCBS has proposed a consistent set of monitoring metrics for all firms. The purpose of this is to assist supervisors across jurisdictions in looking at liquidity risk in global banks, and creating a common language, thereby reducing the risk of misinterpretation of information by bank boards and regulators. It will also have the added advantage of reducing system costs in reporting the liquidity risk being run by such entities.

We discussed a range of reports in Chapter 8. Some of these are in the BCBS list, including:

(i) Loan-to-deposit ratio.
(ii) Cumulative liquidity model – a forward-looking model of

inflows, outflows and available liquidity, accumulated for a 12-month period. It recognizes and predicts liquidity stress points on a cash basis. This will also include 1-week, 1-month and 3-month liquidity ratios.

(iii) Liquidity risk factor (also known as maturity transformation) – the average tenor of assets to average tenor of liabilities.
(iv) Inter-entity funding report for group and consolidated banking entities.
(v) Pricing data.
(vi) Currency analysis.
(vii) Retail and corporate funding levels.
(viii) Long-term-funding/core-funding ratio.
(ix) Liquid asset buffer.
(x) Survival horizon.
(xi) Domestic quantitative ratios.
(xii) Systems and controls questionnaire or qualitative self-assessment.

In addition, there are a number of other reports that the author considers to be useful:

(i) A funding concentration report indicates the extent of reliance on single sources of funds – for example, the top-five biggest single sources, by sector and individual firm/customer. It also ascertains whether the limits set by the bank exceed more than, say, 10% of funds from one single source.
(ii) Report on the amount of funding capacity that exists after taking into account the headroom required to survive a stress event (whether firm specific or market wide), on the extent to which existing liabilities and assets are rolled over and on the amount of new business put on, over a given period of time. We call this metric the 'surplus funding capacity' of a bank.
(iii) A weekly qualitative report that provides a descriptive summary of any material detrimental changes to the above metrics – for example, it explains significant changes in the 1-week and 1-month liquidity ratios, the cash and liquidity gap in the cumulative liquidity model, the liquidity risk factor, intergroup borrowing/lending position, etc.

A bank that reports using the full suite of metrics listed above will be able to give a transparent picture of its liquidity position, which is essential to ensuring orderly regulatory supervision.

Bank senior management and boards must incorporate the constituent elements that make up the BCBS proposals, as they will form an essential part of the new bank model during the next 10 years.

The liquid asset buffer

If one reviewed bank balance sheets from the 1950s through to the 1990s, it was common practice to observe that – on the asset side – part of it would be comprised of government bonds. That this practice fell into disuse reflects the thinking of the last 10–15 years: that market liquidity could be taken for granted and bank 'liquidity' portfolios could be held in the form of higher yielding bank bonds (MTNs and FRNs).

Under the FSA's *Policy Statement 09/16*, a 'liquid asset buffer' (LAB) is now mandatory for all UK-regulated banks. It is to be recommended as a standard part of all bank business models – irrespective of jurisdiction – because of the obvious risk mitigation impact of doing so. Because sovereign bonds pay less than other securities, the implication of this change is clear: RoE will be lower.

Using FSA requirements as a template, a bank should adopt the basic operating model for its LAB by:

- Requiring all branches to hold buffers of liquid assets. The expectation behind this thinking is that LAB assets will retain both value and liquidity in a stressed environment. The evidence for this is strong: in October and November 2008, the only assets that remained liquid, and acceptable for repo, were G7 sovereign securities. Bank CDs, FRNs, corporate bonds and structured finance securities all became illiquid and/or were no longer acceptable as collateral.
- Making the central bank eligibility of the LAB asset irrelevant.
- By funding the LAB by long-term (>90 day) funds including retail and wholesale funds – and not funding in repo. This is to ensure that the bonds can act as a true buffer of liquidity, able to be sold or repoed if funding becomes stressed for the bank.

The LAB for most banks in Western jurisdictions would be expected to be comprised of the following (this is direct from the FSA document):

> 'Highly liquid, high-quality government debt instruments such as gilts, plus bonds rated at least Aa3 issued by the countries of the European Economic Area (EEA), Canada, Japan, Switzerland and the United States; reserves held with the Bank of England's reserve scheme and with the central banks of the U.S, the EEA, Switzerland, Canada and Japan. Designated multilateral development banks including
> – African Development Bank
> – Asian Development Bank
> – Council of Europe Development Bank
> – European Bank for Reconstruction and Development
> – European Investment Bank
> – Inter-American Development Bank
> – International Bank for Reconstruction and Development
> – International Finance Corporation
> – Islamic Development Bank
> – Nordic Investment Bank.'

It is fairly clear that the LAB at a bank must ideally hold only high- quality assets, or otherwise be comprised of cash deposits at the central bank. Because many eligible bonds held in an LAB would pay lower than LIBOR, banks will want to hold such bonds that are longer dated so as not to lose money on the portfolio, if they are funded shorter tenor in a positive-sloping yield curve environment.

The FSA expects a firm to turn over its liquidity buffer on a regular basis, either through the sale of assets or via repo. As we noted above, the portfolio cannot be funded in repo. It must be funded using unsecured funds, retail deposits or term funds – that is, over 90-day maturity. The size of the buffer is a key point. The exact proportion of a bank's balance sheet that has to be held in the form of an LAB is a function of the type of institution and the structure of its funding.

The FSA's calculation suggests that a bank will have to hold the aggregate total of its 3-month funding base as a liquid buffer. In other words, the more longer term funds a bank has, the smaller its buffer. Essentially, the calculation of how much of a buffer a bank needs to hold is a function of how much short-dated (0–90 day) wholesale funding a bank has. The higher the short-dated wholesale funding of a bank, the larger its LAB.

Conclusions and recommendations

A neutral observer of the world's economic system would conclude fairly quickly that financial markets, and banks, are indispensable parts of the economy and societal well-being. It is vital therefore that any regulatory system should incorporate the means of enforcing stability in the banking market. It should also allow for financial market innovation because it has been largely through this that many of the benefits of finance have been made available to the wider population. But the key priority is effective regulation so that – even if individual banks are forced into liquidation – market stability is maintained. In other words, regulation must not only seek to preserve stability but also recognize that the main business of banks involves taking risk: the act of maturity transformation, the cornerstone of banking, creates risk exposure.

Bank senior management and boards should accept that the institutions they run are pivotal parts of society and that in the post-crisis era they will be closely regulated. Contributing to the stability of the market is as important an objective for a board as is achieving shareholder RoE targets. To this end, an understanding and appreciation of market stability is vital. In the first instance, increasing bank capital levels is a necessary though not necessarily sufficient means of ensuring a stable banking system: liquidity management is just as important. In this regard, the UK FSA's requirement that all UK-regulated banks must maintain an LAB is correct. Forcing every bank to invest a proportion of their assets in cash, central bank deposits and liquid AAA-rated sovereign securities is the best insurance protection against future liquidity crises.

We believe all banks should adopt this approach. The exact proportion of the balance sheet that should be placed in the LAB is a function of the liquidity gap that the bank runs as well as the diversity and security of its funding arrangements. One form of LAB is best business practice, and all banks should seek to put it in place. In itself this is not a new suggestion; a truly liquid portfolio was commonplace in banks around the world 15 or 20 years ago. However, banks started to unilaterally relax their own requirements and remove liquidity portfolios, or move them into assets that were not truly liquid (such as bank FRNs), to the point where such portfolios had become rare even in supposedly conservative institutions such as the UK's building societies. It is evident that the prevailing orthodoxy has now gone full circle.

Bank boards should seek to simplify their capital structures in the interests of transparency and investor comfort. The simplest structure may well be the most efficient, with a liability base comprised of pure equity, retained profits, senior unsubordinated bonds and deposits. Deposits are part of a country's deposit guarantee scheme, so such a structure leaves no ambiguity about what stakeholders are at risk should the bank fail.

The nature of bank liquidity management has been transformed, although many of the 'new' requirements in regimes – such as those implemented by the FSA – are more of a return to basics than actual new practices. The new bank business model for the next 10 or 20 years will incorporate these practices, with boards recommended to pay close attention to their banks' liability structures. The basic tenets of the new liability model is less reliance on wholesale funding, less reliance on short-term funding, a more diversified funding base, and genuine self-sufficiency in funding. Under this new model, banks will be considerably less likely to suffer failure at the time of the next market crash or systemic stress event.

REFERENCES

Bank of England (2009) *Financial Stability Report*, Issue No. 26, December.

Choudhry, M. (2007) *Bank Asset and Liability Management*, John Wiley & Sons (Asia) Pte Ltd.

Chapter 10

BANK REGULATORY CAPITAL

The capital allocation requirements of a financial institution are behind overall banking strategy. Asset allocation decisions are influenced to a great extent by the capital considerations that such allocation implies. Lower capital requirements for derivatives explain to a great extent why derivatives are used by banks and corporates instead of cash products. This is as true of the money markets as it is of the bond markets. For that reason, a book on global money markets must cover banking itself, otherwise it will be incomplete. An understanding of banking is not possible without an understanding of one of its key aspects: regulatory capital.

For instance, a key aspect of the money markets involves securitized products – for example, asset-backed commercial paper. Previously, one of the key motivations behind securitization was the requirement to obtain capital relief. This led to mortgages, trade receivables and other assets being securitized. We can see that it is vital to understand the implications of capital costs. Moreover, the issue of cost of capital must also take into account the regulatory capital implications of any asset allocation taken by a trading desk. Money market participants must know about regulatory capital issues – whether they trade CDs, bills, repos, FRNs, ABCPs – or they will not fully understand the cost of their own capital and hence return on capital.

Banking regulatory capital requirements

Banks and financial institutions are subject to a range of regulations and controls, a primary one of which is concerned with the level of capital that a bank holds and whether this level is sufficient to provide a cushion for the activities that the bank enters into. Typically, an institution is subject to the regulatory requirements of its domestic regulator, but it may also be subject to cross-border requirements such as the European Union's capital adequacy directive.[1] A capital requirements scheme proposed by a committee of central banks acting under the auspices of the Bank for International Settlements (BIS) in 1988 has been adopted universally by banks

[1] In the UK, banking regulation is now the responsibility of the FSA, which took over from the Bank of England in 1998. In the US, banking supervision is conducted by the Federal Reserve; it is common for the central bank to be a country's domestic banking regulator.

around the world. These are known as the BIS regulatory requirements or the Basel capital ratios, from the town in Switzerland where the BIS is based.[2] Under the Basel requirements all cash and off-balance-sheet instruments in a bank's portfolio are assigned a risk weighting, based on their perceived credit risk, which determines the minimum level of capital that must be set against them.

A bank's *capital* is, in its simplest form, the difference between the assets and liabilities on its balance sheet, and is the property of the bank's owners. It may be used to meet any operating losses incurred by the bank, and if such losses exceed the amount of available capital then the bank will have difficulty in repaying liabilities, which may lead to bankruptcy. However, for regulatory purposes capital is defined differently; again, in its simplest form regulatory capital is comprised of those elements in a bank's balance sheet that are eligible for inclusion in the calculation of capital ratios. The ratio required by a regulator will be that level deemed sufficient to protect the bank's depositors. Regulatory capital includes equity, preference shares and subordinated debt, as well as general reserves. The common element of these items is that they are all *loss absorbing*, whether this is on an ongoing basis or in the event of liquidation. This is crucial to regulators, who are concerned that depositors and senior creditors are repaid in full in the event of bankruptcy.

The Basel rules on regulatory capital originated in the 1980s, when there were widespread concerns that a number of large banks engaged in cross-border business were operating with insufficient capital. The regulatory authorities of the G10 group of countries established the Basel Committee on Banking Supervision. Its 1988 publication, *International Convergence on Capital Management and Capital Standards*, set proposals that were adopted by regulators around the world as the 'Basel rules'. The Basel Accord was a methodology for calculating risk, weighting assets according to the type of borrower and its domicile. The Basel ratio[3] set a minimum capital requirement of 8% of risk-weighted assets.

---

[2] BIS (1988) *International Convergence of Capital Measurement and Capital Standards*, Basel Committee on Banking Regulations and Supervisory Practice, July.

[3] Also known as the 'Cooke ratio' after the Chairman of the Basel Committee at the time, Peter Cooke.

In this chapter we summarize the essential elements of the current requirements, now referred to as Basel II, and then discuss the BIS proposals now known as Basel III.

Capital adequacy requirements

The origin of the current capital adequacy rules was a desire by banking regulators to strengthen the stability of the global banking system as well as harmonize international regulations. The 1988 Basel Accord was a significant advancement in banking regulation, setting a formal standard for capitalization worldwide. It was subsequently adopted by national regulators in over 100 countries. The Basel rules have no regulatory force as such; rather, individual country regulatory regimes adopt them as a minimum required standard. This means that there are slight variations on basic Basel requirements around the world, of which the European Union's capital adequacy directives are the best example.

Basel I rules

The BIS rules set a minimum ratio of capital to assets of 8% of the value of the assets. Assets are defined in terms of their risk, and it is *weighted risk assets* that are multiplied by the 8% figure. Each asset is assigned a risk weighting, which is 0% for risk-free assets such as certain country government bonds and up to 100% for the highest risk asset such as certain corporate loans. So, while a loan in the inter-bank market would be assigned a 20% weighting, a loan of exactly the same size to a corporate would receive the highest weighting of 100%.

Formally, the BIS requirements are set in terms of the type of capital that is being set aside against assets. International regulation (and UK practice) defines the following types of capital for a bank:

- *Tier 1* – perpetual capital, capable of absorbing loss through the non-payment of a dividend. This is shareholders' equity and also non-cumulative preference shares.
- *Upper Tier 2* – this is also perpetual capital, subordinated in repayment to other creditors; it may include, for example, undated bonds such as building society PIBS, and other irredeemable subordinated debt.
- *Lower Tier 2* – this is capital that is subordinated in repayment to other creditors, such as long-dated subordinated bonds.

The level of capital requirement is given by:

$$\left.\begin{array}{l} \dfrac{\text{Tier 1 capital}}{\text{Risk-adjusted exposure}} > 4\% \\[2ex] \dfrac{\text{Tier 1 + Tier 2 capital}}{\text{Risk-adjusted exposure}} > 8\% \end{array}\right\} \qquad (10.1)$$

The ratios in equation (10.1) therefore set minimum levels. A bank's *risk-adjusted exposure* is cash risk-adjusted exposure together with risk-adjusted off-balance-sheet exposure. For cash products on the banking book, capital charge calculation (risk-adjusted exposure) is given by:

$$\text{Principal value} \times \text{Risk weighting} \times \text{Capital charge (8\%)}$$

calculated for each instrument.

The sum of the exposures is taken. Firms may use netting or portfolio modelling to reduce the total principal value.

Capital requirements for off-balance-sheet instruments are lower because for these instruments the *principal* is rarely at risk. Interest rate derivatives such as forward rate agreements (FRAs) of less than 1 year's maturity have no capital requirement at all, while a long-term currency swap requires capital of between 0.08% and 0.2% of the nominal principal.

The BIS makes a distinction between *banking book* transactions as caried out by retail and commercial banks (primarily deposits and lending) and *trading book* transactions as carried out by investment banks and securities houses. Capital treatment differs between banking and trading books.

A primer on Basel II

The Basel II rules were published in final form in June 2004.[4] This chapter concentrates on the essentials behind the main rulings contained in the BIS document – these are important from an ALM strategist's point of view.

---

[4] The actual title of the document, published by the Basel Committee on Banking Supervision of the Bank for International Settlements on 26 June 2004, is *International Convergence of Capital Measurements and Capital Standards.*

The aim of Basel II was to align economic and regulatory capital more closely than Basel I. It introduces three different approaches that a bank can adopt to achieve this: the standardized approach, which is not far removed from the current Basel I framework but which applies more risk-weighting categories and uses formal credit ratings; and the foundation and advanced internal-ratings-based (IRB) approaches, which are more complex and allow for a bank to use its own risk models and risk exposure data in line with the Basel II framework. Implementation of the new rules should result in changes in certain bank and ALM activity, with certain products and sectors seeing greater activity and other areas less, as capital is realigned and banks seek to meet adjusted target rates of return.

Overview

Given that the primary objective behind Basel II is to better align economic with regulatory capital, we conclude that banking activity exhibiting low economic risk will attract a low capital charge. Such activity might include residential mortgages and high-grade corporate lending. By the same token, business that previously was of interest to banks because regulatory treatment seemed less onerous than perceived economic risk, such as low-rated securitization tranches and non-OECD country lending, should become less attractive. Following this logic, banks that have a high proportion of lower risk business, such as commercial and retail banks, will find that their capital charge has reduced. The model-based approaches – the foundation and advanced IRB – require less capital to be held compared with the standardized approach. Implanting these approaches will call for a large investment in risk management models and internal data systems – something only the larger banks can afford. Thus, an advantage is presented to large banks over small banks straight away.

Three-pillar approach

The cornerstone of the Basel II rules is the three-pillar approach. These are minimum capital requirements, supervisory review and market discipline. A general description of them follows.

Minimum capital requirements. The objective of these is to produce a closer link between economic and regulatory capital. The underlying idea is to remove any possibility of regulatory capital arbitrage, which was common under Basel I. There is a more tailored regime, with more specific targeting of individual credits rather than the broad-brush approach of Basel I which targeted whole asset classes. An example of this was the 20% risk weighting given to OECD country banks, which meant some low-rated banks required the same capital set-aside as very highly rated banks. The 100% risk weighting for all corporates, regardless of their credit quality or country of incorporation, was another example of this. Also under this pillar was a more contentious issue, a new capital charge for operational risk. This would cover the risk of IT breakdown as well as risks such as fraud and trading irregularity.

The definition of bank capital remains as it was under Basel 1, and the minimum capital ratios of 4% for Tier 1 and 8% for total capital also remain in place. So, Pillar 1 – and Basel II as a whole – is concerned only with the denominator of the capital ratio calculation as established under Basel 1 – not the numerator which remains unchanged.[5]

Supervisory review process. This is the focus of Pillar 2 and covers national regulators' reviews of bank capital assessment models. It describes the process by which the regulator sets minimum capital requirements that exceed those outlined in Pillar 1, with the exact requirements being a function of the risk profile of each bank. Banks must also assess their credit concentration risks and stress-test them under various conditions.

Enhanced public disclosure. Pillar 3 requires banks to publish their risk-weighting calculations, capital breakdown and capital adequacy.

Approaches to credit risk

The Basel II rules can be implemented under three alternative approaches: standardized, foundation IRB and advanced IRB. These can be briefly described as follows:

- *Standardized approach*. The most straightforward to apply, with risk weights being assigned according to asset class or formal credit ratings. The assets are described as residential mortgages, corporate loans, and so on.

---

[5] There is a slight change to the numerator in the ratio under Basel II in circumstances where deductions of capital for certain asset classes must be made, but this will not apply to all banks.

- *Foundation IRB*. Under the foundation IRB approach, capital calculation is made after the bank itself sets default probabilities for each class of assets. The bank assigns probabilities of default (PD) to each asset class, or each asset in accordance with credit rating. Using the Basel II guidelines it then sets parameters for loss given default (LGD), exposure at default (EAD) and maturity (M). These inputs are then used to calculate the risk weights for each asset class using the Basel II capital calculation formula. Foundation IRB may be used as a stepping stone before implementation of the advanced IRB methodology, or retained as the calculation method in its own right.
- *Advanced IRB*. Under the advanced IRB approach, a bank will calculate risk weights using its own parameters, which are arrived at from its own default data and internal models.

Under the IRB approach banks may use their own data, though – significantly – it must include data for PD, LGD and EAD. Their own model can be used to calculate risk weights, which is then adjusted by a scaling factor. In practice, this means a scaling factor of 1.06 will be applied. Note that a bank must adopt the same approach for both its banking book and its trading book.

The majority of banks, especially those outside Europe, are expected to employ the standardized approach. Smaller banks with extensive retail and mortgage business are also expected to adopt the standardized approach. Only the largest banks are expected to adopt the advanced IRB approach, which requires significant investment in internal systems. Banks that wish to implement the advanced IRB approach must seek supervisory approval of their systems and models from their national regulator.

Operational risk

Basel II introduced a capital set-aside to cover operational risk – a contentious departure from the requirements of Basel I. Banks are required to calculate a capital charge for operational risk, separate from the capital charge for credit risk. Each approach has its own calculation method. The general calculation is that a bank must apply 15% of its average revenue over the last 3 years – revenue is defined as net interest income (NII) plus non-interest income.[6] Under the standardized approach a bank may calculate its own level of operational risk, per business line, and apply the capital charge based on this risk exposure. The charge itself can then lie within a 12% to 18% range, rather than the uniform 15% level.

Under the advanced IRB approach a bank will calculate its own operational risk level and then apply its own capital charge, under BIS guidelines of course. This enables a bank to set lower operational risk charges for certain business lines, where it can show that risk exposure is lower.

Table 10.1 is a summary of the main differences between Basel I and II by asset class. Certain sectors, such as residential mortgages and high-credit-rated corporate lending, gain substantially under the new regime, whereas some businesses such as fund management, which previously attracted no charge, now carry an operational risk charge.

Impact on specific sectors

To illustrate Basel II further, we consider it with regard to specific selected asset classes. One can gain some idea of the objectives of the new rules by looking at their impact on different business lines. We review sovereigns first, followed by bank assets, structured finance securities, corporates and credit derivatives.

Sovereign business

As was the case with all asset classes, the treatment of sovereign debt under Basel I was very simple. Sovereigns were divided into OECD and non-OECD debt.[7] OECD sovereign debt was risk-weighted at 0%, while non-OECD sovereigns were risk-weighted at 100%. Under Basel II there is a deeper distinction, with risk-weighting

---

[6] Some national regulators have specified that a bank may take average volume of business, such as volume of assets, over the last 3 years rather than revenues.

[7] The member countries of the Organization for Economic Cooperation and Development (OECD) are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, South Korea, Spain, Sweden, Switzerland, Turkey, the UK and the US.

Table 10.1 Comparison of regime change from Basel I to Basel II – risk weights

Asset class	Basel I (%)	Basel II Standardized (%)	Basel II IRB[a] (%)	Notes
Sovereign	0 (OECD)	0–150[b]	0–400	New regime is essentially rating based. 100% risk weighting for unrated sovereigns. Lower rated OECD sovereigns attract higher charges, whereas high-rated non-OECD sovereigns now attract lower charges
	100 (non-OECD)			
Bank sector	20 (OECD)	20–150[b]	6–400	There are two approaches, either (i) one rank lower than sovereign rating or (ii) based on bank's own credit rating
	100 (non-OECD)			Unrated banks carry 50% weighting. Banks rated A to BBB attract a higher charge of 50% from 20% under the old regime
Retail				
– Mortgages	50	35	13–227	Banks with large and/or high-quality mortgage books will have an incentive to move to IRB
– Credit card, etc.	100	75	10–227	Overdue unsecured loans are weighted at 100–150% under the standardized approach

Corporate loans	100	20–150	14–400	Under IRB there is more favourable teatment for investment-grade rated loans. Under the standardized approach there is a gain for certain subinvestment-grade loans and also, paradoxically, for unrated lending. The latter attract 100% under the standardized approach
Small/medium enterprises (SMEs)	100	100	11–198	Certain lending to small corporates (<EUR50 million annual sales) gains advantages under Basel II
Structured finance (ABS, etc.)	100 50 (AAA/AA-rated RMBS)	20–1,250	7–1,250	There is a deduction from capital for tranches rated below B+. There is favourable treatment for senior tranches, which attract lower charges compared with Basel I. This may result in increased demand for senior tranches of ABS/MBS/CDO. There is a higher charge for subinvestment-grade tranches
Operational risk	0	15	12–18	A new charge, whose effect is to incease overall capital charges for most banks. Biggest impact on business lines in banking that attract no regulatory capital charges under Basel I (e.g., fund management, advisory services)

Source: BIS, EU CRD.

[a] Ranges given under assumptions of worst case scenarios including 50% LGD and 10% PD.

[b] There is reduced risk weighting if the exposure is denominated, and funded, in the bank's domestic currency.

Table 10.2 Basel II sovereign debt risk weightings (standardized approach)

Basel I	(%)	**Basel II**	(%)
OECD	0	AA− and above	0
Non-OECD	100	A	20
		BBB	50
		BB+ to B−	100
		Below B−	150
		Unrated	100

Source: BIS.

assigned by credit rating (under the standardized approach). This is shown in Table 10.2.

The IRB approaches use banks' own internal measures of risk. Under the standardized approach, formal credit ratings from external credit assessment institutions (ECAIs) assume a high importance. The BIS document describing Basel II states that if a country carries a rating each from S&P's, Moody's and Fitch's, and one of these is lower than the other two, then the higher can be assumed. For a bank holding the debt of a country like China (which is rated A/A2/A−) this rule has no impact; however, for a bank holding the debt of Malaysia (which is rated A/BBB/A), this is significant. It means that the bank can take the two higher ratings, which enable it to apply a 20% risk weighting. This is considerable compared with a Basel I weighting of 100%.

An effective if simple illustration of the new regime can be given as follows: consider a bank holding two bonds, each of USD10 million nominal, issued by South Africa and South Korea, respectively. Under Basel I – taking the minimum 8% capital requirement – the capital charges for each are

South Africa government bond capital	(10,000,000 × 100% × 8%) or USD800,000
South Korea government bond capital	USD0.00.

Under Basel II's standardized approach the charges are

South Africa	(10,000,000 × 50% × 8%) or USD400,000
South Korea	(10,000,000 × 50% × 8%) or USD400,000.

So, in this stylized example the impact is quite significant. The makeup of government bond portfolios in banks will be reviewed and heavily influenced by each sovereign credit ECAI. As capital charges rise for certain borrowers compared with others, those sovereigns that suffer an adverse impact in terms of the capital that a bank investor is required to hold against them may find their issuance yields rise. It is not necessarily emerging market sovereigns that will be so impacted. Italy is currently rated at A by S&P's (although it is rated Aa2 by Moody's and AA by Fitch's). If one of the other agencies also effects a downgrade to Italian sovereign debt, then such debt will lose its 0% risk weighting under Basel II's standardized approach rules. This point also highlights the advantage of adopting IRB rules. Under foundation IRB, countries such as Italy and Greece, which will or may attract a 20% weighting under the standardized approach, will probably be weighted at 0% under banks' own PD values for sovereign debt. However, there is no doubt that higher rated non-OECD sovereigns will gain under Basel II and may well see their bond yields spread narrow. Less clearcut, but still a strong possibility, is that lower rated OECD members will see their debt attract a higher charge.

Description of calculation

Although we are describing the calculation for sovereign assets here, much of the calculation framework for Basel II is the same for corporates. Under Basel II the standardized approach applies risk weights in accordance with asset credit rating, as shown in Table 10.2. Under the IRB approach banks that meet minimum specified requirements and have obtained their regulator's approval can use their internal estimates of risk parameters to determine their capital requirements. These parameters are

- *Probability of default (PD)*. This is key to the IRB approach. It is the 1-year probability that an obligor will default.
- *Loss given default (LGD)*. This is a measure of the expected average loss that a bank will suffer per unit of asset or exposure in the event of counterparty default. Whereas a borrower can only have one credit rating and hence only one PD, different sets of exposure to the same borrower may have different LGDs – for example, if one exposure is collateralized and another is not.

- *Exposure at default (EAD)*. This is a measure of the extent to which a bank is exposed to a counterparty in the event of the latter's default. For cash transactions, this amount is the nominal amount of the exposure. For derivative transactions and transactions with variable drawdown options, a credit conversion factor is applied to convert notional amounts to nominal values.
- *Maturity (M)*. Generally speaking, longer dated loans represent higher credit risk. Up to a point, the longer the maturity of an exposure the higher the probability of decrease in its credit quality, hence the higher the PD. Somewhat counterintuitively, this effect is higher for better rated entities, because the higher the credit rating the greater the number of downward categories, short of default, there are for the entity to migrate to. Hence, the risk weight in terms of M is actually higher.

Foundation IRB. A bank adopting this approach may use its internal credit risk-scoring model to estimate PD,[8] but must use BIS-prescribed LCG, EAD and M values. Senior unsecured claims on corporates, sovereigns and banks are assigned a 45% LGD; subordinated unsecured borrowings are assigned a 75% LGD. There is an assigned value of 2.5 for M. For EAD a credit conversion factor of 75% is applied for undrawn liquidity facilities and unused credit lines.

Advanced IRB. Banks that implement the advanced IRB approach will use their own values for PD, EAD and LGD and calculate their own M value. Because national regulatory authorities will also be setting their own prescribed levels for these parameters, adopting the advanced approach will be beneficial for banks that believe their own estimates will be lower than those of the regulator. The calculation of M is dependent on the cashflows of actual assets on the book. Generally, if the M value is below 2.5 then the risk weight will be lower under the advanced approach than under the foundation approach. If M lies above 2.5 then the opposite is true. The maximum value for M is 5.0.

Formulae. For all assets not in default, the formulae for calculating risk weights and capital requirements under both the foundation and

[8] There is a minimum level of 0.03% specified by BIS for corporates and banks.

advanced approaches are:

$$R = 0.12 \times \frac{(1 - \exp(-50 \times \text{PD}))}{(1 - \exp(-50))} + 0.24 \times \left[1 - \frac{(1 - \exp(-50 \times \text{PD}))}{(1 - \exp(-50))}\right] \tag{10.2}$$

$$b = (0.11852 - 0.05478 \times \ln(\text{PD}))^2 \tag{10.3}$$

$$K = \left[\text{LGD} \times N\left((1 - R)^{0.5} \times G(\text{PD}) + \left(\frac{R}{(1 + R)}\right)^{0.5} \times G(0.999)\right) - (\text{PD} \times \text{LGD})\right] \times \left(\frac{1}{1 - 1.5 \times b}\right) \times (1 + (M - 2.5) \times b) \tag{10.4}$$

where

$R =$ Correlation;
$b =$ Maturity adjustment;
$K =$ Capital requirement;
$N(\ ) =$ Cumulative distribution function for a standard normal variable with $N(0, 1)$;
$G(z) =$ Inverse cumulative distribution function for a standard normal variable (i.e., the value of x is such that $N(x) = z$)

and

$$\text{Risk-weighted assets (RWA)} = K \times 12.5 \times \text{EAD}$$

The formula for K is saying that – ignoring correlation and maturity factors – the capital requirement represents the difference between loss under the worst case scenario (assumed to be an event with a probability less than 0.1%) and expected loss (given by PD $\times$ LGD).

Of course, the correlation parameter is key because the defaults of different obligors are not independent of each other. General macroeconomic factors impact all obligors, more so for higher rated entities (on the assumption that lower rated firms are more likely to experience difficulty due to firm-specific issues rather than the general state of the economy). The correlation parameter value in the formula lies between 0.12 and 0.24; the value increases from 0.12 for entities as their credit rating increases. The maturity adjustment factor b is a correction to allow for the fact that the tenor of the exposure will be shorter or longer than the benchmark value of 2.5.

The standard formula given here is not used for assets in default. For such exposures the capital requirement is given by

$$\max[0, \text{LGD} - (\text{PD} \times \text{LGD})]$$

where expected loss PD $\times$ LGD is the bank's best estimate. This estimate is used to calculate loan loss provision and setoff charges for each asset in default.

Example illustration[9]

To help illustrate the new calculation rules, and as an indication of how capital requirements can be significantly different under Basel II than under Basel I, we present a stylized example of two sovereign assets. Imagine that a bank holds the following two sovereign bonds:

- USD100 million   Turkey 10-year, rated BB−
- USD100 million   Malaysia 10-year, rated A−

Under Basel I the regulatory capital requirement for this portfolio is zero for the Turkey bond, because the country is an OECD member, and USD8 million for the Malaysia bond which is 100% risk weighted. However, under Basel II this requirement changes, with the exact calculation being dependent on the approach being adopted.

Standardized approach. Under the standardized approach, the ratings of each sovereign bond determine its risk weighting.[10] So, the capital calculation is

- Turkey   USD4 million
- Malaysia   USD1.6 million

This highlights a general point on the impact of Basel II compared with Basel I: under the simple standardized approach, asset portfolios that gain include those of highly rated non-OECD obligations such as China, Chile, Hong Kong and South Africa, while portfolios that would suffer higher capital charges would include OECD member countries that are lower rated, such as Mexico, Poland, Slovakia, South Korea and, as shown here, Turkey. In our example, the holding of Turkey sovereign bonds suffers a significant increase in capital charge, while the holding of Malaysia sovereign bonds benefits from a much-reduced requirement.

---

[9] The author thanks Rameez Saboowala for his assistance with gathering data for use in this section.

[10] In our example there is one uniform rating for each exposure. Very broadly speaking, if a sovereign or other entity is rated differently across different agencies, the lower rating applies.

Table 10.3 Calculation parameters

	PD	Correlation factor	M	LGD[a] (%)	Risk weight (%)
XXXX	0.34	0.2	2.5	45	66
YYYY	0.15	0.2	2.5	45	41

[a] Senior-level debt.

Foundation IRB. For this example we extract statistical data from debt market prices in January 2006 (see Table 10.3). As far as PD values are concerned, these are unnecessarily severe; rating agency PD values for both countries would be nearer to zero.[11] However, the illustration works better using our unrealistic estimates, which produce the risk weights shown in Table 10.3. The M and LGD values are those prescribed in the BIS document for use in the foundation approach.

Using calculated risk weights, we produce a capital requirement of

- Turkey USD5.1 million
- Malaysia USD3.3 million

So, under foundation IRB we have a still-higher capital charge for Turkey and a lower requirement for Malaysia. Note that our calculation, using market data from 2006, produced different results from the BIS's example calculation released at the time of the final draft.

Advanced IRB. Under the advanced IRB approach, as Malaysia has a lower PD value its impact is, somewhat counter-intuitively, greater over a longer period than Turkey's. This produces a greater increase in capital charge for a 10-year exposure for Malaysia than for Turkey. The risk weight for Malaysia rises from 41% to 66%, while that for Turkey rises from 66% to 100%.

Note that the values arrived under advanced IRB are heavily influenced by the PD, M and LGD parameters used. Significant differences in results can emerge based on what values are assigned for these inputs. For example, rating agency PDs often differ greatly from credit default swap-implied PD values. In the case of sovereign

[11] This is significant: at a zero PD there would be a zero capital requirement because there is no minimum level of PD for sovereign exposures. For corporate exposures, a minimum floor PD applies irrespective of rating.

exposures – because PDs can assume zero value – the choice of which number to use is significant.

Bank assets

For bank ALM strategy purposes, this is perhaps the most important asset class to assess with respect to the impact of Basel II. Banks are significant holders of short-term and medium-term bank-issued debt and will look to rebalance liquidity portfolios for any types of assets that are adversely affected under the new rules.[12]

Note that Basel II does not redefine (nor seek to redefine) bank 'capital'. The definition of Tier 1 and Tier 2 capital remains the same as under Basel I. So, a bank holding another bank's capital instruments must continue to observe specific rules, although in practice there might be a possibility of more favourable treatment in practice under the IRB approach. Essentially, a holding of bank capital in the form of equity or subordinated debt by another bank, which is greater than the equivalent of 10% of the holding bank's own capital, is deducted from the holding bank's capital base or risk-weighted at 100%. In other words, a minimum of 8% capital would have to be held against an asset comprised of bank capital, whether this is Tier 1 equity, upper Tier 2 or lower Tier 2 subordinated debt. Under the IRB approach in Basel II, there is no specific new treatment for bank capital, but applying the IRB rules may result in some bank capital being risk-weighted at lower than 100%. We can see how this may well be the case where the instrument is issued by a strongly rated bank.

Short-term debt

The new rules for short-term bank debt can be summarized as follows:

- Debts of 1-year maturity or less are assigned a 20% risk weighting assuming they are rated at A-1/P-1.[13] Short-term bank debt rated

---

[12] Banks hold a large part of their liquidity book in short-term bank debt such as certificates of deposit (CDs), commercial paper (CP) and floating rate notes (FRNs).

[13] Note that the highest S&P short-term rating is A-1+, while the highest Moody's short-term rating is P-1.

at A-2/P-2 is assigned a 50% weighting while A-3/P-3 paper is weighted at 100%.
- Very-short-term debt of 3-month maturity or less that is unrated, but whose issuer has a long-term rating equivalent to A-3/P-3, will be rated at 20%.

Essentially, it is apparent that virtually all short-term bank paper will continue to be rated at 20%, which is unchanged from the Basel I regime. The preferential treatment of very-short-term debt, which enables even low-rated (A-3/P-3) assets to be weighted at 20%, is prescribed in Option 2 of the standardized approach to bank debt (see Example 10.1). It is not available under Option 1, so banks that are required to adopt the latter by their national regulator will not have this flexibility. Under Option 1 short-term assets will be rated at 20%, 50% and 100% for A-1/P-1, A-2/P-2 and A-3/P-3 ratings, respectively. In the event that a sovereign or bank has three ratings, the two highest ratings will apply. Table 10.4 summarizes Option 1 and Option 2 risk weights.

We can identify certain anomalies that may arise under this two-alternative ruling. For all assets of over 3-month maturity, there is a clear difference at the BBB+ to BBB− rating band. Under Option 1 a bank in that rating range would be 100% risk-weighted, whereas under Option 2 it would carry only a 50% risk-weighting. Another potential anomaly is a BBB-rated bank incorporated in an A-rated country: under Option 1 it would carry a 50% weighting, compared with a 100% weighting under Option 2. Note also the preferential treatment for very-short-term bank debt under Option 2.

From Table 10.4 we conclude that banks of lower credit rating but who are incorporated in a highly rated country would benefit from adopting Option 1, while in the converse case Option 2 would be advantageous.[14] Note that the UK's FSA regulatory agency has stated that Option 2 is the more risk sensitive of the two approaches and should be the one that is used.[15]

---

[14] Note that rating agencies do not rate a corporate entity, including a bank, at a higher rating than the rating of its country of incorporation (although an equivalent rating is possible). Hence, such banks are rare beasts.

[15] *Consultation Paper 189*, FSA.

Table 10.4 Basel II bank debt capital charge – Options 1 and 2

Option 1: Central government risk-weight-based method						
Rating of sovereign	AAA to AA−	A+ to A−	BBB+ to BBB−	BB+ to B−	Below B−	Unrated
Risk weight for senior debt	20%	50%	100%	100%	150%	100%
Option 2: Credit assessment-based method						
Rating of bank	AAA to AA−	A+ to A−	BBB+ to BBBB−	BB+ to B−	Below B−	Unrated
Risk weight for senior bank debt	20%	50%	50%	100%	150%	50%
Risk weight for very-short-term senior debt (<3-month maturity)	20%	20%	20%	50%	150%	20%

IRB approach

The procedure for applying IRB rules in both foundation and advanced forms for bank assets is virtually identical to that used for sovereign assets. The only significant difference is that a minimum value of 0.03% for the PD parameter must be applied for bank assets when calculating the risk weighting. If applying foundation IRB, a bank may use its own internal credit analysis results when estimating the PD parameter (subject to the 0.03% minimum), while values for the EAD, LGD and M parameters are set in the BIS guidelines. Senior unsecured bank debt is assigned a 45% LGD value, with subordinated unsecured debt given a 75% LGD level. The value for M is 2.5. If applying advanced IRB, a bank may use its own internally calculated values for PD, EAD, LGD and M.

Repo agreements and securities lending

A 0% risk weight is applied to an exposure that is collateralized under a repo agreement if the counterparty is a 'core market participant'; otherwise, the risk weight is 10%. This assumes that (i) the loan and the collateral are denominated in the same currency, (ii) the position is marked-to-market on a daily basis and margin taken where necessary and (iii) the transaction takes place under a standard legal agreement such as a GMRA.

Any other collateralized exposure is also risk-weighted at 0%, provided that the collateral is in the form of cash or sovereign debt issued by a country that is also risk-weighted at 0% under the standardized approach and there is a haircut of at least 20%.

Derivative positions

Banks are the largest users of off-balance-sheet derivatives such as swaps. Under Basel I banks calculated the credit exposure arising from derivatives trading using the 'current exposure' method, which entailed taking the mark-to-market value of each position and basing exposure on that. Basel II continues essentially with this approach. The counterparty charge for derivatives transactions is given by:

$$\text{Counterparty charge} = [(\text{RC} + \text{Add-on}) - \text{CA}] \times r \times 0.08 \qquad (10.5)$$

where

$$\begin{aligned} \text{RC} &= \text{Replacement cost;} \\ \text{Add-on} &= \text{Potential future exposure;} \end{aligned}$$

$CA =$ Collateral value;
$r =$ Counterparty risk weight.

Note that this only applies to over-the-counter (OTC) derivative contracts – not exchange-traded ones, for which no counterparty charge is required. Equation (10.5) shows that a bank will obtain capital relief for any of its derivatives trades that are collateralized by the counterparty.

Corporate and retail lending

The area of corporate and retail lending saw some of the biggest impacts of Basel II. This is important for ALM practitioners to be aware of because corporate lending is, in many cases, the largest proportion of a bank's balance sheet. Many commentators have remarked that stronger rated corporates will seek greater dis-intermediation, while banks may find it attractive to lend to unrated or low-rated corporates rather than middle-rated corporates. As noted elsewhere, although a full assessment should wait until at least a year after implementation, we present here some basic considerations for the ALM strategist.

Corporate assets

The simple 100% risk weight for corporate lending that applied under Basel I has been discarded. In its place is the ratings-based methodology for the standardized approach shown in Table 10.5. Under the foundation IRB approach the capital charge reduces for higher rated corporates, so that AA-rated companies – previously rated 100% under Basel I – are now around 15%. The class of assets termed 'small- and medium-sized enterprises' (SMEs) also gained under Basel II when compared with non-SME corporates; under the IRB approach it is expected that the weighting will be approximately 20% lower for small SMEs.[16]

Retail asset risk weighting under Basel II was 75% in the standardized approach, compared with 100% under Basel I. Residential mortgage risk weighting will decrease from 50% to 35%; under the IRB method they are expected to fall from this to around 15%.

---

[16] An SME is defined for Basel II purposes as a corporate with annual sales of EUR50 million or less.

Table 10.5 Basel II standardized approach: corporate risk weights

Rating	Risk weight (%)
AAA to AA−	20
A+ to A−	50
BBB+ to BB−	100
Below BB−	150
Unrated	100

Source: BIS.

Thus, banks with large pools of residential mortgages gained in capital charge terms compared with non-mortgage banks.

Corporate assets – the standardized approach

Under the blanket 100% risk weighting of Basel I, banks had a greater incentive, somewhat perversely, to lend to lower rated corporates because this resulted in higher return on capital. This anomaly is better addressed under Basel II. In the standardized approach the obligor's formal credit rating determines capital charge risk weighting. Broadly, the only unchanged case is corporates rated from BBB+ to BB− which remain at 100%. All other corporates have changed risk weights. Banks that adopt the standardized approach then have little incentive to lend to entities in this rating category, whereas they have an incentive to lend to undated corporates compared with those rated below BB−. An unrated corporate will have no incentive to apply for a credit rating unless this is likely to be better than BBB+, as the lending rate may be prohibitive.

Corporate assets – the IRB approaches

Banks implementing the foundation IRB methodology are allowed to use their internal credit risk models to estimate the PD values for each obligor;[17] the values for the LGD, EAD and M parameters are prescribed by the BIS. Under the advanced IRB a bank may use its own estimates of all four parameters.

[17] There is a BIS-imposed minimum PD of 0.03%.

Illustration using a hypothetical example

We use a simple example to illustrate the impact of Basel II. Consider a bank lending to two entities:

- a utility company rated AA;
- an industrial company rated BB−.

Under Basel I a loan of USD10 million to each company would each attract a minimum capital charge of USD800,000.00. Under the standardized approach of Basel II the charge for the loan to the utility company would be USD160,000, while the requirement for the industrial company would be unchanged at USD800,000.

Under the foundation approach, the bank would use its PD value to calculate the risk weighting; assuming the calculation came to 15% for the utility company the capital charge would now be USD120,000. Again, we assume the risk weight for the industrial company was worked out as 95%; this leads to a capital charge of USD760,000. Risk weight values under the advanced IRB would use the bank's internal data for all calculation parameters, but may well be higher for the industrial company, making this asset an even more expensive one when compared with the Basel I regime.

Basel III

In September 2010 the Basel Committee for Banking Supervision (BCBS), which comprises the regulators and central bankers of 27 countries, released details of the new banking regulatory capital rules, which were termed Basel III. The rules require banks to hold a higher amount of core Tier 1 capital than was required under the Basel I and II regimes.

The main provisions of Basel III are as follows:

- the minimum level of core Tier 1 capital to be 4.5% of risk-weighted assets – this compares with the 2% level required under the Basel II accord;
- a 'capital conservation' buffer of 2.5% will also be required, as protection against periods of economic and financial stress;
- there will be a Tier 1 'leverage ratio' of 3%.

Although this additional reserve is not compulsory, a bank that does not put it in place will be restricted from paying dividends to shareholders; therefore, for practical purposes the minimum Tier 1 capital ratio is actually 7%.

In addition, a 'countercyclical' capital buffer of up to 2.5% will be allowable, with national regulators having the authority to impose this requirement when they deem it necessary, as a response to overheating markets.

The definition of core Tier 1 capital is also being simplified under Basel III; going forward, it will comprise only equity, retained reserves and undated preference shares. Tier 2 has also been simplified and will only comprise preferred shares, hybrid subordinated debt and long-term subordinated debt without incentive to redeem (such as step-up coupons).

The timeline for implementation is January 2015, with the capital conservation buffer not required until January 2019.

As of the time of writing, Basel III had not made any modifications to the process of assigning risk weightings to assets. This remains identical to the methodology implemented under Basel II.

Initial impact

The Basel III rules are possibly more onerous for banks than a first reading might suggest, particularly when the Tier 1 capital ratio is taken together with the proposals for a leverage ratio and liquidity buffers. However, although banks will need to hold more high-quality capital, they have been allowed a long-transition phase to implement the new requirements. They will need to hold common equity to the value of 4.5% of their assets by the start of 2015, up from the current 2%. Beyond that, by January 2019 banks will need to hold a 2.5% capital conservation buffer of common equity. The rationale of the buffer is that it is just that – a buffer that can be run down during periods of market stress, without hitting the regulatory reserve and thus preserving the bank as a going concern. The total requirement comprises the common equity ratio of 7% stated above. This is a considerable increase on the previous minimum of 2%.

In addition, the BCBS is introducing new rules from 2012 that demand a more onerous capital regime for trading activities and securitized assets held on the trading book. This is expected to be three times the level required against banking book assets. Large systemically important banks will, at a point in the future, face a capital surcharge on top of the standard requirements.

A more problematic area of the new rules is the countercyclical buffer. If regulators believe that banks are in the midst of a credit bubble they may levy a countercyclical buffer of up to 2.5% of assets, which will be made up of common stock or other equally loss-absorbing instruments.

The Tier 1 leverage ratio of 3% will limit banks to lending 33 times their capital, a significantly lower value than that observed by some banks leading up to the financial crash. This represents a cap on bank risk irrespective of the impact from higher capital numbers. Although this limit is not due to be introduced until 2018, banks will need to disclose the level to the market from 2015 onwards.

BIBLIOGRAPHY

BIS (1988) *International Convergence of Capital Measurement and Capital Standards*, Basel Committee on Banking Regulations and Supervisory Practice, July.

Fabozzi, F. and Choudhry, M. (Eds) (2004) *The Handbook of European Fixed Income Securities*, John Wiley & Sons, Inc.

FSA (2008) *Consultation Paper 189.*

Gup, B. (2004) *The New Basel Capital Accord*, Thomson Corporation, New York.

Appendix A

SUMMARY OF BANK PRODUCT LINE

As part of the introduction to banking we provide a summary of the product line offered by banks. Not all banks offer all these products, but these instruments are available in virtually every banking market. More detailed information is available in the author's books *The Money Market Handbook*, *Fixed Income Markets* and *Bank Asset and Liability Management*, all published by John Wiley & Sons (Asia) Pte Ltd.

Interest-bearing and non-interest-bearing current accounts

These are also known as cheque accounts or (in the USA) checking accounts; they are the simplest form of short-term deposit or investment instrument. Customer funds may be withdrawn instantly on demand and banks generally pay interest on surplus balances, although not in all cases. Current accounts are a cheap source of funding for banks, as well as a stable one, but the funds are less valuable from a liquidity metrics point of view because their balances are instant access.

Demand deposits

Also referred to as sight deposits, they are similar to cheque accounts but are always interest bearing. The funds are available on demand, but cannot be used for cheques or other similar payments.

Time deposits

Time or term deposits are interest-bearing deposit accounts of fixed maturity. They are usually offered with a range of maturities ranging from 1 month to 5 years, with longer dated deposits attracting higher interest. This reflects the positive yield curve, which indicates the funding value to the bank of longer term liabilities. Most time deposits pay a fixed rate of interest, payable on maturity. Accounts of longer than 1-year maturity often capitalize interest on an annual basis.

Government bonds

The secondary market in government bonds is provided by banks that choose to be market-makers or primary dealers. Sovereign debt is essentially a plain vanilla market, with the vast majority of bonds being fixed coupon and fixed maturity. Governments also issue index-linked bonds which offer return linked to the rate of inflation.

Floating rate notes

Floating rate notes (FRNs) are bonds that have variable rates of interest; the coupon rate is linked to a specified index and changes periodically as the index changes. An FRN is usually issued with a coupon that pays a fixed spread over a reference index (e.g., the coupon may be 50 bp over the 6-month Libor rate). Since the value for the reference benchmark index is not known, it is not possible to calculate the redemption yield for an FRN. Additional features have been added to FRNs, including floors (the coupon cannot fall below a specified minimum rate), caps (the coupon cannot rise above a maximum rate) and *callability*.

Generally, the reference interest rate for FRNs is the London interbank offered rate or Libor. An FRN will pay interest at Libor plus a quoted margin (or spread). The interest rate is fixed for a 3-month or 6-month period and is reset in line with the Libor fixing at the end of the interest period. Hence, at the coupon reset date for a sterling FRN paying 6-month Libor + 0.50%, if the Libor fix is 7.6875%, then the FRN will pay a coupon of 8.1875%. Interest will therefore accrue at a daily rate of £0.0224315.

On the coupon reset date an FRN will be priced precisely at par. Between reset dates it will trade very close to par because of the way in which the coupon is reset. If market rates rise between reset dates an FRN will trade slightly below par; similarly, if rates fall the paper will trade slightly above. This makes FRNs very similar in behaviour to money market instruments traded on a yield basis, although of course FRNs have much longer maturities. Investors can opt to view FRNs as essentially money market instruments or as alternatives to conventional bonds. For this reason we can use two approaches when analysing FRNs. The first approach is known as the *margin method*. This calculates the difference between the return on an FRN and that on an equivalent money market security. There are two variations on this: simple margin and discounted margin.

Letter of credit

A letter of credit (LoC) is a standard vanilla product available from a commercial bank. It is an instrument that guarantees that a buyer's payment to a seller will be received at the right time and for the specific amount. The buyer is the customer of the bank. If the buyer is unable to make payment on the due date, the bank will cover the full amount of the purchase. The bank therefore takes on the credit risk of the buyer when it writes an LoC on the buyer's behalf. The buyer therefore pays a fee for the LoC that reflects its credit standing.

LoCs are used in domestic and international trade transactions. Cross-border trade transactions involve both parties in issues such as distance, different legal jurisdictions and lack of any available due diligence on the counterparties. An LoC is a valuable tool that eases the process for the buying and selling parties. The bank also acts on behalf of the buyer (the purchaser of the LoC) because it would only make payment when it knows that the goods have been shipped. For the seller, an LoC substitutes the credit of the buyer for that of the bank, which is an easier risk exposure for the seller to take on.

There are essentially two types of LoC: commercial and standby. A commercial LoC is the primary payment mechanism for a transaction, while a standby LoC is a secondary payment mechanism.

Commercial letter of credit

A commercial LoC is a contract between a bank, known as the issuing bank, on behalf of one of its customers, authorizing another bank, known as the advising or confirming bank, to make payment to the beneficiary. The issuing bank makes a commitment to guarantee drawings made under the credit. The beneficiary is normally the provider of goods and/or services. An advising bank, usually a foreign correspondent bank of the issuing bank, will advise the beneficiary but otherwise has no other obligation under the LoC.

An LoC is generally negotiable; this means that the issuing bank is obliged to pay the beneficiary but – should the issuing bank so request – any bank nominated by the beneficiary could make the payments. To be negotiable, the LoC features an unconditional promise to pay on demand at a specified time.

Standby letter of credit

A standby LoC is a contract issued by a bank on behalf of a customer to provide assurances of its ability to perform under the terms of a contract between it and the beneficiary. In other words, a standby LoC is more of a guarantee, as both parties to the transaction do not expect the LoC will be drawn on. It essentially provides comfort to the beneficiary, as it enhances the creditworthiness of its customer.

Structured deposits

A structured deposit is a deposit whose payoff or return profile is structured to match a specific customer requirement. The structuring results from the use of an embedded derivative in the product, which links the deposit to changes in interest rates, FX rates or other market rates. There is a wide range of different products available that fall in the class of 'structured deposit'. An example is the following: a customer places funds on deposit at a specific interest rate and fixed term. Under the agreement, if the central bank base interest rate remains between 4% and 5%, then return is enhanced by 100 bp. If the rate moves below 4% or above 5%, then the deposit forfeits all interest for the remaining term of its life. This is an example of a 'collared range accrual' deposit.

Liquidity facilities

Liquidity facility is the generic term for a standing loan agreement, against which a borrower can draw down funds at any time up to the maximum value of the line. The borrower pays a fee, called the standing fee, even if the line is not used and then pays the agreed rate of interest on any funds that it does draw.

We distinguish between the following:

- *Back-up facility*. A facility that is not used in the normal course of business. It is generally drawn down if the borrower is experiencing some difficulty in obtaining funding from its usual sources.
- *Revolving credit facility (RCF)*. A commitment from a bank to lend on a revolving basis under pre-specified terms. Under an RCF there is usually a regular drawdown and repayment of funds during the life of the facility.
- *Term loan*. This is distinct from liquidity lines in that it is a non-revolving facility and will be drawn down at execution. It has a fixed repayment date, although this may be on an amortized basis.

Liquidity facilities require full regulatory capital backing, as the capital treatment is to assume that they are being used at all times.

Syndicated loans[1]

To raise debt capital, companies may issue bonds or loans (as well as other debt-like instruments), both of which are associated with a certain seniority or ranking. In a liquidation or winding up, the borrower's remaining assets are distributed according to a priority waterfall: debt obligations with the highest seniority are repaid first; only if assets remain thereafter are obligations with lower seniorities repaid. Further, debt instruments may be secured or unsecured: if certain of the borrower's assets are ring-fenced to serve as collateral for the lenders under a particular obligation only, this obligation is deemed to be 'secured'. Together, seniority and collateral determine the *priority* of an obligation. As illustrated in Table A.1, bonds and loans issued by investment-grade companies, as well as bonds issued by sub-investment-grade companies, called 'high-yield bonds', are typically senior unsecured. However, loans issued by sub-investment-grade companies are typically senior secured. Often, these are called 'leveraged loans' or 'syndicated secured loans'. The market often uses both terms interchangeably.

Table A.1 Typical priorities of corporate bonds and loans of investment grade and sub-investment-grade borrowers

	Investment-grade borrower	**Sub-investment-grade borrower**
Bonds	Senior unsecured	Senior unsecured (high-yield bonds)
Loans	Senior unsecured	Senior secured (leveraged loans/syndicated secured loans)

Source: Choudhry (2010).

The definition of 'leveraged loan' is not universal, however. Various market participants define a leveraged loan to be a loan with a sub-investment-grade rating, while other users view it as one with a certain spread over Libor (say 100 bp or more) and sometimes a certain debt/EBITDA ratio of the borrower. S&P, for instance,

[1] This section is an extract from chapter 11 of the author's book *Structured Credit Products: Credit Derivatives and Synthetic Securitisation*, 2nd edition, John Wiley & Sons (Asia), 2010. This chapter from the author's book was co-written with Timo Schlafer and Marliese Uhrig-Homburg.

calls a loan 'leveraged' if it is rated sub-investment grade or if it is rated investment grade but pays interest of at least Libor + 125 bp. Bloomberg uses a hurdle rate of Libor + 250 bp. Essentially, the market refers to leveraged loans and high-yield bonds as 'high-yield debt'.

Leveraged loans may be arranged either between a borrower and a single lending bank, or, more commonly, between a borrower and a syndicate of lending banks. In the latter case, one (or more) of the lending banks acts as lead arranger. Before any other lending banks are involved, the lead arranger conducts detailed due diligence on the borrower. Also, the lead arranger and borrower agree on the basic transaction terms, such as size of the loan, interest rate, fees, loan structure, covenants and type of syndication. These terms are documented in a 'loan agreement'. Based on the information received in the due diligence process, the lead arranger prepares an information memorandum, also called the 'bank book' which is used to market the transaction to other potential lending banks or institutional investors. Together, the lead arranger and the other lenders constitute the primary market. If the transaction is an 'underwritten syndication', the lead arranger guarantees the borrower that the entire amount of the loan will be placed at a pre-defined price. If the loan is undersubscribed at that price, the lead arranger is forced to absorb the difference. If the transaction is a 'best efforts syndication', the lead arranger tries to place the loan at the pre-defined terms but will, if investor demand is insufficient, adjust these terms to achieve full placement.

Leveraged loans are usually secured by particular assets of the borrower. These assets are listed in the loan agreement and may comprise all tangible and intangible assets of the borrower. This means that, in the event of default, lenders can take possession of these assets, liquidate them and use the proceeds to satisfy their claims in the order of priority stipulated in the loan agreement and the related inter-creditor agreement. This happens before the claims of any unsecured lenders are satisfied.

Leveraged loans typically consist of a revolving credit facility (or 'revolver') and 'term loans'. Term loans are usually tranched into an amortizing term loan (term loan A), provided by syndicate banks, and institutional tranches (term loans B, C and D), provided by institutional investors. In the US market, amortizing term loans have become increasingly rare as institutional investors are now the primary buyers of leveraged loans. Term loan D may represent a further subdivision, called 'second-lien tranche', which is subordinate to term loans A, B and C (called 'first-lien tranches'), but ranks senior to all other debt of the borrower. Historically, this structure has resulted in significantly higher recovery rates of first-lien tranches compared with second-lien tranches.

Term loan A is usually repaid on scheduled repayment dates during its life, whereas term loans B, C and D are mostly subject to bullet repayment (i.e., a one-off repayment on the maturity date). Once repaid, term loans cannot be re-borrowed. This is the principal difference from the revolving credit facility, usually provided by syndicate lenders, which allows the borrower to borrow, repay, and re-borrow funds during the life of the loan in accordance with predetermined conditions. In addition to interest on borrowed funds, borrowers are charged a commitment fee on unused funds. Revolvers are often used to fund working capital and capital expenditure requirements that can fluctuate significantly over time. Table A.2 summarizes this discussion.

Table A.2 Typical structure of leveraged loans

	Lien	**Lender**	**Repayment**
Revolving credit facility	First lien	Banks	Discretionary
Term loans A	First lien	Banks	Amortizing
Term loans B	First lien	Institutional investors	Bullet
Term loans C	First lien	Institutional investors	Bullet
Term loans D	Second lien	Institutional investors	Bullet

Source: Choudhry (2007).

Leveraged loans pay floating rate coupons. These are composed of Libor (or another inter-bank rate, depending on the loan's currency), plus a certain spread (i.e., risk premium); typically, they are payable quarterly. Floating rate coupons provide an effective hedge against interest rate risk: if interest rates rise, so does the coupon and vice versa. Consequently, floating rate coupons are particularly popular in times of rising interest rates. Often, the spread of leveraged loans is not fully fixed but moves according to a pricing grid pre-defined in the loan agreement: if the borrower's credit condition improves (e.g., indicated by a decline in financial leverage and/or a rating upgrade), the spread decreases and vice versa.

Leveraged loans commonly mature between 7 to 10 years after issuance. The effective life of leveraged loans, however, tends to be significantly shorter as the borrower is typically allowed to prepay or 'call' the loan at any time at no premium or a limited premium. Prepayment is generally seen as a negative by lenders. This is because borrowers tend to prepay when their refinancing costs decrease; for instance, when they are upgraded to investment grade or acquired by an investment-grade-rated company or when interest rates decrease. For lenders, this means that they bear all the downside (i.e., rising interest rates or a deterioration in the borrower's credit condition) but retain a limited upside. As mentioned, floating rate coupons mitigate lenders' risk associated with rising interest rates. To some extent, pricing grids can do the same for the risk associated with a deterioration in the borrower's credit condition.

REFERENCE

Choudhry, M. (2007). *Bank Asset and Liability Management*, Singapore: John Wiley & Sons.

This page intentionally left blank

Appendix B

FINANCIAL MARKETS ARITHMETIC

Simple interest

A loan that has one interest payment on maturity is accruing simple interest. On short-term instruments there is usually only the one interest payment on maturity, hence simple interest is received when the instrument expires. The terminal value of an investment with simple interest is given by:

$$\mathrm{FV} = \mathrm{PV}(1 + r) \tag{B.1}$$

where

$\mathrm{FV} =$ Terminal value or future value;
$\mathrm{PV} =$ Initial investment or present value;
$r =$ Interest rate.

So, for example, if PV is £100, r is 5% and the investment is 1 year. Then

$$\mathrm{FV} = £100(1 + r) = £105$$

The market convention is to quote interest rates as *annualized* interest rates, which is the interest that is earned if the investment term is 1 year. Consider a 3-month deposit of £100 in a bank, placed at a rate of interest of 6%. In such an example the bank deposit will earn 6% interest for a period of 90 days. As the annual interest gain would be £6, the investor will expect to receive a proportion of this:

$$£6.00 \times \frac{90}{365}$$

So, the investor will receive £1.479 interest at the end of the term. The total proceeds after the 3 months is therefore £100 plus £1.479. If we wish to calculate the terminal value of a short-term investment that is accruing simple interest we use the following expression:

$$\mathrm{FV} = \mathrm{PV}\left(1 + r \times \frac{\mathrm{Days}}{\mathrm{Year}}\right) \tag{B.2}$$

The fraction $\frac{\mathrm{Days}}{\mathrm{Year}}$ refers to the numerator, which is the number of days the investment runs, divided by the denominator, which is the number of days in the year. In sterling markets the number of days in a year is taken to be 365; however, certain other markets (including euro currency markets) have a 360-day year convention. For this reason we simply quote the expression as 'days' divided by 'year' to allow for either convention.

Compound interest

Let us now consider an investment of £100 made for 3 years, again at a rate of 6%, but this time fixed for 3 years. At the end of the first year the investor will be credited with interest of £6. Therefore, for the second year the interest rate of 6% will be accruing on a principal sum of £106, which means that at the end of Year 2 the interest credited will be £6.36. This illustrates how *compounding* works, which is the principle of earning interest on interest. What will the terminal value of our £100 3-year investment be?

In compounding we are seeking to find a *future value* given a *present value*, a *time period* and an *interest rate*. If £100 is invested today (at time t_0) at 6%, then 1 year later (t_1) the investor will have $£100 \times (1 + 0.06) = £106$. In our example the capital is left in for another 2 years, so at the end of Year 2 (t_2) we will have:

$$\begin{aligned} £100 \times (1 + 0.06) \times (1 + 0.06) &= £100 \times (1 + 0.06)^2 \\ &= £100 \times (1.06)^2 \\ &= £112.36 \end{aligned}$$

The outcome of the process of compounding is the *future value* of the initial amount. We don't have to calculate the terminal value long hand as we can use:

$$\mathrm{FV} = \mathrm{PV}(1 + r)^n \tag{B.3}$$

where

$r =$ Periodic rate of interest (expressed as a decimal);
$n =$ Number of periods for which the sum is invested.

In our example, the initial £100 investment after 3 years becomes $£100 \times (1 + 0.06)^3$ which is equal to £119.10.

When we compound interest we have to assume that the reinvestment of interest payments during the investment term is at the same rate as the first year's interest. That is why we stated that the 6% rate in our example was *fixed* for 3 years. However, we can see that compounding increases our returns compared with investments that accrue only on a simple interest basis. If we had invested £100 for 3 years fixed at a rate of 6% but paying on a simple interest basis our terminal value would be £118, which is £1.10 less than our terminal value using a compound interest basis.

Compounding more than once a year

Now let us consider a deposit of £100 for 1 year, again at our rate of 6% but with quarterly interest payments. Such a deposit would accrue interest of £6 in the normal way, but £1.50 would be credited to the account every quarter, and this would then benefit from compounding. Again assuming that we can reinvest at the same rate of 6%, the total return at the end of the year will be:

$$100 \times ((1 + 0.015) \times (1 + 0.015) \times (1 + 0.015) \times (1 + 0.015)) = 100 \times (1 + 0.015)^4$$

which gives us 100×1.06136, a terminal value of £106.136. This is some 13 pence more than the terminal value using annual compounded interest.

In general, if compounding takes place m times per year, then at the end of n years mn interest payments will have been made and the future value of the principal is given by:

$$\mathrm{FV} = \mathrm{PV}\left(1 + \frac{r}{m}\right)^{mn} \tag{B.4}$$

As we showed in our example, the effect of more frequent compounding is to increase the value of total return when compared with annual compounding. The effect of more frequent compounding is shown below, where we consider annualized interest rate factors, for an annualized rate of 5%.

Compounding frequency	**Interest rate factor**
Annual	$(1 + r) = 1.050000$
Semi-annual	$\left(1 + \frac{r}{2}\right)^2 = 1.050625$
Quarterly	$\left(1 + \frac{r}{4}\right)^4 = 1.050945$
Monthly	$\left(1 + \frac{r}{12}\right)^{12} = 1.051162$
Daily	$\left(1 + \frac{r}{365}\right)^{365} = 1.051267$

This shows us that the more frequent the compounding the higher the interest rate factor. The last case also illustrates how a limit occurs when interest is compounded continuously. Equation (B.4) can be rewritten as:

$$\begin{aligned} \text{FV} &= \text{PV}\left(\left(1+\frac{r}{m}\right)^{m/r}\right)^{rn} = \text{PV}\left(\left(1+\frac{1}{m/r}\right)^{m/r}\right)^{rn} \\ &= \text{PV}\left(\left(1+\frac{1}{n}\right)^{n}\right)^{rn} \end{aligned} \tag{B.5}$$

where $n = m/r$. As compounding becomes continuous and m and hence n approach infinity, equation (B.5) approaches a value known as e, which is shown by:

$$e = \lim_{n\to\infty}\left(1+\frac{1}{n}\right)^{n} = 2.718281\ldots$$

If we substitute this into (B.5) we get:

$$\text{FV} = \text{PV}e^{rn} \tag{B.6}$$

where we have continuous compounding. In equation (B.6) e^{rn} is known as the *exponential function* of rn; it tells us the continuously compounded interest rate factor. If $r = 5\%$ and $n = 1$ year then:

$$e^{r} = (2.718281)^{0.05} = 1.051271$$

This is the limit reached with continuous compounding. To illustrate continuous compounding from our initial example, the future value of £100 at the end of 3 years – when the interest rate is 6% – can be given by:

$$\text{FV} = 100e^{(0.06)\times 3} = £119.72$$

Effective interest rates

The interest rate quoted on a deposit or loan is usually the *flat* rate. However, we are often required to compare two interest rates which apply for a similar investment period but have different interest payment frequencies – for example, a 2-year interest rate with interest paid quarterly compared with a 2-year rate with semi-annual interest payments. This is normally done by comparing equivalent *annualized* rates. The annualized rate is the interest rate with annual compounding that results in the same return at the end of the period as the rate we are comparing.

The concept of the effective interest rate allows us to state that:

$$\mathrm{PV} \times \left(1 + \frac{r}{n}\right)^n = \mathrm{PV} \times (1 + \mathrm{AER}) \tag{B.7}$$

where AER is the equivalent annual rate. Therefore, if r is the interest rate quoted that pays n interest payments per year, AER is given by:

$$\mathrm{AER} = \left(\left(1 + \frac{r}{n}\right)^n - 1\right) \tag{B.8}$$

The equivalent annual interest rate AER is known as the *effective* interest rate. We have already referred to the quoted interest rate as the 'nominal' interest rate. We can rearrange equation (B.8) to give us equation (B.9) which allows us to calculate nominal rates:

$$r = \left((1 + \mathrm{AER})^{1/n} - 1\right) \times n \tag{B.9}$$

We can see then that the effective rate will be greater than the flat rate if compounding takes place more than once a year. The effective rate is sometimes referred to as the *annualized percentage rate* or APR.

Interest rate conventions

The convention in both wholesale or personal (retail) markets is to quote an annual interest rate. A lender who wishes to earn interest at the rate quoted has to place her funds on deposit for 1 year. Annual rates are quoted irrespective of the maturity of a deposit, from overnight to 10 years or longer. For example, if one opens a bank account that pays interest at a rate of 3.5% but then closes it after 6 months, the actual interest earned will be equal to 1.75% of the sum deposited. The actual return on a 3-year building society bond (fixed deposit) that pays 6.75% fixed for 3 years is 21.65% after 3 years. The quoted rate is the annual 1-year equivalent. An overnight deposit in the wholesale or *inter-bank* market is still quoted as an annual rate, even though interest is earned for only one day.

The convention of quoting annualized rates is to allow deposits and loans of different maturities and different instruments to be compared on the basis of the interest rate applicable. We must also be careful when comparing interest rates for products that have different payment frequencies. As we have seen from the foregoing paragraphs the actual interest earned will be greater for a deposit earning 6% on a semi-annual basis compared with 6% on an annual basis. The convention in the money markets is to quote the equivalent interest rate applicable when taking into account an instrument's payment frequency.

Discount factors

The calculation of present values from future values is also known as *discounting*. The principles of present and future values demonstrate the concept of the *time value* of money which is that in an environment of positive interest rates a sum of money has greater value today than it does at some point in the future because we are able to invest the sum today and earn interest. We will only consider a sum in the future compared with a sum today if we are compensated by being paid interest at a sufficient rate. Discounting future values allows us to compare the value of a future sum with a present sum.

The rate of interest r, known as the *discount rate*, is the rate we use to *discount* a known future value in order to calculate a present value. We can rearrange equation (B.1) to give:

$$\mathrm{PV} = \mathrm{FV}(1 + r)^{-n}$$

The term $(1 + r)^{-n}$ is known as the n-year discount factor:

$$df_n = (1 + r)^{-n} \tag{B.10}$$

where df_n is the n-year discount factor.

The 3-year discount factor when the discount rate is 9% is:

$$df_3 = (1 + 0.09)^{-3} = 0.77218$$

We can calculate discount factors for all possible interest rates and time periods to give us a *discount function*. Fortunately, we don't need to calculate discount factors ourselves as this has been done for us (discount tables for a range of rates are provided in Table B.1).

Table B.1 Discount Factor Table

Discount rate (%)													
Years	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**15**	**20**
	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1	0.12	0.15	0.2
1	0.990099	0.980392	0.970874	0.961538	0.952381	0.943396	0.934579	0.925926	0.917431	0.909091	0.892857	0.869565	0.833333
2	0.980296	0.961169	0.942596	0.924556	0.907029	0.889996	0.873439	0.857339	0.841680	0.826446	0.797194	0.756144	0.694444
3	0.970590	0.942322	0.915142	0.888996	0.863838	0.839619	0.816298	0.793832	0.772183	0.751315	0.711780	0.657516	0.578704
4	0.960980	0.923845	0.888487	0.854804	0.822702	0.792094	0.762895	0.735030	0.708425	0.683013	0.635518	0.571753	0.482253
5	0.951466	0.905731	0.862609	0.821927	0.783526	0.747258	0.712986	0.680583	0.649931	0.620921	0.567427	0.497177	0.401878
6	0.942045	0.887971	0.837484	0.790315	0.746215	0.704961	0.666342	0.630170	0.596267	0.564474	0.506631	0.432328	0.334898
7	0.932718	0.870560	0.813092	0.759918	0.710681	0.665057	0.622750	0.583490	0.547034	0.513158	0.452349	0.375937	0.279082
8	0.923483	0.853490	0.789409	0.730690	0.676839	0.627412	0.582009	0.540269	0.501866	0.466507	0.403883	0.326902	0.232568
9	0.914340	0.836755	0.766417	0.702587	0.644609	0.591898	0.543934	0.500249	0.460428	0.424098	0.360610	0.284262	0.193807
10	0.905287	0.820348	0.744094	0.675564	0.613913	0.558395	0.508349	0.463193	0.422411	0.385543	0.321973	0.247185	0.161506
11	0.896324	0.804263	0.722421	0.649581	0.584679	0.526788	0.475093	0.428883	0.387533	0.350494	0.287476	0.214943	0.134588
12	0.887449	0.788493	0.701380	0.624597	0.556837	0.496969	0.444012	0.397114	0.355535	0.318631	0.256675	0.186907	0.112157
13	0.878663	0.773033	0.680951	0.600574	0.530321	0.468839	0.414964	0.367698	0.326179	0.289664	0.229174	0.162528	0.093464
14	0.869963	0.757875	0.661118	0.577475	0.505068	0.442301	0.387817	0.340461	0.299246	0.263331	0.204620	0.141329	0.077887
15	0.861349	0.743015	0.641862	0.555265	0.481017	0.417265	0.362446	0.315242	0.274538	0.239392	0.182696	0.122894	0.064905

16	0.852821	0.728446	0.623167	0.533908	0.458112	0.393646	0.338735	0.291890	0.251870	0.217629	0.163122	0.106865	0.054088
17	0.844377	0.714163	0.605016	0.513373	0.436297	0.371364	0.316574	0.270269	0.231073	0.197845	0.145644	0.092926	0.045073
18	0.836017	0.700159	0.587395	0.493628	0.415521	0.350344	0.295864	0.250249	0.211994	0.179859	0.130040	0.080805	0.037561
19	0.827740	0.686431	0.570286	0.474642	0.395734	0.330513	0.276508	0.231712	0.194490	0.163508	0.116107	0.070265	0.031301
20	0.819544	0.672971	0.553676	0.456387	0.376889	0.311805	0.258419	0.214548	0.178431	0.148644	0.103667	0.061100	0.026084
21	0.811430	0.659776	0.537549	0.438834	0.358942	0.294155	0.241513	0.198656	0.163698	0.135131	0.092560	0.053131	0.021737
22	0.803396	0.646839	0.521893	0.421955	0.341850	0.277505	0.225713	0.183941	0.150182	0.122846	0.082643	0.046201	0.018114
23	0.795442	0.634156	0.506692	0.405726	0.325571	0.261797	0.210947	0.170315	0.137781	0.111678	0.073788	0.040174	0.015095
24	0.787566	0.621721	0.491934	0.390121	0.310068	0.246979	0.197147	0.157699	0.126405	0.101526	0.065882	0.034934	0.012579
25	0.779768	0.609531	0.477606	0.375117	0.295303	0.232999	0.184249	0.146018	0.115968	0.092296	0.058823	0.030378	0.010483
26	0.772048	0.597579	0.463695	0.360689	0.281241	0.219810	0.172195	0.135202	0.106393	0.083905	0.052521	0.026415	0.008735
27	0.764404	0.585862	0.450189	0.346817	0.267848	0.207368	0.160930	0.125187	0.097608	0.076278	0.046894	0.022970	0.007280
28	0.756836	0.574375	0.437077	0.333477	0.255094	0.195630	0.150402	0.115914	0.089548	0.069343	0.041869	0.019974	0.006066
29	0.749342	0.563112	0.424346	0.320651	0.242946	0.184557	0.140563	0.107328	0.082155	0.063039	0.037383	0.017369	0.005055
30	0.741923	0.552071	0.411987	0.308319	0.231377	0.174110	0.131367	0.099377	0.075371	0.057309	0.033378	0.015103	0.004213

Formula summary

Discount factor with simple interest	$df = \dfrac{1}{\left(1 + r\,\dfrac{\text{Days}}{\text{Year}}\right)^n}$
Discount factor with compound interest	$df_n = \left(\dfrac{1}{1+r}\right)^n$

Earlier we established the continuously compounded interest rate factor as e^{rn}. Therefore, using a continuously compounded interest rate we can establish the discount factor to be:

$$\left.\begin{aligned} df &= \frac{1}{1 + (e^{r \times \text{Days/Year}} - 1)} = e^{-r \times \text{Days/Year}} \\ \therefore\ df_n &= e^{-rn} \end{aligned}\right\} \tag{B.11}$$

The continuously compounded discount factor is part of the formula used in option-pricing models. It is possible to calculate discount factors from the prices of government bonds. The traditional approach described in most textbooks requires that we first use the price of a bond that has only one remaining coupon, its last one, and calculate a discount factor from this bond's price. We then use this discount factor to calculate the discount factors of bonds with ever-increasing maturities, until we obtain the complete discount function.

Present values with multiple discounting

Present values for short-term investments of under 1-year maturity often involve a single interest payment. If there is more than one interest payment then any discounting needs to take this into account. If discounting takes place m times per year then we can use equation (B.4) to derive the present value formula:

$$\text{PV} = \text{FV}\left(1 + \frac{r}{m}\right)^{-mn} \tag{B.12}$$

For example, what is the present value of the sum of £1,000 which is to be received in 5 years where the discount rate is 5% and there is semi-annual discounting?

Using equation (B.12) we see that

$$\text{PV} = 1{,}000\left(1 + \frac{0.05}{2}\right)^{-2\times 5} = £781.20$$

The effect of more frequent discounting is to lower the present value. As with continuous compounding, the limiting factor is reached by means of continuous discounting. We can use equation (B.6) to derive the present value formula for continuous discounting

$$\text{PV} = \text{FV}e^{-rn} \tag{B.13}$$

If we consider the same example as before but now with continuous discounting, we can use this expression to calculate the present value of £1,000 to be received in 5 years' time as:

$$\text{PV} = 1{,}000e^{-(0.05)\times 5} = £778.80$$

MULTIPLE CASHFLOWS

Future values

Up to now we have considered the future values of a single cashflow. Of course, the same principles of the time value of money can be applied to a bundle of cashflows. A series of cashflows can be at regular or at irregular intervals. If we wish to calculate the total future value of a set of irregular payments made in the future we need to calculate each payment separately and then sum all the cashflows. The formula is represented as:

$$\text{FV} = \sum_{n=1}^{N} C_n(1+r)^{N-n} \tag{B.14}$$

where C_n is the payment in year n; and the symbol $\sum$ means 'the sum of'. We assume that payment is made and interest credited at the end of each year.

It is much more common to come across a regular stream of future payments. Such a cashflow is known as an *annuity*. In an annuity the payments are identical and so C_n – as given in equation (B.14) – simply becomes C. We can then rearrange equation (B.14) as:

$$\text{FV} = C\sum_{n=1}^{N}(1+r)^{N-n} \tag{B.15}$$

This equation can be simplified to give us:[1]

$$\mathrm{FV} = C\left(\frac{(1+r)^N - 1}{r}\right) \tag{B.16}$$

This formula can be used to calculate the future value of an annuity. For example, if we consider an annuity that pays £500 each year for 10 years at a rate of 6%, its future value is given by:

$$\mathrm{FV} = 500\left(\frac{(1.06)^{10} - 1}{0.06}\right) = £6{,}590.40$$

The common definition of an annuity is a continuous stream of cashflows. In practice, the pension represented by an annuity is usually paid in monthly instalments, similar to an employed person's annual salary. Certain regular payments compound interest on a more frequent basis than annually, so equation (B.15) needs to be adjusted slightly. If compounding occurs m times each year, then equation (B.15) needs to be altered to equation (B.17) to allow for this:

$$\mathrm{FV} = C\sum_{n=1}^{N}\left(1 + \frac{r}{m}\right)^{m(N-n)} \tag{B.17}$$

To make calculations simpler we can multiply both sides of equation (B.17) by $(1 + (r/m))$ and subtract the result from equation (B.17). Simplifying this will then result in:

$$\mathrm{FV} = C\left(\frac{(1 + (r/m))^{mN} - 1}{(1 + (r/m))^{m} - 1}\right) \tag{B.18}$$

For example, a 10-year annuity that has annual payments of £5,000, but compounded on a quarterly basis at a rate of 5%, will have a

---

[1] If we multiply both sides of equation (B.15) by $1 + r$ and then subtract the result from equation (B.15) we obtain:

$$\begin{aligned}\mathrm{FV} - (1+r)\mathrm{FV} &= C\left(\sum_{n=1}^{N}(1+r)^{N-n} - \sum_{n=1}^{N}(1+r)^{N-n+1}\right)\\ &= -C\big((1+r)^N - 1\big)\end{aligned}$$

future value of £63,073 as:

$$\mathrm{FV} = 5{,}000\left(\frac{(1.025)^{20} - 1}{(1.025)^{2} - 1}\right) = £63{,}073$$

Where there is continuous compounding, as before the limiting factor will result in equation (B.23) becoming:

$$\mathrm{FV} = C\left(\frac{e^{rN} - 1}{e^{r} - 1}\right) \tag{B.19}$$

Equations (B.18) and (B.19) can be adjusted yet again to allow for frequent payments together with frequent compounding, but such a stream of cashflows is rarely encountered in practice. In the case of continuous compounding of continuous payments, the limiting factor expression is:

$$\mathrm{FV} = C\left(\frac{e^{rN} - 1}{r}\right) \tag{B.20}$$

Present values

Using similar principles to those employed for calculating future values, we can calculate present values for a stream of multiple cashflows. The method employed is slightly different according to whether cashflows are regular or irregular.

For irregular payments we calculate present value by applying the conventional present value formula to each separate cashflow and then summing the present values. This is represented by:

$$\mathrm{PV} = \sum_{n=1}^{N} C_n (1 + r)^{-n} \tag{B.21}$$

where C_n is the cashflow made in Year n.

Consider a series of annual cash payments made up of £100 in the first year and then increasing by £100 each year until the fifth year. The present value of this cashflow stream is:

$$\begin{aligned}
\mathrm{PV} &= 100(1.05)^{-1} + 200(1.05)^{-2} + 300(1.05)^{-3} + 400(1.05)^{-4} \\
&\quad + 500(1.05)^{-5} \\
&= 95.24 + 181.41 + 259.15 + 329.08 + 391.76 \\
&= £1{,}256.64
\end{aligned}$$

The more frequently encountered type of cashflow stream is an *annuity*, regular annual payments with annual discounting. To calculate the present value of an annuity we can use a variation of equation (B.16):

$$\begin{aligned}\mathrm{PV} &= \frac{\mathrm{FV}}{(1+r)^N}\\ &= C\left(\frac{(1+r)^N-1}{r}\right)\left(\frac{1}{(1+r)^N}\right)\\ &= C\left(\frac{1-(1+r)^{-N}}{r}\right)\end{aligned}\tag{B.22}$$

Consider now an annuity paying £5,000 each year for 20 years at an interest rate 4.5%. The present value of this annuity is:

$$\begin{aligned}\mathrm{PV} &= 5{,}000\left(\frac{1-(1.045)^{-20}}{0.045}\right)\\ &= 65{,}039{,}68\end{aligned}$$

We illustrate this principle using a 20-year annuity that employs annual discounting. If a cashflow stream employs more frequent discounting we need to adjust the formula again. If an annuity discounts its cashflows m times each year then the present value of its cashflow stream is found using the present-value-adjusted equation – that is, equation (B.18). This becomes:

$$\mathrm{PV} = \frac{\mathrm{FV}}{\left(1+\dfrac{r}{m}\right)^{mN}} = c\left(\frac{1-(1+(r/m))^{-mN}}{(1+(r/m))^m-1}\right)\tag{B.23}$$

If continuous discounting is employed then this results once again in the limiting factor for continuous discounting, so we adjust equation (B.23) and the new expression is:

$$\mathrm{PV} = C\left(\frac{1-e^{-rN}}{e^r-1}\right)\tag{B.24}$$

The last case to consider is that of the payments stream that has more frequent cashflows in addition to more frequent discounting. Such a payments stream will have m cashflows each year which are also discounted m times per year. To calculate the present value of the cashflows we use:

$$\mathrm{PV} = \frac{\mathrm{FV}}{(1+(r/m))^{mN}} = C\frac{1-(1+(r/m))^{mN}}{r}\tag{B.25}$$

The limiting factor for continuous discounting of continuous payments is:

$$\mathrm{PV} = C\left(\frac{1 - e^{-rN}}{r}\right) \tag{B.26}$$

Payment streams that have cashflow frequencies greater than annually or semi-annually occur quite often in the markets. To illustrate how we might use equation (B.25), consider a mortgage-type loan taken out at the beginning of a period. If the borrower is able to fix the interest rate being charged to the whole life of the mortgage, she can calculate the size of monthly payments required to pay off the loan at the end of the period.

For example, consider a repayment mortgage of £76,000 taken out for 25 years at a fixed rate of interest of 6.99%. The monthly repayments that would be charged can be calculated using equation (B.25) as:

$$C_i = \frac{C}{12} = \frac{\mathrm{PV}}{12}\left(\frac{r}{1 - (1 + (r/m))^{-12\times N}}\right) \tag{B.27}$$

where C_i is the size of the monthly payment. Substituting the terms of the mortgage payments into the equation we obtain:

$$C_i = \frac{76{,}000}{12}\left(\frac{0.0699}{1 - (1 + (0.0699/12))^{-12\times 25}}\right) = £536.67$$

The monthly repayment is therefore £536.67 and includes interest chargeable in addition to repayment of some of the principal (hence the term *repayment* mortgage, as opposed to *endowment* mortgage which only pays off the monthly interest charge). A repayment mortgage is also known as an *amortized* mortgage. An amortized loan is one where a proportion of the original loan capital is paid off each year. Loans that require the borrower to service the interest charge once a year are known as *straight* or *bullet* loans. It is for this reason that plain vanilla bonds are sometimes known as bullet bonds, since the capital element of a loan raised through a vanilla bond issue is repaid only on maturity.

Perpetual cashflows

The type of annuity that we as individuals are most familiar with is the *annuity pension*, purchased from a life assurance company using the proceeds of a pension fund at the time of retirement. Such an annuity pays a fixed annual cash amount for an undetermined period, usually until the death of the beneficiary. An annuity with no set finish date is known as a *perpetuity*. As the end date of a perpetuity is unknown we are not able to calculate its present value with certainty; however, a characteristic of the term $(1+r)^{-N}$ is that it approaches zero as N tends to infinity. This fact reduces our present value expression to:

$$\mathrm{PV} = \frac{C}{r} \tag{B.28}$$

We can use this formula to approximate the present value of a perpetuity.

The UK gilt market includes four gilts that have no redemption date – so-called *undated bonds*. The largest issue amongst undated gilts is the $3\frac{1}{2}\%$ war loan, a stock originally issued at the time of the 1914–1918 war. This bond pays a coupon of £$3\frac{1}{2}$ per £100 nominal of stock. Since the cashflow structure of this bond matches a perpetual, its present value – using equation (B.28) when long-dated market interest rates are at, say, 5% – would be:

$$\mathrm{PV} = \frac{3.5}{0.05} = £70$$

The present value of the cashflow stream represented by the war loan stock when market rates are 5% would therefore be £70 per £100 nominal of stock. In fact, because this bond pays coupon on a semi-annual basis we should adjust the calculation to account for the more frequent payment of coupons and discounting, so the present value (price) of the bond is more accurately described as:

$$\mathrm{PV} = \frac{C/3}{r/2} = \frac{1.75}{0.025}$$

although – as we would expect – this still gives us a price of £70 per £100 nominal!

Corporate finance project appraisal

Two common techniques used by corporates and governments to evaluate whether a project is worth undertaking are *net present value* and *internal rate of return*. Both techniques evaluate the anticipated cashflows associated with a project, using the discounting and present value methods described in this chapter. Generally speaking, it is a company's *cost of capital* that is used as the discount rate in project appraisal, and most companies attempt to ascertain the true cost of their capital as accurately as possible. As most corporate financing is usually a complex mixture of debt and equity this is sometimes problematic.

Net present value

In the case of an investment of funds made as part of a project, we would have a series of cashflows – some of which would be positive and others negative. In the early stages of a project we would typically forecast negative cashflows as a result of investment outflows, followed by positive cashflows as the project began to show a return. Each cashflow can be present-valued in the usual way. In project appraisal we would seek to find the present value of the entire stream of cashflows; the sum of all positive and negative present values added together is the *net present value* (NPV). As the appraisal process takes place before the project is undertaken, the future cashflows that we are concerned with will be estimated forecasts and may not actually be received once the project is under way.

The net present value equation is used to show that:

$$\mathrm{NPV} = \sum_{n=1}^{N} \frac{C_n}{(1+r)^n} \tag{B.29}$$

where C_n is the cashflow used for the project during period N. The rate r used to discount cashflows can be the company's cost of capital or the rate of return required by the company to make the project viable.

Companies will apply NPV analysis to expected projected returns because funds invested in any undertaking have a time-related cost – the opportunity cost that is the corporate cost of capital. In effect, NPV measures the present value of the gain achieved from investing in the project (provided that it is successful!). The general rule of thumb applied is that any project with a positive NPV is worthwhile, whereas those with a negative NPV, discounted at the required rate of return or the cost of capital, should be avoided.

Example B.1

What is the NPV of the following set of expected cashflows, discounted at a rate of 15%?

Year 0	−£23,000
Year 1	+£8,000
Year 2	+£8,000
Year 3	+£8,000
Year 4	+£11,000

$$\text{NPV} = 23{,}000 - \frac{8{,}000}{(1.15)} + \frac{8{,}000}{(1.15)^2} + \frac{8{,}000}{(1.15)^3} + \frac{11{,}000}{(1.15)^4} = £1{,}554$$

The internal rate of return

The internal rate of return (IRR) for an investment is the discount rate that equates the present value of expected cashflows (the NPV) to zero. Using the present value expression we can represent it by rate r such that:

$$\sum_{n=0}^{N} \frac{C_n}{(1+r)^n} = 0 \tag{B.30}$$

where

C_n = Cashflow for the period N;
n = Last period in which a cashflow is expected; and
$\sum$ = Sum of discounted cashflows at the end of periods 0 through n.

If the initial cashflow occurs at time 0, equation (B.30) can be expressed as:

$$C_0 = \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \cdots + \frac{C_N}{(1+r)^N} \tag{B.31}$$

In corporate finance project appraisal, C_0 is a cash outflow and C_1 to C_N are cash inflows. Thus, r is the rate that discounts the stream of future cashflows (C_1 through C_n) to equal the initial outlay at time 0. We must therefore assume that the cashflows received are subsequently reinvested to realize the same rate of return as r. Solving for the internal rate of return, r cannot be found analytically and has to be found either through numerical iteration or using a computer or programmable calculator.

To illustrate the IRR consider the project cashflows given in Example B.1. If we wish to find the IRR long hand then we would have to obtain the NPV using different discount rates until we found the rate that gave an NPV equal to zero. The quickest way to do this manually is to select two discount rates, one giving a negative NPV and the other a positive NPV, and then *interpolate* between them. This method of solving for IRR is known as an iterative process and involves converging on a solution through trial and error. This is in fact the only way to calculate the IRR for a set of cashflows; it matches exactly the iterative process that a computer uses (the computer is just a touch quicker!). If we have two discount rates – say, x and y that give positive and negative NPVs, respectively, for a set of cashflows – the IRR can be estimated using:

$$\begin{aligned}\text{IRR estimate} &= x\% + (y\% - x\%) \\ &\quad \times \left(\frac{\text{Positive NPV value}}{\text{Negative NPV value} - (-\text{NPV value})}\right)\end{aligned} \tag{B.32}$$

Example B.2

Using a discount rate of 15% produced a positive NPV in Example B.1. Discounting the cashflows at 19% produces an NPV of −£395. Therefore, the estimate for IRR is:

$$15\% + 4\% \times 1{,}554/(1{,}554 - (-395)) = 18.19\%$$

The IRR is approximately 18.19%. This can be checked using a programmable calculator or spreadsheet programme; it may also be checked manually by calculating the NPV of the original cashflows using a discount rate of 18.19% – it should come to −£23,000. We obtain an IRR of 18.14% using a calculator.

The relationship between the IRR and the NPV of an investment can be summed up as follows: while the NPV is the value of projected returns from the investment using an appropriate discount rate (usually the company's cost of capital), the IRR is the discount rate which results in the NPV being zero. For this reason it is common to hear the IRR referred to as a project's *breakeven* rate. A conventional investment is considered attractive if the IRR exceeds a company's cost of capital and the NPV is positive. In the context of bond markets, as long as the discount rate applicable does indeed remain constant for the reinvestment of all cashflows arising from a financial instrument, the IRR can then be assumed to be the *yield to maturity* for that instrument. Yield to maturity is the main measure of the rate of return achieved from holding a bond.

Interpolation and extrapolation

Interest rates in the money markets are always quoted for standard maturities: for example, overnight, 'tom next' (the overnight interest rate starting tomorrow, or 'tomorrow to the next'), spot next (the overnight rate starting 2 days forward), 1 week, 1 month, 2 months and so on up to 1 year. Figure B.1 shows a typical brokers' screen as seen on news services such as Reuters and Telerate.

If a bank or corporate customer wishes to deal for non-standard periods, an inter-bank desk will calculate the rate chargeable for such an 'odd date' by *interpolating* between two standard period interest rates. If we assume that the rate for all dates in between two periods increases at the same pace, we can calculate the required rate using the formula for *straight line* interpolation:

$$r = r_1 + (r_2 - r_1) \times \frac{n - n_1}{n_2 - n_1} \tag{B.33}$$

where

$r =$ Required odd date rate for n days;
$r_1 =$ Quoted rate for n_1 days;
$r_2 =$ Quoted rate for n_2 days.

Dow Jones Markets : martin_g Telerate 4734 Wed Dec 08 09:00:44 1999

08/12 8:54 GMT [GARBAN INTERCAPITAL-EUROPE] 12/08 02:12 4734

	FRA		GBP CDS DEPO	GBP INTERBANK DEP	GBP REPO(GC)	
1X4	6.020-990	O/N	-	5 1/16-4 15/16	-	O/N
2X5	6.110-080	T/N	-	5 3/8 -5 1/4	-	T/N
3X6	6.230-200	1WK	-	5 1/4 -5 1/8	-	1WK
4X7	6.330-300	1MO	5 25/32-5 23/32	5 7/8 -5 13/16	-	2WK
5X8	6.420-390	2MO	5 15/16-5 7/8	5 31/32-5 29/32	-	3WK
6X9	6.510-480	3MO	6-5 15/16	6-5 15/16	-	1MO
9X12	6.760-730	4MO	6 1/32-5 31/32	6 1/32-5 31/32	-	2MO
		5MO	6 1/16- 6	6 1/16- 6	-	3MO
1X7	6.240-210	6MO	6 1/8 -6 1/16	6 5/32-6 3/32	-	4MO
2X8	6.330-300	7MO	6 5/32-6 3/32	6 7/32-6 5/32	-	5MO
3X9	6.420-390	8MO	6 7/32-6 5/32	6 9/32-6 7/32	-	6MO
4X10	6.520-490	9MO	6 9/32-6 7/32	6 5/16-6 1/4	-	9MO
5X11	6.610-580	10M	6 11/32-6 9/32	6 3/8 -6 5/16	-	1YR
6X12	6.700-670	11M	6 13/32-6 11/32	6 7/16-6 3/8		
		12M	6 15/32-6 13/32	6 1/2 -6 7/16		

[FRA 695-2040, EUROSTG 695-2030, GBP REPOS 695-2255]

Figure B.1 A typical brokers' screen.

Let us imagine that the 1-month (30-day) offered interest rate is 5.25% and the 2-month (60-date) offered rate is 5.75%. If a customer wishes to borrow money for a 40-day period, what rate should the bank charge? We can calculate the required 40-day rate using straight line interpolation. The increase in interest rates from 30 to 40 days is assumed to be 10/30 of the total increase in rates from 30 to 60 days. The 40-day offered rate would therefore be:

$$5.25 + (5.75 - 5.25) \times 10/30 = 5.4167\%$$

Example B.3

An inter-bank desk is quoting the 7-day offered rate (the rate at which a bank will *offer* or lend money) at $5\frac{11}{16}\%$, while the 14-day rate is $5\frac{13}{16}\%$. What rate should he quote for the 10-day offered rate?

$$5.6875 + (5.8125 - 5.6875) \times 3/7 = 5.7411\%$$

What about the case of an interest rate for a period that lies just before or just after two known rates – but not in between them? When this happens we *extrapolate* between the two known rates, again assuming a straight line relationship between them, and for a period after (or before) the two rates.

Example B.4

The 1-month offered rate is 5.25% while the 2-month rate is 5.75% as before. What is the 64-day rate?

$$5.25 + (5.75 - 5.25) \times 34/30 = 5.8167\%$$

This page intentionally left blank

Appendix C

ABBREVIATIONS AND ACRONYMS

ABCP	Asset-Backed Commercial Paper
ABS	Asset-Backed Security
AER	Annual Equivalent Rate
ALCO	Asset–Liability COmmittee
ALM	Asset Liability Management
AMA	Advanced Measurement Approach
APR	Annualized Percentage Rate
ASW	Asset Swap Spread
BAU	Business As Usual
BBA	British Bankers Association
BCBS	Basel Committee for Banking Supervision
BIA	Basic Indicator Approach
BIS	Bank for International Settlements
CA	Capital Allocation
CD	Certificate of Deposit
CDO	Collateralized Debt Obligation
CDS	Credit Default Swap
CP	Commercial Paper
CRD	Capital Requirements Directive
DV01	Dollar Value of loss for a 1 bp rise in yields
EAD	Exposure At Default
ECAI	External Credit Assessment Institution
ECB	European Central Bank
ECP	Euro Commercial Paper
EEA	European Economic Area
EURIBOR	Euro Interbank Offered Rate
FI	Fixed Income
FRA	Forward Rate Agreement
FRN	Floating Rate Note
FSA	Financial Services Authority
FtD	First-to-Default
FX	Foreign eXchange
GC	General Collateral
GMRA	Global Master Repurchase Agreement
IAA	Internal Assessment Approach
IR	Interest Rate
IRB	Internal Ratings Based
IRR	Internal Rate of Return
ISDA	International Swaps and Derivatives Association
LAB	Liquid Asset Buffer
LG	Letter of Guarantee
LGD	Loss Given Default

LIBID	London Interbank BID Rate
LIBOR	London InterBank Offered Rate
LIFFE	London International Financial Futures Exchange
LRF	Liquidity Risk Factor
LTD	Loan To Deposit
LTV	Loan To Value
M	Maturity
MATIF	French Futures Exchange
MPC	Monetary Policy Committee
MTN	Medium-Term Note
NED	Non-Executive Director
NIBL	Non-Interest-Bearing Liability
NII	Net Interest Income
NPL	Non-Performing Loan
NPV	Net Present Value
NSFR	Net Stable Funding Ratio
OBS	Off Balance Sheet
OIS	Overnight Index Swap
OTC	Over The Counter
P&L	Profit & Loss
PD	Probability of Default
PF	Persistence Factor
PIBS	Permanent Interest-Bearing Share
PSA/ISMA	Public Securities Association/International Securities Market Association
PVBP	Present Value of a Basis Point
RBA	Ratings-Based Approach
RMBS	Residential Mortgage-Backed Security
ROA	Return On Assets
ROC	Return On Capital
ROE	Return On Equity
RPI	Retail Prices Index
SA	Standardized Approach
SBU	Strategic Business Unit
SF	Supervisory Formula
SIV	Structured Investment Vehicle *also known as* Special Investment Vehicle
SONIA	Sterling OverNight Interest rate Average
SPC	Special Purpose Corporation
SPV	Special Purpose Vehicle
TLP	Transfer Liquidity Pricing, also known as Term Liquidity Premium

TP	Transfer Price
TRS	Total Return Swap
USCP	US Commercial Paper
WACC	Weighted Average Cost of Capital

INDEX

This page intentionally left blank